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EDUCATION FOR SUSTAINABILITY: EXPLORING TEACHING
PRACTICES AND PERCEPTIONS OF LEARNING ASSOCIATED WITH A
GENERAL EDUCATION REQUIREMENT

A Dissertation Presented

by

Lisa Watts Natkin

to

The Faculty of the Graduate College

of

The University of Vermont

In Partial Fulfillment of the Requirements
For the Degree of Doctor of Philosophy
Specializing in Educational Leadership and Policy Studies

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ABSTRACT

Nationwide, higher education institutions are increasingly interested in infusing sustainability content into their curricula. The world is facing complex and interconnected problems creating a need for college graduates with an understanding of the ecological, economic, and social dimensions of sustainability. There is a shortage of research studying sustainability-related teaching practices, particularly in higher education contexts. The University of Vermont (UVM) recently established Sustainability Learning Outcomes (SLOs) as a general education requirement. As a result of this initiative, sustainability-designated courses are offered across the university that fulfill the requirement, creating a unique opportunity to explore related teaching practices. The purpose of this study was to explore how instructors structured and taught the SLOs, how students learned UVM's SLOs, and which teaching practices students found helpful to their learning, within courses designed to meet this general education requirement.

To systematically gather people's perceptions of and experiences with the new general education requirement, this study used the following methods: 1) instructor interviews; 2) course document reviews; 3) classroom observations; 4) student focus groups; and 5) an online student survey. Data were collected from eight sustainability-designated courses. The variety of data collection methods enabled identification and triangulation of strong themes. Instructors used class discussions, papers, readings, projects, guest speakers, case studies, and reflective activities to teach sustainability content and skills. Students reported the following teaching practices as particularly helpful: experiencing a real world application, discussing sustainability issues in class, exploring different perspectives, and hosting guest speakers. Moreover, certain instructional methods may be better received with students with prior exposure to sustainability content. Findings suggest that learning from case studies, guest speakers, and written papers may be more helpful to students with higher levels of prior exposure to sustainability courses. This study's findings add to what we know about how instructors teach sustainability content and students' experiences of their teaching practices. They also suggest a number of implications for policy and practice around supporting professional development opportunities in teaching practices and assessment strategies, creating a teaching culture of experimentation and reflection, and using a variety of methods to assess teaching and learning.

Keywords: Education for Sustainability, Assessment for Learning, General Education Requirements, Teaching Practices, Student Learning, Curriculum Design

DEDICATION

I dedicate my dissertation research to my son Colin Jackson Natkin. I am very concerned about how climate change is going to affect our lives and the amount of human suffering it will cause. My research was motivated by my desire to figure out how to teach and inspire young adults to take action and create change. I want you to love learning as much as I do. Identifying ways students enjoy to learn was my way of trying to cultivate curricula change that spreads a love of learning and a sense of agency.

“Unless someone like you cares a whole awful lot,
nothing is going to get better, it’s not.”

Dr. Seuss

“How could I look my grandchildren in the eye and say I knew about this-
and I did nothing?”

Sir David Attenborough

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CHAPTER ONE: INTRODUCTION

“The crisis we face is first and foremost one of mind, perception, and values: hence, it is a challenge to those institutions presuming to shape minds, perceptions, and values. It is an educational challenge. More of the same kind of education can only make things worse. This is not an argument against education but rather an argument for the kind of education that prepares people for lives and livelihoods suited to a planet with a biosphere that operates by the laws of ecology and thermodynamics.” (Orr, 2004 p.27)

Changing climate, growing population, increasing levels of poverty, decreasing access to clean water, intensifying social justice concerns, rising demand for energy, and falling levels of biodiversity are some of today’s complex problems (Johnston, 2013).

The complexity of these interconnected problems creates a need for college graduates with the ability to understand how systems interact equipped with problem solving skills.

Desha and Hargroves (2014) explain that “the imminent risk from inaction to reduce greenhouse gas emissions, curb energy demand, and adapt to extreme weather patterns and temperature fluctuations means that capacity building is urgently required across all professional disciplines and vocational programs” (p. 3). Higher Education Institutions (HEIs) have the opportunity to play a critical role in improving our future by teaching about the interconnections of economic, ecological, and social dimensions of sustainability issues (Association for the Advancement of Sustainability in Higher Education (AASHE), 2010).

Sustainability is “the pursuit of ecological, social, and economic vitality with the understanding that the needs of the present be met without compromising the ability of future generations to meet their own needs” (Hill & Wang, 2014, p. 4). Education for Sustainability (EfS) is a framework for teaching sustainability that can offer guidance to HEIs’ instructors (Cirillo & Hoyer, 2015). EfS is an approach to teaching that aims to motivate and transform students to learn by linking knowledge, inquiry, and action

through innovative pedagogy, such as inquiry-based, project-based, place-based, and service-learning, where students learn to think critically, work collaboratively, and take action towards a sustainable future (Cirillo & Hoyer; Nolan, 2016). EfS involves teaching practices that stimulate transformative learning going beyond foundational knowledge to cultivate values and dispositions in students who will support global justice valuing other people's right to meet their basic needs (Chalkley, 2006; Sterling, 2004b; Sterling, 2009).

Nationwide, HEIs are undertaking important efforts to incorporate sustainability content into their curricula. Emerging initiatives are calling upon HEIs to do this, such as the United Nations asking universities to revise their curriculum to include a clear focus for cultivating sustainability knowledge, skills, and values among students (Tilbury, 2011; Wals, 2014). Additionally, over 700 schools have signed the American College and University President's Climate Commitment (ACUPCC) indicating that they will make sustainability a part of their curricula for all students (AASHE, 2010; Hattan, 2009). HEIs have adopted a variety of strategies for introducing students to sustainability content. Many HEIs have added sustainability content to orientation programs, assigned a campus wide summer reading, used aspects of the universities' operations and buildings as teaching tools, created distinct sustainability majors or minor, and increased sustainability course offerings (Hatton, 2009; Rowe, 2002). The drawback to these strategies is they do not reach all students.

Creating general education programs is a comprehensive way to teach all students (Maki, Schneider, & Association of American Colleges and Universities, 2015). HEIs are increasingly interested in establishing sustainability general education programs, which require students take a stand-alone sustainability course or embedding

related content into a variety of existing courses (Hattan, 2009). The ACUPCC recommends incorporating sustainability in all disciplines, rather than isolated courses, with the ultimate goal of full integration throughout curriculum (Hattan, 2009). Many HEIs are committed to comprehensively embedding sustainability into their curricula but are doing so with limited ability to make recommendations to instructors about how to teach related content and skills. Overall, there is a shortage of research on how to best structure and teach sustainability into the higher education curricula (Holdsworth, Thomas, & Hegarty, 2013; Rowe & Johnston, 2013).

In April 2015, UVM passed four learning outcomes as an undergraduate sustainability general education requirement. Faculty interested in teaching a course that fulfills the requirement must apply for designation. In the application, they must explain how they will teach Sustainability Learning Outcomes (SLOs) to students and assess for learning. This new requirement creates a unique opportunity to explore instructors' teaching practices and students' learning experiences in a variety of disciplines. Simply increasing the number of sustainability courses is not necessarily going to lead to the desired student learning and skill development. The purpose of this study was to explore how instructors structured and taught the SLOs, how students learned UVM's SLOs, and which teaching practices students found helpful to their learning, within courses designed to meet this general education requirement.

Drawing on the experience of one HEI, UVM, this study aims to shed light on these questions:

- (1) In what ways did instructors structure and teach the Sustainability Learning Outcomes (SLOs) in their SU designated courses?

- (2) In what ways did instructors assess whether students are learning the SLOs?
- (3) To what extent did students perceive they learned the SLOs in sustainability-designated courses?
- (4) To what extent did students perceive their instructors' teaching practices influenced their learning?

This study of UVM's sustainability general education requirement holds potential for contributing to two distinct bodies of literature: (a) how instructors incorporate sustainability learning outcomes into their curricula; and (b) students' perception of helpful teaching practices for learning about sustainability. Exploring instructors' teaching and students' learning experiences within one university's sustainability general education courses will highlight considerations for other HEIs designing and implementing their own sustainability general education programs.

The remainder of this chapter is organized as follows: (1) describes the definition sustainability, (2) offers an overview of sustainability education happening at HEIs, (3) provides a description of sustainability education initiatives happening at UVM, including a faculty professional development program and the general education requirement, (4) gives an overview of this research study, including its purpose, questions and approach, and (5) concludes with a summary outlining potential contributions.

Sustainability Definition

Sustainability is an ambiguous and complex concept that can be used in a variety of ways in different contexts. The UVM Faculty Senate defines sustainability "as the pursuit of ecological, social, and economic vitality with the understanding that the needs of the present be met without compromising the ability of future generations to meet their

own needs” (Hill & Wang, 2014 p. 4). Critical to this definition is valuing future generations’ ability to meet their needs. To learn about sustainability issues one must understand how environmental, economic, and social systems interact, influence and depend on one another. The ecological systems provide the resources for the economic and social systems. Equity issues arise when resources are not evenly distributed, leaving some with more than their fair share of resources and others unable to meet their basic needs (Nolet, 2016; Raworth, 2012). Conflicting values and social justice issues are at the heart of sustainability, therefore teaching approaches involve transforming of values and worldviews aiming to cultivate a sense of global citizenship among students (Nolet, 2016).

HEIs Sustainability Initiatives Overview

HEI representatives have participated in many international sustainability initiatives. Starting in 1978 with the United Nations UNESCO_UNEP International Environmental Education Programme, followed by the Talloires Declaration of 1990, to the 1992 Rio Declaration, to the COPERNICUS Chapter in 2002 (Nolan, 2012; Raworth, 2012; Wals, 2014; Wright, 2004). More recently, the UN held a Conference on Sustainable Development known as Rio +20 (2012) and the High-Level Summit on the Millennium Development Goals (2013) (Raworth, 2012; Wals & Dillon, 2013). These initiatives discussed a wide range of sustainability issues (poverty, health, consumption rates, gender inequality, etc.), mentioning education as an important vehicle for change; however, they were not directly focused on education. These declarations conveyed a moral responsibility among HEIs to contribute to solving sustainability issues, fostering sustainable operations practices, and establishing interdisciplinary sustainability

curriculum (Wright, 2004). As a result, HEIs are increasingly interested in adopting reforms that further sustainability education.

Many staff and administrators at HEIs have successfully implemented changes to facility operations towards sustainability, but faculty members have been slow to make necessary curricula changes (Desha & Hargroves, 2014; Holdsworth et al., 2013; Kaza, Natkin, & Rowse, 2015). In 2005, the United Nations, declared the Decade of Education for Sustainable Development, recommending that universities revise curriculum to include a clear focus of cultivating sustainability knowledge, skills, and values among students and to conduct curriculum and learning research around sustainability issues (Lotz-Sisitka, Fien, & Ketholiew, 2013; Tilbury, 2011; Wals, 2014). However, an analysis of the types of articles appearing in the *International Journal of Sustainability in Higher Education* shows a focus on reducing university footprints and environmental management, with articles on pedagogy, learning, and instruction appearing only recently (Wals, 2014). Despite interest in these international sustainability education initiatives, the extent to which reforms have been implemented and research conducted has been insufficient with respect to curricula change (Raworth, 2012).

The Association for the Advancement of Sustainability in Higher Education (AASHE) administers a self-reporting rating system called STARS (Sustainability Tracking Assessment Rating System). Institutions participating in the STARS rating system earn points in the following four categories: Academics, Engagement, Operations, and Planning and Administration. Within the Academics category there are points earned for institutions that assess students' knowledge about sustainability. The points earned do not reflect how much students know; rather points are earned for assessing 90% of their

students and re-assessing that same cohort of students at another point. Of the 161 schools that submitted data, the average points earned for this credit was 0.6 out of 4 possible points (AASHE, n.d.). This indicates a lack of sustainability knowledge assessment efforts happening on higher education campuses; hopefully this is changing.

Rowe (2002) summarizes different ways for trying to foster sustainability education at higher education institutions, creating sustainability majors or minors, infusing concepts across all disciplines in many different courses, developing interdepartmental minors, using aspects of the universities' latent curriculum (using buildings as teaching tools, etc.), incorporating sustainability into the mission statement of the institution, and establishing a general education requirement. Some HEIs have been able to include a dedication to sustainability into their mission statement, which is a powerful way to give administrators leverage to create change on campus. A few HEIs have ensured all students learn about sustainability by making sustainability the theme for the entire required general education program (Hattan, 2009). For example, Green Mountain College created four-core sustainability courses taught to all students by instructors from across the college. Unity College created five interdisciplinary core courses focused on Eco literacy and require a capstone environmental stewardship project to be completed by all enrolled students. All students at Sterling College take a core 11 sustainability core courses in order to graduate.

Rowe (2002) recommends establishing a general education program that encourages a variety of courses to teach sustainability because this is a quick and effective way to infuse sustainability throughout all curricula. General education programs were created to prepare all students to become educated citizens and workers

with the ability to think critically, problem solve, learn collaboratively, use evidence based reasoning, and have a sense of social responsibility communication skills and ethical and social responsibility to navigate a complex world (Gaston, 2015; Maki, 2015). There is a natural affinity between general education programs and EfS, particularly given the interdisciplinary nature of sustainability issues.

To determine how many institutions have sustainability general education requirements I consulted AASHE's STARS database (described above), emailed the green schools' listserv and the Association for Environmental Studies and Sciences listserv. I reviewed all submissions for STARS AC-2: Learning Outcomes credit, which institutions earn credit based on the percentage of students who graduate from a program that includes sustainability as a learning outcome. I asked members of the two listservs to share any information about colleges and universities that have a sustainability general education. There are 18 institutions with explicit sustainability general education requirements, which fall into two categories: 1) small private institutions (less than 3,000 students), and 2) large public institutions (more than 10, 000 students). UVM joins the short nationwide list of larger public universities with an explicit sustainability general education requirement. (See Appendix A for a complete list of HEIs, including a website with information about their general education programs.)

There are a few different approaches to sustainability general education programs such as creating sustainability components of general education learning outcomes, requiring a distinct course, or embedding it through a variety of different required courses (Hattan, 2009; Rowe, 2002). Oakland Community College has added components of sustainability to their general education learning outcomes, such as critical thinking,

global understanding and social responsibility. Babson College, Ball State University, Bucknell University, and California State University Monterey Bay have instituted explicitly stated sustainability learning goals. The College of Menominee Nation, Florida Gulf Coast University, and University of Colorado Springs require all of their students to take a specific sustainability course. St. Lawrence University, Central College, Oberlin College, Portland State University, University of Wisconsin Green Bay and Stevens Point, and UVM have an embedded course model for their sustainability general education program.

Given the potential of sustainability general education programs, not much is known about how instructors are teaching sustainability learning outcomes and how students perceive they are learning within general education courses; this study responds to this need by exploring UVM's general education requirement (Holdsworth et al., 2013). The following sections provide background information on sustainability initiatives at UVM, including a description of the new sustainability undergraduate general education requirement and a faculty professional development program.

Sustainability Education at UVM

UVM is known for its academic programs in environmental studies. In 1972, UVM established one of the nation's first Environmental Studies Programs. In more recent years, UVM established an Office of Sustainability (2007), signed the American College and University President's Climate Commitment (2007), committed to climate neutrality by 2025 (2010), and created a LEED Silver Building Policy (2011). Recently, UVM submitted to AASHE's Sustainability Tracking, Assessment & Rating System™ (STARS) and earned a gold rating. Sustainability initiatives happening at UVM have

largely focused on facilities and operations. The recently passed sustainability general education requirement has and will continue to create changes to UVM's curricula. This study uses UVM as a context for exploring how instructors teach sustainability content within general education courses. UVM's general education requirement was established after six years of a sustainability focused faculty professional development program, which is critical to the success of integrating "sustainability-across-the-curriculum" (Barlett & Chase, 2012).

Sustainability faculty fellows (SFF). The SFF program was designed to cultivate a sustainability-focused faculty learning community where participants become part of a network committed to learning how to incorporate sustainability concepts into their curriculum and teaching. Cox (1999) defines a faculty learning community as "a cross-disciplinary group of ten or so teachers who engage in an extended (typically yearlong) planned program to enhance teaching and learning, and which incorporates frequent activities to facilitate learning, development, and community building" (p. 40). Faculty learning communities can support the integration of sustainability content into courses by helping overcome common challenges, such as not enough planning time or time to covering additional content, feeling uncertain about sustainability issues, and insufficient resources, through building instructor capacity to teach sustainability within a network of peers (Barlett & Rappaport, 2009; Jones, Trier, & Richard, 2008; Natkin & Kolbe, 2016).

In 2009, UVM established its SFF program after two key campus leaders attended a Chase and Barlett workshop on developing sustainability-focused FLCs (Barlett & Chase, 2012). The SFF program was established with three goals in mind: (1) creating a community of faculty who are committed to integrating interdisciplinary approaches to

sustainability in UVM's curricula; (2) enhancing the understanding of sustainability concepts among faculty and students, particularly those not trained in environmental fields; and (3) exploring teaching and course design strategies that will engage students in sustainability, from a multidisciplinary perspective (Kaza, et al., 2015; Natkin & Kolbe, 2016). The program operates as a partnership among four UVM organizations – the Environmental Program, the Center for Teaching and Learning, the Office of Sustainability, and the GreenHouse Residential Learning Community – and a community partnership with Shelburne Farms, a local nonprofit organization whose mission is to educate for a sustainable future. Representatives from each organization and a member of the Sustainability Curriculum Review Committee comprise the SFF program's coordinating committee.

Over the course of an academic year, SFF participants engage in multiple activities intended to expand their understanding of sustainability concepts and increase their capacity to effectively integrate sustainability content in their teaching. Program participants represent a broad range of disciplines that adds richness to the discussions and reflects the interdisciplinary nature of sustainability issues. The two-day institute is the program's cornerstone. During the institute, participants engage in a mix of dialogue, reflection, writing, and critical thinking that helps them explore sustainability concepts and teaching practices. On the institute's first day, SFF participants explore five major topics: (1) place, as a learning framework; (2) outdoor exploration, looking for signs of systems and patterns; (3) definitions of sustainability; (4) systems thinking; and (5) issues of diversity and privilege. A key activity during the institute's first day is the "sustainability buffet" where participants view images, policy statements, and quotes

reflecting different sustainability definitions and subsequently discusses the complexities in defining sustainability. The institute's second day introduces participants to UVM's sustainability initiatives, and UVM's Center for Teaching and Learning discusses course design and teaching strategies.

After attending the institute, program participants are expected to design or enhance a course to integrate sustainability concepts. In addition to the institute, participants attend four faculty luncheons, each with a different theme. Participants also have access to an online repository of professional materials to support their work and receive a \$400 professional development stipend after completing the two-day institute. Each year the program accepts 15-20 individuals, and by 2016, 118 individuals representing 38 departments have completed the SFF program. SFF program alumni were critical supporters in the turbulent process of gaining the Faculty Senate's approval for sustainability to become a general education requirement (Kaza et al., 2015).

UVM's sustainability general education requirement. In Fall 2010, UVM established a learning outcomes approach to its general education requirements, creating a variety of pathways (course, curriculum and co-curricular) to meet requirements. Learning outcomes are what learners can do as a result of learning, they can be observed, demonstrated, or measured (Nusche, 2008). In March 2010, UVM's Student Government Association (SGA) submitted a resolution supporting the creation of a university-wide sustainability curricular requirement for all undergraduate students. A majority of students indicated their support of this resolution in a student survey. In response to UVM's SGA's resolution, an ad-hoc Sustainability General Education Committee was formed in Fall 2012 with the responsibility of creating sustainability learning outcomes.

In April 2014 the Faculty Senate approved the four learning outcomes created by the ad-hoc committee and established the Sustainability Curriculum Review Committee (SCRC) charged with designing and implementing the sustainability designation application process. Table 1.1 outlines the events that led to the creation of UVM's Sustainability General Education requirement.

Table 1.1

Timeline of Events Creating the Sustainability General Education Requirement

Time	Event
Fall 2010	UVM established a learning outcomes approach to general education, creating a variety of pathways (course, curriculum, and co-curricular)
March 2010	UVM's Student Government Association (SGA) submitted a resolution supporting the creation of a university-wide sustainability curricular requirement for all students
Fall 2012	Faculty Senate established an ad-hoc Sustainability General Education Committee charged with creating sustainability learning outcomes
April 2014	Faculty Senate approved four sustainability learning outcomes created by ad-hoc committee and established the Sustainability Curriculum Review Committee (SCRC) charged with designing and implementing the sustainability designation application process
March 2015	Faculty Senate approved Sustainability Learning Outcomes to become a general education requirement for all undergraduate students starting in Fall 2015.
May 2015	Board of Trustees approved the sustainability general education requirement for all incoming students starting in the Fall 2015 semester

In March 2015, UVM's Faculty Senate approved SLOs as a general education requirement for all undergraduate students. UVM's Faculty Senate defines sustainability "as the pursuit of ecological, social, and economic vitality with the understanding that the needs of the present be met without compromising the ability of future generations to meet their own needs" (Hill & Wang, 2014 p. 4). The sustainability learning outcomes are:

- **Learning outcome 1:** Students can have an informed conversation about the multiple dimensions and complexity of sustainability. (knowledge category)
- **Learning outcome 2:** Students can evaluate sustainability using an evidence-based disciplinary approach and integrate economic, ecological, and social perspectives. (skills category)
- **Learning outcome 3:** Students think critically about sustainability across a diversity of cultural values and across multiple scales of relevance from local to global. (values category)
- **Learning outcome 4:** Students, as members of society, can recognize and assess how sustainability impacts their lives and how their actions impact sustainability. (personal domain) (Hill & Wang, 2014, pp. 4-5).

All undergraduate students matriculating into UVM beginning in Fall 2015 must satisfy the sustainability requirement in order to graduate (Kaza et al., 2015). Students may satisfy this requirement through a designated major, course, or co-curriculum program. The co-curricular program is still being developed. Now that the general education requirement is established, the next step is exploring how instructors are teaching and assessing the SLOs, how students are learning the SLOs, and how students are experiencing those teaching practices. Study findings may help other HEIs who are considering establishing sustainability general education programs. The following section provides an overview of this research study.

Research Overview

Research questions and purpose. The purpose of this study was to explore how instructors structured and taught the SLOs, how students learned UVM's SLOs, and which teaching practices students found helpful to their learning, within courses designed to meet this general education requirement.

Specifically, this study addresses the following research questions:

1. In what ways did instructors structure and teach the SLOs in their SU designated courses?
2. In what ways did instructors assess whether students are learning the SLOs?
3. To what extent did students perceive they are learned the SLOs in sustainability-designated courses?
4. To what extent did students perceive their instructors' teaching practices influenced their learning?

Research approach and methods. Based on the broad nature of the research questions, this study relied on both qualitative (interviews, document review, and focus groups) and quantitative (survey) methods. This study was framed by a constructivist philosophical approach: assuming that the reality is socially constructed by people interpreting and making meaning of their experiences (Glesne, 2011). The most appropriate methods to answer the research questions were selected. I used qualitative methods to talk with people about their perceptions and experiences to understand the process of teaching and learning. I used quantitative methods to expand on my findings with descriptive data from 178 students about their experience learning in sustainability-

designated courses (Bloomberg & Volpe, 2012; Greene, Caracelli, & Graham, 1989). Eight instructors teaching a sustainability course during the Spring 2016 semester participated in this study. Study participation involved being interviewed, sharing course documentation, completing an assessment matrix, and having their classroom observed. Students enrolled in the participating courses were invited to take an online survey and participate in a focus group about their learning experience.

Summary

Simply increasing the number of sustainability courses is not necessarily going to lead to the desired student learning and skill development; teaching practices need to be effective. HEIs are increasingly adopting sustainability curricula and requirements, but are doing so with limited ability to make recommendations to instructors about how to effectively teach sustainability content. Overall, there is a shortage of research that looks at which teaching practices are happening in the classrooms and the extent to which students are learning, particularly in higher education contexts (Christie, Miller, Cook, & White, 2013; Holdsworth et al., 2013; Lundholm, Hopwood, & Richkinson, 2013; Rowe, 2002). This study responds to the need to that need. UVM's recently approved sustainability general education requirement served as a unique opportunity to explore one university's effort to investigate sustainability-related teaching practices and student learning. This study has the potential to make the following two important contributions: (1) how instructors incorporate sustainability learning outcomes into their curricula; and (2) students' perceptions of helpful teaching practices for learning about sustainability.

The remainder of this dissertation is organized into the following chapters: (2) a review of literature on student learning theories related to sustainability, effective

instructional practices for delivering sustainability content in higher education, common assessment strategies in higher education and a description of the conceptual and theoretical framework guiding this study; (3) a description of the research design and methodology; (4) a scholarly article communicating findings about teaching practices and their helpfulness to student learning; and (5) a conclusion discussing the study's implications and significance.

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

This study gathered data about instructors' teaching practices and students' learning experiences within a sample of UVM's sustainability-designated (SU) courses. In this chapter, I explore three main areas of research: student-learning theories related to sustainability, Education for Sustainability (EfS) teaching practices, and types of assessment strategies. This research study holds potential for contributing to what we know about how instructors teach sustainability content and which teaching practices students find helpful.

When reviewing this literature summary, it is important to understand that EfS is not a subject to be taught; rather it is a way of thinking to be developed (Leal Filho, 2009). It is "not primarily teaching *about* sustainability but teaching *towards* sustainability" (Jenson, 2013, p. 25). Nolet (2016) explains EfS's aim as changing students' worldviews, defining a sustainability worldview as a "way of seeing and engaging with the world through the lens of sustainability"; it prompts us to consider the impacts of our decisions and behaviors on others now and in the future (p. 10). Students need to gain knowledge but also learn how to ask critical questions, think systematically, and clarify personal values (Tilbury, 2011).

Capra (2005) describes the importance of interpreting life through a systems framework; understanding the processes, interdependence, relationships, connectedness, and patterns of nature with the knowledge that infinite growth does not exist. This literature review will present some important sustainability concepts; however, the goal of EfS is not understanding content, rather it is developing skills and values that will

enable students to address the complexity of sustainability issues and creatively solve problems.

Learning Sustainability

Knowledge of student development theories can help inform higher education pedagogies (Myers & Beringer, 2010). This section will review the Perry's Scheme of Intellectual and Ethical Development, which is a common learning theory model for undergraduate students because it explains how students can shift from seeing the world with clear rights and wrongs to understanding the complexities associated with knowledge. The second learning theory is sense-making, which explains how students' previous experiences influence learning new information. The final learning theory presented is transformational learning, which is related to threshold concepts (critical ideas that leads to deeper learning). The goal of EfS is supporting students through a transformation of their worldview.

Perry's Scheme of Intellectual and Ethical Development. Perry characterized nine psychological positions. Most students arrive at college expecting the instructors to be the holders of knowledge, giving them the facts and the answers to questions. From a cognitive development perspective, most students enter college believing in a right and wrong, which Perry characterizes as dualism; dualism is position two of the Perry's model (Nelson, 2010). Instructors are challenged to support students' transition to the next developmental position, multiplicity. Multiplicity occurs when students acknowledge that there is lots of uncertainty and complexity in the world, recognizing that there may not be a "right" answer. As students begin to understand the uncertainty of knowledge their sense of self may shift. This theory is applicable to learning about

sustainability because if students transition from dualism to multiplicity, they are cognitively able to understand complexity, consider different perspectives, and contemplate how differing values complicate global issues. This study's student survey asked questions related to Perry's dualism position to explore the relationship between dualistic thinking and sustainability learning.

Sense making. Sense-making is how a person constructs and interprets new information. Everyone interprets the world through their unique lens, which is cultivated by their cumulative experiences, emotions, values, and beliefs (Spillane, 2004). Students experience curriculum in different ways; constructing their own meaning, being influenced by their values, previous experiences, and perception of relevance to their own lives (Lundholm et al., 2013). Students who are familiar with sustainability concepts may have an easier time grasping related content and students with less familiarity will need more support and time to accommodate new information (Wals & Dillon, 2013). It is easier to maintain your current opinions and beliefs, usually it takes a significant event to question deeply held assumptions, which is necessary for sustainability education (Cranton, 2006). The student survey asked how many sustainability courses they had previously taken and to rate their familiarity with sustainability prior to this semester, as a way to measure prior knowledge.

Threshold concepts. Threshold concepts are critical ideas that lead to a deeper understanding; these concepts are transformative, irreversible, troublesome, and integrative (Meyer & Land, 2005). Once a threshold concept is understood it alters a students' worldview, influences how they think, and challenges their existing assumptions about the world (Sandri, 2013). Threshold concepts are hard to teach, as they

are difficult to comprehend, but have the potential to have a transformative influence on students' perspectives, values, and attitudes. Students begin to see connections between things they did not see before and these relationships cannot be unlearned (Nolet, 2016). The effects of understanding a threshold concept is similar to opening up a new way of thinking, which is a critical aspect of EfS (Meyer & Land, 2005). As a number of sustainability big ideas (presented below) are threshold concepts, they provide a useful framework for understanding the learning processes associated with EfS (Nolet, 2016; Sandri, 2013).

Transformative learning. Sterling (2004a) argues that sustainability education needs to be transformative to be successful. Transformative learning is focused on “the notion of recreating underlying thoughts and assumptions about the systems, structures, and societies that we are part of” (Moore, 2005, p. 86). Transformative learning is not about learning content; it is about developing skills to think systematically and critically, promoting reflection, and taking other perspectives into consideration (Rowe & Johnston, 2013; Sterling, 2009). Given the complexity of societal values associated with sustainability issues, it is important for students to have the ability to work with others who may have a different values systems and be able to cope with uncertainty (Myers & Beringer, 2010; Nolet, 2016; Sterling, 2009). To facilitate transformative learning, it is helpful for students to be encouraged to critically reflect on their assumptions, be open to other viewpoints and engage in discourse (Mezirow, 1997).

Sustainability Content

There are many important key concepts for students to understand when they are cultivating a sustainability worldview, such as the underlying principles that govern

complex systems. A system is an interconnected network of elements with a shared organization and purpose (Meadows & Wright, 2008). Examples of principles that govern complex systems include: nestedness, positive and negative feedback loops, limits to growth, second law of thermodynamics (entropy), emergent properties, closed vs. open systems, difference between linear and complex systems, cycles, flows, interdependence, and the laws of self-regulation and self-organization in complex systems (Capra, 2005; Meadows & Wright, 2008; Nolet, 2016; Wessels, 2006). It is also important for students to learn basic ecological principles such as: importance of diversity for healthy ecosystems, self-organization (coevolution and specialization), carrying capacity, and dynamic equilibrium (Capra, 2005; Nolet, 2016; Wessels, 2006). Nolet (2016) presents the science of climate change, greenhouse effect, and equity and justice issues as important sustainability concepts.

The Sustainability Schools Project of Shelburne Farms' framework for Education for Sustainability highlights three necessary elements of cultivating a sustainability worldview: 1) understanding that the world is interconnected, 2) knowledge of human and natural communities, and 3) realizing that students have agency or an ability to make a difference (Cirillo & Hoyer, 2015). Big ideas are overarching concepts that are important to understanding the core of a discipline (Wiggins & McTighe, 2005). As identified by the Sustainability Schools Project, the big ideas of sustainability are:

- Community: a group of living and non-living things sharing a common purpose or space
- Systems: parts are connected through larger patterns
- Diversity: all systems and places function because of variety

- Interdependence: all living things are connected and depend on each other
- Cycles: every organism and every system goes through different stages
- Limits: every system has a carrying capacity
- Change over time: all organisms, places, and systems are constantly changing
- Fairness/equity: resources are shared to meet the needs of living things- across places and generations
- Place: natural and human communities together make up one's place
- Ability to make a difference: everyone has the ability to change or impact a system, community and themselves
- Long-term effects: actions have effects beyond immediate reactions
- Equilibrium: a state of balance

However, as mentioned earlier, EfS is more than teaching content knowledge; the literature about EFS concentrates on how students should be able to think and what they should be able to do compared to outlining specific curricular topics. Wiek, Farioli, Fukushi, and Yarime, (2012) analyzed 43 articles in an effort to synthesize previous literature on sustainability competencies. They describe five key areas of competences:

1. Systems-thinking competence (ability to analyze complex systems on multiple scales)
2. Anticipatory competence (ability to think in a forward-looking manner and make predictions)
3. Normative competence (ability to navigate a variety of differing values and goals associated with sustainability issues and considering issues of equity)
4. Strategic competence (ability to work towards accomplishing actions)

5. Interpersonal competence (ability to collaborate, communicate with and motivate others through leadership skills) (Nolet, 2016; Svanström, Lozano-Garcia, & Rowe, 2008; Wals, 2014)

Nolet (2016) identified many of the same competencies but added adaptive expertise (being able to be flexible and creative when problem solving), thinking critically, making decisions using knowledge and judgment, and having strong character (tenacious values and disposition). Other researchers added perspective taking (Svanström et al., 2008), being reflective and self-reliant (Barth, Godemann, Rieckmann, & Stoltenberg, 2007), being empathetic (Wals, 2014), and cultivating effective change agent skills (Rowe, 2002). The following section discusses the instructional practices that support the cultivation of these dispositions and skills.

Sustainability Instructional Practices

Curriculum is the planned content, activities, and assessment strategies to facilitate student-learning experiences; it is “what” that happens in the classroom and instructional practices are “how” the content is taught. In alignment with the constructivists approach to this research project, EfS advocates recommend constructivist approaches to learning, which fosters learning environments where teachers facilitate opportunities for students to construct knowledge (Holdsworth et al., 2013). This section will review commonly recommended instructional practices for EfS, many of them overlap and can be used together. Using the pedagogies for teaching for sustainability outlined in Nolet’s (2016) book entitled *Educating for Sustainability Principles and Practices for Teachers* and my review of literature, I identified four types of teaching practices that have been used to deliver sustainability content. They are: 1) experiential,

2) inquiry-based, 3) collaborative, and 4) reflective learning. Each practice is described below.

Experiential learning. Experiential learning is engaging learners in direct experiences to build knowledge and skills (Nolet, 2016). Experiential learning methods teach students course material with real life applications through case studies, connecting material to their lives, and encouraging students to creatively problem solve through applied learning (Christie et al., 2013; Cirillo & Hoyler, 2015; Holdsworth et al., 2013; Nolet, 2016; Shriberg, 2004; Sterling, 2004a; Svanström et al., 2008; Wals & Dillon, 2013; Wiek et al., 2012; Woolson, 2015). Place-based education (using local place as a way to connect material to student lives to enhance stewardship) and service learning projects (linking service experiences with curriculum by asking students to address real world issues while fostering relationships with communities) are examples of experiential learning techniques (Christie et al., 2013; Cirillo & Hoyler, 2015; Nolet, 2016; Shepard, 2008; Shriberg, 2004; Wals, 2014; Woolson, 2015).

Most of the different characterizations of experiential learning approaches involve engaging students with the local area or a local partner as a way of learning about sustainability issues. Instructor may take students on a field trip, watch a film, see an art exhibit, or bring in a guest speaker. Student might engage in a role play activity where they have to take a position on an issue. Case studies are highly recommended classroom activities to help create an active learning environment with real life application (Christie et al., 2013; Holdsworth et al., 2013; Mezirow, 1997; Paolini, 2014; Shepard, 2008; Sterling, 2004b; Svanström et al., 2008; Wals & Dillon, 2013; Woolson, 2015). An example of using a case study approach is a geography class looking at the non-

sustainable practices of ancient civilizations – such as Maya, Akkadians, and Anasazi – to explore patterns of behavior leading to their collapse with real world examples (Galgano & Rosier, 2013). Another example of using an experiential learning technique (place based) is a class touring college campus buildings learning about sustainability operations practices.

Inquiry based learning. Inquiry-based learning occurs when instructors facilitates learners as they take responsibility for investigating open-ended questions in a way that is meaningful to them (Nolet, 2016). Two approaches to inquiry-based learning are project based learning and posing essential questions to students. Project based learning is engaging students with a problem, complex question, or challenge for an extended period of time to build skills and is an example of an inquiry based learning technique. Students could explore how storm water runoff creates an issue in their community, culminating in a report presented to city planners (Nolet, 2016).

Facilitating class discussions, and asking critical or essential questions are also practices of inquiry based learning (Cirillo & Hoyler, 2015; Nolet, 2016; Paolini, 2015; Shepard, 2008; Wals & Dillon, 2013; Woolson, 2015). Essential questions “serve not only to promote understanding of the content of a unit on a particular topic; they also spark connections and promote transfer of ideas from one setting to others” (Wiggins & McTighe, 2005, p. 107). Asking essential questions is well aligned with backwards design, which has three stages: 1) identify desired results, 2) determine acceptable evidence, and 3) plan learning experiences and instruction (Wiggins & McTighe, 2005). The backwards design process builds unit topics around big ideas, essential questions, and enduring understandings. An example of an essential question a geography class

might explore: Why do certain populations in certain location experience greater suffering from sustainability issues compared to other populations and locations? These students contemplated the relationship between landscapes characteristics and human culture (Galgano & Rosier, 2013).

Collaborative learning. Collaborative learning is when learners work together to accomplish learning goals (Nolet, 2016). This can happen in many different types of class activities such as discussions, group projects, papers, presentations, or peer review of each other's work. Collaborative learning compliments many of the learning approaches previously discussed. Participating in collaborative learning activities challenges students to articulate their understanding to their peers (Simon, 2002). Collaborative learning experiences can range from a brief experience (class discussion) to several weeks and focus on developing social skills as well as academic knowledge (Nolet, 2016). Small group learning is a highly recommended method (Cirillo & Hoyler, 2015; Nolet, 2016; Paolini, 2015; Sterling, 2004a; Woolson, 2015). For instance, instructors may assign students to comment on other's posts or assignment (on an online platform) to encourage discussion, critical analysis, and peer review or pose an open-ended question asking students to discuss in small groups or students could discuss a course reading (Morfe, 2013; Simon, 2002).

Reflective learning. Reflective learning is allowing students to analyze and give serious thought to how their learning experience, new knowledge, and skill development relate to their lives and identity (Nolet, 2016). In reflective learning, it is the "guided reflection of the meaning of the activity, not the activity itself that causes the learning" (Wiggins & McTighe, 2005, p. 243). Nolet (2016) recommends teaching practices that

support students reflecting about their own way of looking at the world and their societies' values; asking them to question their assumptions, beliefs, and values. Learning about values is an important part of EfS (Shepard, 2008). Having students write reflection papers can be a useful method to learn about their values (Zulauf, 2007). Exemplar reflective activities include students writing a reflective analysis of their course reading with the intention of enhancing their critical thinking skills or writing a weekly journal focusing on their connection to nature using past experiences, recent encounters, or class activities (Morfei, 2013).

In addition to teaching practices it is helpful to know how to scaffold activities; building off basic material to more advanced issues over several class sessions (Nolet, 2016; Paolini, 2015). Overall effective instructional practices include giving clear explanations, highlighting core ideas, using a variety of teaching techniques, respectful of different culture, being passionate, leading class discussions that build collective knowledge, and identifying patterns of student understanding and then designing practice to support a deep understanding among students (Nolet, 2016). It is also important for instructors to be reflective learners themselves, aware of how their worldview influences their sustainability teaching practices and constantly considering how students seem to be learning the course material making necessary curricula adjustments (Woolson, 2015).

Assessment Strategies

Assessment is the gathering of data on student learning with the intent to improve teaching practices and student learning (Walvoord, 2010). Assessment should not be confused with accountability, which is using data to demonstrate an institution's ability to meet their objectives for external audiences (Maki et al., 2015; Walvoord, 2010). Many

accrediting bodies are mandating that HEIs assess student learning, which is bringing attention to effective assessment strategies (Walvoord, 2010). Assessment does not necessarily mean large scale standardized tests; it is any effort to measure student learning and can happen at the institutional, program, and classroom levels; this study is assessing student learning at the classroom level (Tam, 2014). This section will review common assessment strategies at the institutional and classroom level as they relate to this study.

Institutional level assessment. HEIs are increasingly experiencing pressure to account for how effectively they teach students (Nusche, 2008). Many different stakeholders (parents, potential students, policymakers, taxpayers, and employers) have vested interests in having information about how effectively HEIs are preparing students to contribute to community, especially since tuition costs and internal operational costs are rising (Nusche, 2008). Assessment needs to focus on what students are actually learning, not what institutions plan to teach (Nusche, 2008). Tam (2014) describes how HEIs are shifting their approach to assessment from focusing on teaching behavior to focusing on students' skills and learning.

Measuring effective teaching is challenging because measuring learning is hard. "An effective teacher is skillful at creating conditions conducive to learning" (Stark & Freishtat, 2014, p. 10). Due to the wide range of course content and learning goals, higher education lacks a universal way to assess the quality of classroom instruction. Since no consistent college-level assessment measures exist, most HEIs use student feedback, peer observation, self assessment, teaching portfolios, and program capstone projects to assess teaching efficacy (Paolini, 2015; Pounder, 2007; Stigall & Blincoe, 2015). The most

common teaching assessment tool is the end of the semester student assessment of teaching quality, where students provide feedback on an instructor's subject matter expertise, preparedness, and overall effectiveness (Pounder, 2007; Spooren, Brockx, & Mortelmans, 2013; Stark & Freishtat, 2014). Student assessments are popular due to their low class time investment and their ease of administration and data interpretation (Spooren et al., 2013).

However, many people have noted serious shortcomings. Stark and Freishtat (2014) point out several flaws for relying on students' teaching evaluation scores to measure teaching effectiveness including: differences between non-responders and responders; variables beyond instructors control (i.e., time or location of class, class size, course content); students' concerns about anonymity; statistical concerns with averaging ordinal categorical variables; and concerns about how instructor's gender, ethnicity and age influence data. Stark and Freishtat (2014) recommend using student comments on teaching effectiveness, such as instructor's clarity and excitement for subject, approachability, and availability outside class, in combination with other methods for evaluating teaching. Examples of other methods for assessing teaching effectiveness include reviewing course material (syllabi, lecture notes, assignments, and textbooks), sampling student work, classroom observation, and inviting instructors to submit teaching portfolios (Stark & Freishtat, 2014).

Benton, Duchon, and Pallett (2013) examined the relationship between student self-reported learning progress and their grades received on exams. They found that students that rated their learning as exceptional or substantial correlated significantly with higher exam grades; this supports the validity of student reported ratings of their learning.

Their findings are in agreement with previous findings that students rating their own learning correlate positively with the instructor's measure of how much they have actually learned (Benton et al., 2013; Beleche, Fairris, & Marks, 2012; Stark & Freishtat, 2014). Overall, classes with students that reported learning the most also had higher ratings on teacher evaluations (Benton et al., 2013); this is consistent with Beleche and colleagues' positive associations between measures of student learning and course evaluations.

These research studies indicate that student assessments can be accurate reflections of the extent of student learning happening in classrooms; however, student ratings are not a measurement of teaching effectiveness rather an indication of student learning (Stark & Freishtat, 2014). These findings support this study's method of asking students to indicate how much they learned in their SU course through a survey and focus group. When students experience their preferred teaching practices, their self reported learning gains are greater and their performance is enhanced; the inverse relationship also exists. Therefore, knowing which teaching practices students find helpful will improve their learning (Struyven, Dochy, & Janssens, 2008).

Classroom level assessment strategies. There are two types of assessment that happen in classrooms: formative and summative. Both types of assessment involve gathering information about student learning but they have different purposes. Formative assessment is for improving learning (usually conducted during a learning experience) and summative assessment is for making a judgment about students' performance or competence (usually conducted after a learning experience) (Chappuis, Siggins, Chappuis, & Arter, 2012; Gardner, 2011; Patton, 2002). Summative assessments create

student grades; they are the assignments that instructors use to make a judgment on how well a student performed in their class. Examples of common summative assessment include: exams, class participation, quizzes, papers, presentations, and projects.

The goals of formative assessments are to gather information about how students are learning with the goal of using the information to effectively improve student learning (Chappuis et al., 2012). Wiggins and McTighe (2005) discuss the importance of teachers doing a formative assessment of what students know and are able to do because it enables teachers to be able to make necessary adjustments to their teaching and it helps if there is intentional alignment between learning outcomes, instructional practices and assessment strategies. Having these well aligned makes it a little easier to try to collect accurate data about teaching effectiveness. Examples of formative assessments include: quizzes, class discussions, reflective papers, mid-semester exams, or small group discussion with the instructor walking around listening. This study explored how instructors use summative and formative assessment processes in their SU course through classroom observation, interviews, and the assessment matrix.

Summary

Understanding how undergraduate students tend to interpret and make sense of the world can help instructors support students when they are learning challenging concepts leading to a transformation of their worldview. Transformative learning is not about learning content; rather it is about developing skills to think systematically and critically, promoting reflection, and taking other perspectives into consideration (Rowe & Johnston, 2013; Sterling, 2009). Advocates for EfS strongly encourage teaching practices where students question their assumptions, beliefs, and values while being exposed to

different ways of thinking and worldviews. Research suggests teaching strategies encouraging experiential, inquiry-based, collaborative, and reflective learning help to achieve EfS goals.

This study gathered assessment data on students' learning experiences within UVM's SU courses with the intent of improving teaching practices. Understanding the relationship between sustainability teaching and learning, such as those associated with UVM's sustainability learning outcomes, is important not only for helping UVM refine and improve how courses are taught, but also for adding to the larger conversation among HEIs for improving sustainability curricula. Overall, there is a shortage of research looking at the extent to which EfS associated instructional practices are being actualized in classrooms and how students best learn about sustainability (Christie et al., 2013; Lundholm et al., 2013; Rowe, 2002). This dissertation study responds to that need with the potential for contributing to two distinct bodies of literature: (1) how instructors incorporate sustainability learning outcomes into their curricula; and (2) how students perceived they learned and identified teaching practices that students find helpful to their learning about sustainability.

Conceptual Framework

The conceptual framework guiding this dissertation is an iterative theory of change model (see Figure 2.1). It shows the cyclical process of students learning the sustainability learning outcomes in the sustainability-designated courses and the information about how students learn influencing changes in the planned curriculum. It begins and ends with the instructor's planned curriculum incorporating the four sustainability-learning outcomes in their sustainability designated (SU) course. The

planned curriculum interacts with the characteristics of the community of learners that participates in the SU course. All of the instructors' and students' previous experiences, values, beliefs, opinions, worldviews, and cognitive abilities cumulatively make up the community of learners. Everyone will experience the course activities in different ways by constructing their own meaning influences by their unique lens (Lundholm et al., 2013).

Figure 2.1. Sustainability Learning Process Conceptual Framework

The communities of learners experience the course activities, which include what sustainability content that is taught, how much content is taught, how frequently it is taught, and the way it is taught. There are many different ways to teach sustainability including: class discussions, lectures, small group projects, case studies, exams, and papers. There are four major categories of instructional practices: (1) experiential (engaging learners in direct experiences to build knowledge and skills, usually involving a reflective aspect), (2) inquiry-based (facilitating learners as they take responsibility for

investigating open-ended questions in a way that is meaningful to them), (3) collaborative (learners work together to accomplish learning goals), and (4) reflective learning (allowing students to analyze how their learning experience is related to their lives) (Nolet, 2016).

The desired outcomes are students experiencing an improvement in their understanding and ability to meet the four sustainability learning outcomes: (1) students can have an informed conversation about the multiple dimensions and complexity of sustainability, (2) students can evaluate sustainability using an evidence-based disciplinary approach and integrate economic, ecological, and social perspectives, (3) students can think critically about sustainability across a diversity of cultural values and across multiple scales of relevance from local to global, and (4) students, as members of society, can recognize and assess how sustainability impacts their lives and how their actions impact sustainability (Hill & Wang, 2014, pp. 4-5).

It is hoped that the planned curriculum supports the communities of learners to strengthen their knowledge, skills, and values related to sustainability. To investigate this theory of change, assessment strategies need to be implemented to gather data about student learning. Assessment is gathering data on student learning with the intent to improve teaching and learning (Walvoord, 2010). Instructors reflect upon the information gathered to inform changes to the planned curricula for the next communities of learners. The unit of analysis in this study is not individual students, rather the collective teaching and learning happening within UVM's SU courses.

Theoretical Framework

To understand the process of learning about sustainability within courses more deeply, data was gathered about how instructors designed their course, how the topics were taught, and how instructors reported students learned the content. Specifically, the following three questions need to be investigated to gain an understanding of student learning outcomes: (1) How did instructors design the course to be taught? (2) Which teaching practices were implemented to teach sustainability content? and (3) How students are learning? (Christie et al., 2013; Lundholm et al., 2013; Rowe, 2002). Figure 2.2 uses a Venn diagram to show the synergy of the necessary components that need to come together for students to learn the SLOs. The diagram depicts the iterative cycle of the teaching process, where curriculum (course design, practices, and assessment strategies) is planned and then the instructor reflects on their teaching experiences making informed changes to the next time they teach the course.

Figure 2.2. Sustainability Learning Theoretical Framework

The following section will provide a detailed explanation of this study's research design and methodology, including a description of protocols and instruments administered.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

Introduction

The purpose of this study was to explore how instructors are teaching sustainability content and how students are learning within UVM's recently implemented sustainability general education requirement. Of particular interest were how instructors structured and taught SU courses and what students reported as helpful teaching practices in SU courses. This requirement will result in an increased number of sustainability courses; however, simply increasing the number of sustainability courses does not necessarily lead to the desired student learning and skill development, as articulated by UVM's SLOs.

Given the newness of this requirement, research is needed to explore its impact on teaching and learning. Specifically, this study will address the following research questions:

1. In what ways did instructors structure and teach the Sustainability Learning Outcomes (SLOs) in their SU designated courses?
2. In what ways did instructors assess whether students are learning the SLOs?
3. To what extent did students perceive they learned the SLOs in sustainability-designated courses?
4. To what extent did students perceive their instructor's teaching practices influenced their learning?

In this study, I interviewed people involved creating and implementing the SU general education requirement, interviewed a sample of instructors teaching SU courses, reviewed relevant course material, facilitated student focus groups, and administered a

student survey. Findings from this study will potentially make the following two important contributions: (1) how instructors incorporate sustainability learning outcomes into their curricula; and (2) students' perceptions of helpful teaching practices for learning about sustainability.

The remainder of the research methods chapter is organized as follows: 1) a description of the research design; 2) an explanation and justification of the research sample; 3) a description of the data sources, including the instruments and protocols implemented; 4) a description of the data collection methods; and 5) an outline of the data analysis procedure.

Research Design

This study is framed by a constructivist philosophical approach; this research study assumes that humans have the capacity to interpret and construct their experiences and their knowledge of reality is influenced by their cultural context and worldview (Bloomberg & Volpe, 2012; Creswell, 2013; Glesne, 2011; Patton, 2002). Everyone interprets the world through their unique lens, which is cultivated by their cumulative experiences, emotions, values, and beliefs and new knowledge is constructed on the basis of what is already understood and believed (Spillane et al., 2006).

This study collected data from instructors and students in a sample of SU designated courses using the following methods: 1) document review, 2) instructor interviews, 3) classroom observations, 4) student focus groups, and 5) student survey. The most appropriate methods to answer the research questions were selected, seeking to expand the type of data collected, using qualitative methods to talk with people about their perceptions and experiences to understand the process of teaching and learning, and

quantitative methods to gather descriptive data from many students about their perceptions of learning in the sustainability-designated course (Bloomberg & Volpe, 2012; Greene et al., 1989). The research study was not designed to test a theory; rather it sought to learn about how the process of how the general education requirement was experienced by a small sample of instructors and students in SU courses (Bloomberg & Volpe, 2012; Patton, 2002). Data were collected to explore the meaning participants created through their experiences within this study's context, with the hope of transferability to similar settings (Bloomberg & Volpe, 2012; Creswell, 2013; Patton, 2002).

Based on my research questions, I conducted a single case study using both qualitative and quantitative methods (Yin, 2003). Case studies are characterized by studying a bounded integrated system (UVM's new sustainability general education requirement) to investigate a phenomenon within its real-life contemporary context, and typically involve observation, interviews, surveys, focus groups, and document review (Bloomberg & Volpe, 2012; Creswell & Plano Clark, 2011; Glesne, 2011; Yin, 2003). Stake (1994) states that case study is what is being researched, not a methodology of research; however, this study aligns with Bloomberg's and Volpe's (2012), Creswell's (2011) & Plano Clark's (2011), Glesne's (2011), and Yin's (2003) conception of case study being a methodology *and* the object of study. This study described and analyzed the process of the UVM sustainability general education requirement in its early implementation looking for themes and patterns (Bloomberg & Volpe, 2012; Yin, 2003).

In May 2015, the UVM Board of Trustees approved a sustainability general education undergraduate requirement. Instructors interested in designating their course to

fulfill this requirement had to submit an application to the Sustainability Curriculum Review Committee for consideration. Due to the recent adoption of a sustainability requirement, many instructors are changing their course content to address the four sustainability learning outcomes associated with the requirement. This created an opportunity to explore instructors' sustainability teaching practices and student learning.

Given the newness of the SU general education requirement, the following research methods were not appropriate: ethnography (lack of established culture), grounded theory (too early to develop a theory but might be a future study), narrative (more than one individual), or phenomenology (the essence of the SU requirement is not established but again might be a future study) (Creswell, 2013). Yin (2003) outlines three conditions that make case study an appropriate choice for my study: 1) the “how” nature of my research questions – how are faculty teaching and how are students learning; 2) the lack of control I have over the being able to manipulate instructor's teaching practices and which students take the SU courses, and 3) the SU requirement is being implemented now, resulting in my ability to conduct a variety of methods including interviews, observations, document review, and survey students. These methods enabled me to present an in-depth understanding of UVM's SU requirement (Creswell, 2013 & Plano Clark, 2011).

The case in this study is UVM's sustainability general education requirement. UVM's general education program is a good example to study because it is an embedded course model with learning outcomes. The ACUPCC recommends the embedded course pathway to general education as a good way to infuse sustainability across the curriculum (Hattan, 2009). The general education requirement consists of four SLOs, which

instructors have to submit an application explaining how they are addressing each learning outcome in their course to earn SU. The general education program does not require students to take one specific sustainability course; rather instructors choose to incorporate sustainability content into their course. To explore how the general education requirement is being taught and how students are learning, this study explored a sample of SU courses. It is an embedded case study because there was more than one unit of analyses (SU courses) (Yin, 2003).

Data from the courses is presented collectively to explore the implementation of the SU requirement (Yin, 2003). A concern with an embedded case study is only gathering data on the unit of analysis and not the holistic context of the case. To ensure information was gathered about UVM's general education program, I conducted interviews with key informants involved in its creation and implementation. Key informants were asked about the process of establishing general education programs at UVM, how this requirement was passed, how they hope it influences teaching and learning on campus, and the future of UVM's general education program.

Yin (2003) identifies three common critiques of case study research, which are as follows: (1) they lack rigor, (2) they provide little basis for scientific generalization, and (3) they take too long to conduct and result in massive reports. I took the following actions to address these critiques. To design a rigorous study, I used a variety of methods following detailed systematic procedures, which are outlined in the following sections. This study was not designed to produce generalizable findings; rather it was to expand what we know about teaching students sustainability concepts. This study tries to understand the complex interactions between students and teachers in a university

classroom not test a cause and effect relationship (Creswell, 2013). Data collection methods took three months. Significant findings will be presented in journal articles, which have strict length requirements forcing concise and clear writing.

I used several different types of research methods: interviews, focus groups, classroom observations, survey, and document review. All methods have advantages and disadvantages. Surveys are straightforward to administer potentially reaching many people but it is harder to ensure questions are not misinterpreted. Observations allow opportunity to witness events as they happen within the context but researcher's perceptions may cloud data. Interviews have the ability to gather rich descriptions of personal perceptions and experiences; however, the quality of the data gathered is dependent on people's ability to communicate clearly and willingness to be truthful (Bloomberg & Volpe, 2012). They are dependent on the social interaction between interviewee and interviewer. Document review allows easy accessibility to already existing information but reporting bias can be an issue. Focus groups allow participants to express their opinions in a group discussion where people can consider their thoughts in context to other perspectives; however, some voices may overshadow other people's voices and peer pressure may influence data (Patton, 2002; Yin, 2003). Using a variety of methods to gather data strengthens this study because it allowed for data triangulation and helped to address the weaknesses associated with individual methods.

When designing this study, I considered creating a rubric to assess student learning in my sample of SU courses. Using the same rubric to grade student work across different courses, assignments, and instructors is difficult and has issues with reliability (Walvoord, 2010). Data about student learning can also be gathered by asking students to

share about their learning experience (Walvoord, 2010). Table 3.1 provides an overview of the research design, which will be discussed in the following sections of this chapter.

Research Questions:

1. In what ways did instructors structure and teach the Sustainability Learning Outcomes (SLOs) in their SU designated courses?
2. In what ways did instructors assess whether students are learning the SLOs?
3. To what extent did students perceive they learned the SLOs in sustainability-designated courses?
4. To what extent did students perceive their instructor's teaching practices influenced their learning?

Table 3.1

Overview of Research Design

RQ	Data Elements	Method	Data Analysis
#1	Information about how faculty members taught the SLOs, what content they taught, and how often they are taught.	*Document review *Classroom observation *Instructor interview	Coded transcripts to identify themes about instructors teaching practices. Reported frequencies of themes, looked for triangulation of the data.
#2	Information about the assessment methods used by instructors such as exams, class discussions, quizzes, projects, papers, etc.	*Document Review *Instructor Interview * Classroom Observation *Student Assessment Matrix	Coded transcripts to identify themes about instructor's assessment practices. Reported frequencies of themes, looked for triangulation of the data.
#3	Students' self assessment of their improvements in understanding the SLOs	*Student survey likert scale question & Student Focus Groups	Reported frequencies of likert scale survey question about learning and reported themes emerging from analysis of focus group transcriptions
#4	Student opinions about which course content, activity, or experiences were helpful in their learning process.	*Student focus groups *Student survey open ended question and likert scale question	Reported frequencies of likert scale survey question, coded and reported open ended survey question, and reported themes emerging from analysis of focus group transcriptions

Research Sample

This section will review the sampling rationale for the different research methods.

Class selection and recruitment. Purposeful sampling strategy was used to select a sample of courses to illustrate characteristics of interest to facilitate comparisons (Patton, 2002). The first criterion was being a fully designated SU course being taught in the Spring 2016 semester. In an effort to meet capacity issues for all Fall 2015 matriculating students, 21 courses were given a one-year provisional SU designation; those courses did not qualify for this study because instructors did not design or re-design their courses to specifically embed the four SLOs into their curriculum. Courses that occur abroad (Costa Rica) or were internship based were not included as potential recruitments, as the logistics of the classroom observation would be prohibitive. Upper level courses were not included because the target audience of the new requirement is lower level courses. Courses were chosen to create maximum variation among specific characteristics (Creswell & Plano Clark, 2011).

Information was gathered about each qualifying course across three dimensions: size, department, and whether the instructor participated in the Sustainability Faculty Fellows program. Eight courses were selected, attempting to balance representation of the three variables. All variables were selected due to an interest to explore if it has any impact on teaching practices and student learning. Table 3.2 displays a breakdown of courses, with course characteristics, and course ID that participated in this study. In this study, small classes had less than 25 students, medium size classes had between 25-60 students, and large classes had more than 60 students. Selecting class characteristic variables was not done for generalization or statistical representation, but rather to be able

to look at potential patterns that may emerge across these course characteristics. These criteria were selected to identify potentially information-rich examples of courses within UVM's sustainability general education program, which is this study's case (Patton, 2002).

Table 3.2.

Sustainability Course Summary

Department	Class Size	SFF	Course ID
Geography	L (106)	No	GEOG
Natural Resources	M (53)	Yes	NR
Economics	L (116)	Yes	ECON
Elementary Education	S (14)	Yes	EDEL
Electrical Engineering	S (16)	No	EE
Environmental Studies	M (36)	Yes	ENVS
Nutrition	L (69)	No	NFS
Plant Biology	L (69)	Yes	PBIO

The eight instructors teaching these courses were emailed a letter inviting them to participate in this research study (see Appendix B). If an instructor agreed to participate, they completed the following six tasks: (1) signed consent form (Appendix C); (2) submitted course documentation (syllabi, course assignments narratives, exams, and grading rubrics); (3) scheduled one course session for observation, preferably when sustainability content is being taught; (4) participated in one interview (~45 minutes) towards the end of the semester; (5) shared a list of student email addresses; and (6) completed an assessment matrix.

Interviews. One-on-one semi-structured interviews were conducted with the eight course instructors. Instructors signed a consent form and were reminded at the beginning

of their interview that their participation is voluntary and they could stop the interview at any time for any reason.

In addition to interviewing the instructors, I interviewed four key informants for the sustainability general education requirement. Key informants are people who are particularly knowledgeable about the case study context, whose perspectives can be helpful in understanding the circumstances of the setting (Patton, 2002). I interviewed a co-chair of the sustainability curriculum review committee (the other co-chair is on sabbatical), the associate provost of teaching and learning, the co-creator of the Sustainability Faculty Fellows program, who is also the vice-president of the faculty senate, and the co-creator of the Sustainability Faculty Fellows program, who is also the assessment coordinator for the sustainability general education requirement. These four people were selected because of their experience gaining approval for the sustainability general education requirement. Through email, all key informants agreed to be interviewed. They signed a consent form (Appendix D). In total, I interviewed 12 people.

Student focus groups. Students enrolled in participating courses were invited to participate in a focus group through email. Participants were compensated for their time and travel with a \$20.00 credit to the student account (CATS scratch). Funding for the compensation came from UVM's Office of the Associate Provost for Teaching and Learning. Patton (2002) recommends focus groups of 6-10 people, so I aimed for two focus groups with 8 students each (n=16). However, due to students not showing up, I facilitated three focus groups, one with 7 students, one with 5 students, and the last one with 4 students. Two students from each course participated. Each student signed a

consent form (Appendix E). They were encouraged to carefully review the form and ask questions or discuss concerns about their participation.

Student survey. All students (n=479) enrolled in the participating SU courses were emailed (addresses provided by instructor) an invitation to participate in a survey about their experience learning in the SU course. The survey link was embedded in the email, so students were directed to the online survey by clicking on the link. Consent information was provided at the beginning of the survey, which assured students that their data would be confidential and informed them that by taking the survey they are giving their implied consent. The data collection section below describes the survey development and implementation.

Instruments and Protocols

The following section describes the instruments and protocols: document review protocol, SU course assessment matrix, classroom observation protocol, interview protocol, focus group protocol, and student survey. Copies of all protocols and instruments can be referred to in the Appendices. Using multiple methods to gather data reduces the potential problems of construct validity because “multiple sources of evidence essentially provide multiple measures of the same phenomenon” (Yin, 2003, p. 99). Table 3.3 displays a summary of the data collection procedures. Each instrument and protocol will be described in detailed, followed by a section outlining the data collection methods.

Table 3.3

Summary of Data Collection Procedures

Procedure	Description	Schedule/ Frequency
Document Review	Using the document review protocol, I reviewed and took notes about the course material provided by the instructor. Course material includes; class syllabi, SU course designation application, assignment descriptions, exams, and other course documentation.	Material was collected from instructors and analyzed throughout the semester.
SU Course Assessment Matrix	For each learning outcome, instructors indicated methods used for assessing student learning, what they learned from assessment, and what actions (if any) they plan to take to address findings.	Instructors emailed me a completed matrix at the end of the semester.
Classroom Observation	I observed one class session per participating SU course and took structured field notes according to observation rubric. The instructors chose the class session.	One class session per SU class for approximately 60-75 minutes
Interviews	One-on-one semi-structured interviews were conducted with instructors and key informants. They loosely followed the specific interview protocols. Interviews were digitally recorded for transcription and analysis.	Each instructor and key informant was interviewed once for approximately 45-60 minutes.
Student Focus Group	Three focus groups were conducted. Two representatives from each class participated (n=16). I facilitated the focus groups in a semi-structured style following the focus group protocol.	Three student focus groups were facilitated for 60 minutes each.
Student survey	Students were emailed inviting them to complete an online survey towards the end of their course. The survey was anonymous.	The one survey took students about 12 minutes to complete.

Document review protocol. The purpose of the document review was to gather data to help answer this study's first two research questions: (1) In what ways are instructors structuring and teaching the SLOs in their SU designated courses? and (2) In what ways are instructors assessing whether students are learning the SLOs?

Systematically reviewing course documentation provided information about how

instructors are structuring the sustainability content within their courses and how instructors are assessing knowledge by the breakdown of how student earn grades. Instructors were asked to submit course materials including: the course syllabus, SU designation application, assignment instructions, exams, and grading rubrics (if any). I synthesized data captured from the multiple documents submitted per class onto one protocol form (Appendix F). To account for where the information came from, I indicated the document source in the last column of the protocol. This document was modified to meet the needs of accurately capturing the information gathered from the specific course material provided.

I looked for evidence of course content, instructional practices, and assessment strategies, which reflects my theoretical framework. Each section developed was informed by the literature. The document review protocol and the classroom observation protocol have four types of instructional practices: There are four major categories of instructional practices: experiential (engaging learners in direct experiences to build knowledge and skills, usually involving a reflective aspect), inquiry-based (facilitating learners as they take responsibility for investigating open-ended questions in a way that is meaningful to them), collaborative (learners work together to accomplish learning goals), and reflective learning (allowing students to analyze how their learning experience is related to their lives) (Nolet, 2016). Within the experiential learning, instructors used course material with real life applications that encourage problem solving skills, role play, place-based, service learning projects, or case studies (Christie et al., 2013; Cirillo & Hoyler, 2015; Holdsworth et al., 2013; Mezirow, 1997; Nolet, 2016; Paolini, 2014; Shepard, 2008; Sterling, 2004a; Striberg, 2004; Svanström et al., 2008; Wals & Dillon,

2013; Wiek et al., 2012; Woolson, 2015). Within the inquiry based learning, instructors used project based or essential questions (Christie et al, 2013; Cirillo & Hoyler, 2015; Nolet, 2015; Shepard, 2008; Shriberg, 2004; Wals, 2014; Woolson, 2015). Within the collaborative learning category, instructors assigned group projects or facilitate class discussions. Within the reflective category instructors assigned reflective papers or activities (Shepard, 2008; Zulauf, 2007).

The final two sections of the document review protocol are course content and assessment strategies. The course content section gathered information about what was taught in the course related to sustainability. The form needed to be modified to reflect individual course's content. Commonly taught sustainability content includes: systems characteristics (Capra, 2005; Meadows & Wright, 2008; Nolet, 2016; Wessels, 2006), ecological principles, including community, cycles, limits and interdependence (Capra, 2005; Cirillo & Hoyler, 2015; Nolet, 2016; Wessels, 2006), science of climate change (Nolet, 2016), fairness and equity, place, long-term effects, equilibrium, and ability to make a difference (Cirillo & Hoyler, 2015).

On the document review protocol's assessment strategies section, information was gathered about how students earn grades. During class observations, instructor interviews, and through the assessment matrix, data were collected about other types of assessment strategies used. In the protocol, I provided a rich description of the types of graded assignments from the syllabi and other documents provided. The document review protocol was designed to gather information from course material to answer the research study first question about how instructors are structuring and teaching the SU courses. To answer the second research question about how instructors are assessing

student learning, instructors will be asked to fill out the SU course student assessment matrix.

SU course assessment matrix. This form (Appendix G) was to gather information to help answer this study's second research question: In what ways are instructors assessing whether students are learning the SLOs? This matrix was designed during an assessment workshop held by Barbara Walvoord, an assessment consultant hired by UVM to assist in the creation of a university wide assessment plan, with special focus on the general education requirements. She recommended asking instructors to fill out a matrix to indicate their assessment method, what they found out about how students are learning the individual learning outcomes, what actions they can take to address those findings, and what actions the university can take to support the SLOs. The purpose of this matrix was to understand how instructors approached student assessment and how that information informs their teaching practices. It also gathered information about how the larger context of this case study, UVM, can help support instructor's teaching the SLOs.

Class observation protocol. The purpose of observing classrooms was to help answer this study's first two research questions: (1) In what ways are instructors structuring and teaching the SLOs in their SU designated courses? and (2) In what ways are instructors assessing whether students are learning the SLOs? In alignment with case study characteristics, I observed instructors teaching and students learning in their natural setting, their classroom. I was a nonparticipant observer because I took notes in the back of the classroom without any direct involvement with the class (Creswell & Plano Clark, 2011).

The classroom protocol (Appendix H) was designed to take detailed notes of what happened in class, focusing on instructors' teaching practices and assessment strategies. A systematic observation requires an instrument, which is best designed for the specific focus (in this case it is the process of teaching) (Bradshaw & Glatthorn, 2001; Popham, 2013). The protocol includes space for a narrative summary, a written summary of main activities, and examples of teaching practices (Richards & Farrell, 2011). My notes were informative, not evaluative. After the class, I used the memo box to write reflective thoughts and initial impressions about the class, which is a recommended qualitative method (Miles & Huberman, 1994).

The protocol is structured with tables with space to write descriptions. The tables include: classroom layout, outline of class activities, general narrative notes, inquiry based learning, collaborative learning, experiential learning, reflective learning and assessment strategies. There is an explanation and examples of what each category might look like in practice. The final table is where I wrote my thoughts and impressions right after the observation. The protocol design was informed by the same literature as summarized in the description of the document review protocol development.

Interview protocol. Interviews were conducted with instructors participating in this study and key informants; the questions were different among informants and instructors but the process will be the same. The purpose of the instructor interviews was to learn more about instructors teaching experience in their recently taught SU course. The purpose of the key informant interviews was to learn about their perceptions on how the general education requirement came to fruition. The key informant interviews and the seventh instructor interview question enabled this case study to provide a rich description

of the UVM's sustainability general education requirement context. The key informant protocol (Appendix I) outlines the steps I took to interview the key informant, which includes five open-ended questions. The questions were designed to gather information about the process of sustainability becoming a general education requirement, what role they had in that process, and how it may change teaching and learning at UVM, and the role of assessment.

The instructor interview protocol (Appendix J) was designed to address the shortage of research looking at the extent to which EfS pedagogies are being actualized in classrooms and how instructors assess if students are learning, particularly in a higher education setting (Christie et al., 2013; Lundholm et al., 2013; Rowe, 2002). These interviews helped to identify promising teaching practices for teaching sustainability. Table 3.4 lists the questions that the instructors were asked, aligning them with one of the first two research questions: (1) in what ways did instructors structure and teach the SLOs in their SU designated courses? and (2) in what ways did instructors assess whether students are learning the SLOs? Table 3.5 also displays examples of the data elements collected. The last interview question asked interviewees if there is anything else they would like to add, which is Patton (2002) recommended interview strategy.

Table 3.4

Interview Questions and Desired Data Elements

Interview Question	Research Question & Data Elements
Please describe any changes you made to your course to fulfill the SU course designation requirements.	Q1: actions taken to change their course to gain SU approval; added readings, projects, content, activities, etc..
Please describe the sustainability related activities you taught in your SU course.	Q1: Overview of actions the instructor took to teach the SLOs. Content connections, assignments, activities
Please describe one or two highlights of your experience teaching the sustainability related activities.	Q1: Data about what the instructor enjoyed most about teaching sustainability
In your classroom, what kind of information/activities do you offer that highlight the integration of economic, social, and ecological perspectives?	Q1: Data about how the instructor approached integrating the three components of sustainability
How did you assess students' learning related to the sustainability content?	Q2: Examples of assessment methods, how they determined if students were learning the SLOs
Please describe what you learned from filling out the student assessment matrix and what actions you plan to take resulting from what you learned.	Q2 & Case study: Feedback on the process of filling out the matrix and how instructors are approaching assessment
What do you think the UVM sustainability general education initiative needs to be working on to improve students learning the sustainability learning outcomes?	Case Study: Feedback from instructors who taught SU courses about how the entire UVM community can support the new general education requirement

Focus group protocol. The purpose of the focus groups was to learn more about students' learning experience in the SU courses. The focus group protocol (Appendix K) was designed to gather that information. Of particular interest is which teaching practices students report as helpful to their learning process. The focus group protocol consists of eight open-ended questions. Walvoord (2010) recommends conducting focus groups of students in general education courses asking how well they thought they achieved the learning objectives, what aspects of the course were most helpful, and what suggestions they have for improvement.

The focus group questions were edited and follow up questions were added based on data gathered from the document review and classroom observation, this emergent design process allows the researcher the flexibility to adapt desired information needs based on the data collection process (Creswell, 2013). Follow-up questions were asked during the focus group, both to pursue related topics and to probe for more elaborated responses (Patton, 2002). The focus group questions were designed to address this case study's third and fourth research questions: (3) To what extent did students perceive they learned the SLOs in sustainability-designated courses? and (4) To what extent did students perceive their instructor's instructional practices influenced their learning? Table 3.5 lists the focus group questions, their associated research questions, and the desired data elements.

Table 3.5

Focus Group Questions

Interview Question	Data Elements
Describe your favorite learning experience in your recent SU designated course.	Q4: Descriptions of what types of teaching practices and activities students enjoyed
What aspects of your course helped you with your learning? Why were they helpful?	Q4: Information about which specific teaching practices helped students and why they think they were helpful
What changes to the curriculum or classroom strategies could help you better achieve learning about sustainability?	Q4: Information about how instructors teaching practices could change to better meet students perceived learning needs
In what ways did your course address the complexities surrounding sustainability issues? What were some of those complexities?	Q3 & 4: Students perceptions about how instructors taught SLO #1 and information about what they learned about sustainability complexities
Do you feel you could have an informed conversation about sustainability with other adults and young adults?	Q3: Students perceived ability to have an informed conversation about sustainability, which is SLO #1
What is your sense of how your own actions impact sustainability of global	Q3: Students sense of their actions impacting sustainability and others,

environmental and social systems?	which is SLO #4
What actions could the university take to support the sustainability general education requirement?	Case Study: Collecting student feedback about the sustainability general education implementation

Student survey instrument. The purpose of the survey was to assess the extent to which students perceive they learned the sustainability learning outcomes in their SU course (research question #3). The survey (Appendix L) was designed to assess students learning the SLOs:

- Learning outcome 1: Students can have an informed conversation about the multiple dimensions and complexity of sustainability. (knowledge category)
- Learning outcome 2: Students can evaluate sustainability using an evidence-based disciplinary approach and integrate economic, ecological, and social perspectives. (skills category)
- Learning outcome 3: Students think critically about sustainability across a diversity of cultural values and across multiple scales of relevance from local to global. (values category)
- Learning outcome 4: Students, as members of society, can recognize and assess how sustainability impacts their lives and how their actions impact sustainability. (personal domain)

Some questions were designed exclusively for this study to capture students' perception of how the course helped to expand their ability and knowledge related to the SLOs. Questions were created using best practices: questions avoid negative stems, are not trick questions, and try not to be over complicated (Holsgrove, 1992). They covered the following components of the SLOs: ability to have an informed conversation about

the complexity of sustainability, evaluate the economic, ecological, and social perspectives of an issues, think critically about diverse values from a local to a global scale, and recognize how their lives impact sustainability. This survey was not designed to measure students' learning the SLOs, rather to measure students' perceptions of what they learned in their course.

Some questions were replicated from existing instruments. The SLOs are framed by knowledge, skills, values, and personal domain categories and no other survey found covers all four categories. I borrowed items from three existing tools: Seattle University's SUSTLit scale (values and attitudes), the Learning Environment Preferences (LEP) instrument (student learning theory), and The Ohio State's Assessment of Sustainability Knowledge (ASK) tool (knowledge).

The SUSTLit scale was designed to measure sustainability knowledge and beliefs (Obermiller & Atwood, 2013). I was granted permission to use parts of the survey and chose nine statements (that assess students' attitudes and values related to sustainability issues (C. Obermiller, personal communication, 2016). The entire scale (a portion used) demonstrated good internal reliability and predictive validity, but poor accuracy, so troublesome items were replaced. The LEP instrument is a tool based on qualitative research done by Perry's intellectual and ethic development model for college students (Moore, 1989). I was granted permission to use a subset of statements and given a shortened version focusing on the "dualism" position that has not been well tested but item characteristics are strong (W. Moore, personal communication, 2016). I chose seven of the 15 statements from the shorter tool to gain an understanding of students' perceptions of the role of teachers in their learning process (Q3).

Twelve multiple-choice questions assessing students' knowledge of sustainability were taken from the new shortened version of the ASK tool. These questions were developed through expert input, focus groups, pilot testing, and item response theory analysis (Zwickle, Koontz, Slagle, & Bruskotter, 2014). A 30-question survey instrument was analyzed using Item Response Theory (IRT) to select 16 items. Zwickle et al. (2014) gave permission to this tool and is administering the 12-item version of this survey at Montana State University, which opens the possibility of benchmarking results from this study in the future. (A. Zwickle, personal communication, 2016). This tool was designed to assess undergraduate students' sustainability knowledge across the environmental, economics, and social domains. Some questions were designed so respondents had to apply concepts in different ways that would require an understanding of the concept and some level of critical thinking to apply that concept to a specific context (Zwickle et al., 2014). Answer choices were designed to allow analysis to inform an educated guess and a "don't know" option was supplied to reduce guessing (Zwickle et al., 2014).

Please refer to Table 3.6 for a summary of the survey questions, source of the questions and data elements. This table excludes demographic questions. Please refer to Appendix L for the entire survey.

Table 3.6

Survey Items and Desired Data Elements

Survey Question	Source (if applicable)	Data Elements
# 3	Learning Environment Preferences	Characteristics of learning environments that students prefer and preference of instructors role in their learning, aligned with Perry's intellectual and ethnical development model
# 4, 5, 6, 7	Design for this study	Students' perceptions of how their SU course expanded their abilities related to the SLOs. Indication of teaching activities that happened in their SU course and how helpful those activities were to their learning.
# 8, 9, 10	Design for this study	These are open ended questions asking for student descriptions of their favorite learning experiences, helpful course aspects, and changes in teaching strategies they feel would be helpful to their learning.
# 11	SUstLit	Assessing students values and beliefs associated with humans role in climate change (SLO #1), value of plants and animals (SLO #3), environmental justice issues (SLO #3), sustainability consideration in lifestyle choices (SLO #4), business decisions amongst ethical and economic tensions (SLO #2 & 3), and people's lifestyle choices with global impact (SLO #3 & 4)
#11-23	The Ohio State Assessment of Sustainability Knowledge	Content questions about students sustainability knowledge- some questions are related to other SLOs but a majority of the questions are related to SLO #1 but using a tested survey

Data Collection

This section describes data collection procedures for the different methods. A discussion of consent procedures used to keep data secure and protect confidentiality also is presented. This study received UVM Institutional Review Board (IRB) approval.

Document Review

The eight instructors were sent a recruitment letter (Appendix B) explaining the study and inviting them to participate. Participating instructors were emailed an IRB approved consent form (Appendix C) to review and sign. Second, they emailed course materials including their syllabus, explanations of assignments, exams, grading rubrics, and their application to earn SU designation. I sent reminder emails until the material was collected, the amount of material collected varied by course. In addition to this information, instructors were asked to complete the SU course assessment matrix. This matrix asks instructors to outline their evidence for student learning (assessment method), describe what they learned about students learning the SLOs, share actions they will take based on findings, and provide ideas for actions the university can take to support the SU learning outcomes.

When course materials were received, I deleted the course identifying information, replacing it with the course ID. Course IDs are the acronyms used for their department and are displayed in Table 3.2. The original material submitted, the de-identified material, and all related data are kept on my password-protected computer in my locked office. The submitted material was summarized through the document review protocol (Appendix F). One document protocol will be filled out for each course.

Classroom Observations

After course materials was received, I asked instructors to choose a class session (ideally when they are teaching sustainability content) for me to observe. I only observed each course once and stayed for one entire class period. Courses last between 50 minutes and 75 minutes, with the exception of one three-hour course. Observations took place

during regular class sessions in March or April 2016. I was a non-participating observer sitting in the back of the classroom (Patton, 2002). The instructor let students know that I am observing the class to witness teaching practices.

Classroom observations followed the classroom protocol (Appendix H). The protocol was designed to collect narrative summaries of particular themes happening in the classroom including: description of classroom layout, outline of major class activities, general notes, inquiry based learning, collaborative learning, experiential learning, reflective learning, and assessment strategies. A narrative summary is a description of the sequence of events with as much information as possible but not evaluative (Richards & Farrell, 2011). Descriptions were accurate, detailed accounts to capture the classroom setting, gaining insight of the process of teaching and learning (Patton, 2002).

Immediately after each observation, I wrote a memo (in the space provided on the protocol), which included my general impressions, reactions, questions and surprises (Miles & Huberman, 1994). Glesne (2011) recommends recording your thoughts as they occur as a way to begin the analysis process.

Interviews

Towards the end of the semester, I emailed instructors asking for a convenient time and location for their one-on-one semi-structured interview. All interviews took place in their office. I followed the instructor interview protocol (Appendix J). In addition to the instructor interviews I will be interviewing key informants following the appropriate protocol (Appendix I). All of the key informants (a co-chair of the sustainability curriculum review committee, the associate provost of teaching and learning, the co-creator of the Sustainability Faculty Fellows program and vice-president

of the faculty senate, and the co-creator of the Sustainability Faculty Fellows program and assessment coordinator for the sustainability general education requirement) agreed to be interviewed and signed a consent form (Appendix D). We arranged a convenient time and location (three were in their office and one was over the phone) for their one-on-one semi-structured interview.

Interviews were audiotaped and transcribed for analysis. In an effort to protect confidentiality, I refrained from saying the interviewees' name during recording. All of the transcriptions and related data are kept on my password-protected computer. A private contractor converted the de-identified audio recording into text. The private contractor signed a confidentiality agreement, which outlines the precautions they need to take to ensure the security of the data files. These files are saved on my password-protected computer and organized by the course ID or key informant position (not the interviewee's name). The interviews lasted no longer than an hour, out of respect for the interviewee's time. The interview protocol consists of a set of open-ended questions designed to gather data about interviewees' perspective (Patton, 2002). I asked follow-up questions to pursue related topics and to probe for more elaborate responses (Patton, 2002). I added clarifying questions resulting from discoveries through the classroom observation or document review.

Focus Groups

I contacted students participating SU courses, using email addresses provided by the instructors, asking if they were interested in participating in a focus group. Participating students received \$20 gift cards for their time and travel. I planned to conduct two focus groups with eight students each, Patton (2002) recommends 6-10

people as an ideal focus group size. However, some students did not show up so I arranged a third focus group, ensuring that two student representatives for all eight courses (n=16) were included. Focus groups lasted one hour. Two occurred in the UVM student center and one in the living and learning center.

Consent forms were given to each student (Appendix E). I encouraged students to ask questions or discuss concerns about their participation. They were offered an extra consent form copy to keep for their records. After gaining permission to record the focus group, I turned on my audio recording device. I refrained from using names and other identifying information. Focus groups were audiotaped and transcribed for analysis. All audio, text, and related files are kept on my password-protected computer. A private contractor signed a confidentiality agreement before converting the audio recording into text.

My role as moderator in the focus groups was guiding the group discussion so students had the chance to respond to each other's ideas (Patton, 2002). I managed the conversation making sure a few students did not dominate it. Students appeared to be comfortable sharing as the conversation topic was not controversial in nature. My focus group protocol consisted of eight questions; Patton (2002) recommends asking no more than 10 questions for a focus group with eight people.

Student Surveys

Instructors provided me with a list of email addresses for students enrolled in their courses. The registrar's office removed any student that has a non-disclosure agreement with UVM. The list of email addresses was kept on my password-protected computer and was not associated with the collected survey data. Toward the end of the semester, I sent

an email (with an embedded link to the online survey) inviting students to participate in the survey. At the beginning of the survey, there was a short paragraph explaining that by completing the survey they are giving their consent to participate in this research study (Appendix L).

The advantages of using an online survey include: reduce data entry error, ability to email the non-respondents, creating enforced skip patterns, and the ability to keep responses confidential (Dillman, Smyth, & Christian, 2009; Nulty, 2008). I incorporated the following characteristics of tailored design methods into my survey tool and implementation: explain the purpose of the survey in the email, asking students to help improve the process of the sustainability general education requirement, making it short, convenient and easy to complete, limiting the amount of personal information requested, providing an incentive and ensuring confidentiality and security of information (Dillman et al., 2009; Nulty, 2008).

Following Dillman and colleagues' (2009) recommendations, I emailed the survey for the first time early in the morning at the beginning of the week, my second email request was later in the week and in the afternoon, my third email was early in the following week in the mid- morning, my fourth email was at the end of the week early in the morning and the final request was early in the week in the early afternoon (Nulty, 2008). The survey was available for two weeks.

The survey was administered through Survey Gizmo. Survey data were confidential (not associated with their email address) and secured by my user name and password combination. Students were instructed to email me after they completed the survey to enter a drawing for four students to win \$20 on their student account; students

had to email me separately as their email address is not associated with their survey data. After I closed the survey, I used a random number generator to pick four numbers (each student was associated with a numbered excel row). The students who won were notified by email that \$20 was added to their student account.

The survey was pilot tested with students (n=30) in an SU course not participating in this study. The testing process was both developmental – with respondents answering questions about readability, understanding, and overall content and flow – and procedural, where respondents provided feedback on potential difficulties with the survey’s online format and administration. Feedback from the pilot was used to improve the survey implementation.

Data Analysis

Multiple sources of information were gathered to provide a more comprehensive understanding of the process of teaching and learning related to the SU general education requirement (Patton, 2002). Data from all of the sources gathered were analyzed holistically to answer this study’s research questions. The purpose of the analysis was not generalizing beyond this case study but rather to provide a rich description of the case, identifying themes and patterns, in order to understand its process and implementation (Bloomberg & Volpe, 2012). The goal of providing a rich description is transferability, where people in similar contexts can benefit from understanding the process of UVM’s sustainability general (Bloomberg & Volpe, 2012). This section will describe the data analysis procedures for this study.

I conducted a within-course analysis followed by an across-course analysis, which means I analyzed information about each course through a variety of methods gaining an

understanding of that course and then looked at all courses in a holistic manner to analyze the entire SU general education process (Bloomberg & Volpe, 2012). Data analysis of interviews, focus groups, and surveys were conducted after all data were collected. However, I began to analyze the classroom observations and document review protocols throughout the semester because my findings informed changes to the survey, interviews, and focus groups.

Analytic Approach

I familiarized myself with all of the course material that instructors shared, looking for examples of the different aspects of instructional practice, sustainability content, and assessment methodology. I reviewed the SU course designation application the instructor submitted to earn SU designation. This application is a matrix where an instructor explains how their course teaches and were assessing students learning the SLOs. This process happened before the classroom observation and instructor interview, enabling me to get to know the structure of the course.

As I reviewed course document review material (assignment descriptions, course observation notes, syllabi, etc.) looking for examples of the different aspects of instructional practice, sustainability content, and assessment methodology, I began to build a list of codes. Codes are “labels for assigning unit of meaning to the descriptive or inferential information compiled during a study (Miles & Huberman, 1994, p. 56). Coding data allowed me to organize related evidence of a topic from multiple data sources and retrieve all of it together. I did not start the data analysis process with a set of codes; rather I inductively created codes as I reviewed the data, which allowed for a more

open approach and ability to respond to the context specific process (Miles & Huberman, 1994).

After the document review process, I thought the following categories of codes would be present in the data: instructional practices (ways, methods, and techniques for teaching student), course content (sustainability topics covered in the courses), setting characteristics (aspects of the SLOs, process of gaining SU approval, structural aspects of teaching at UVM), perspectives (ways of thinking about sustainability), assessment strategies (exams, quizzes, projects, I-clickers, class discussions, homework, papers), and learning processes (characteristics of learning environments that instructors or student prefer). These categories or schemes helped me think about the specific codes as I developed them (Miles & Huberman, 1994).

The instructor interviews, key informants, and student focus groups were transcribed and analyzed. At first I printed the transcriptions so I could make notes in the margins as I carefully reviewed them. After spending time looking for commonality, I created codes that emerged from my data and then operationally defined them (Miles & Huberman, 1994). I clustered codes around common themes, which consist of several codes put together under broad units to form a common idea (Creswell, 2013). I created code labels, organized by themes. Transcripts and the list of codes were uploaded to HYPER research. I assigned the codes to the transcripts, protocols, and open-ended survey questions. The same codes were used for all data sources; even if a code is not applicable to all data from all sources it will still be part of the master list of codes.

All data from protocols, interviews, and focus groups, as well as open-ended survey questions were coded; codes were organized into emergent themes. Counts and

frequencies across data sources for different coding categories were calculated and taken into consideration. I triangulated strong themes and trends from different data sources (Creswell, 2013). I pieced together themes to tell the story of this case study. I thought about how each theme (group of codes) fit into my conceptual and theoretical framework. Qualitative research is about showing relationships between things (Glesne, 2011). To aid in my analysis I created a table summarizing each course's characteristics by content, teaching practices, and assessment strategies using information from the document review, the instructor interviews, and the SU assessment matrix (see Appendix M). This table allowed me to compare and contrast across courses.

My belief in the importance of education for sustainability may have biased my findings analysis and interpretation. Writing the memos of my impressions immediately after each interview, focus group, and classroom observation encourages awareness of how my emotions could have influenced my findings. I also wrote notes throughout the data analysis, as a way to support analysis but also to reflect on my potential bias. One measure to help control my bias was asking another researcher to assign codes to one of the interview transcripts and one of the focus group transcripts for inter-rater reliability. We talked through any differences in coding coming to an agreement. Utilizing the HYPER research program's ability to pull all text assigned to each code, I carefully read through the text to ensure that there was consistency and not any code drift. Having another researcher code a transcript, writing memos of my thoughts, and reading through all codes to ensure consistency were steps taken to ensure trustworthiness. This study's usage of a variety of methods will enable triangulation of findings to increase trustworthiness (Glesne, 2011).

Survey data were cleaned, correcting any errors, reverse coding necessary scores, and computing new variables, some through factor analysis. I explored the data conducting statistical analysis to see the distribution of data and descriptive analysis (Creswell & Plano Clark, 2011). Frequencies – means, regressions, factor analysis, crosstabs and chi-squared – were used to analyze relationships between data from the survey questions. Table 3.7 outlines the data analysis processes that were taken for data elements in each survey question. Survey respondent data are presented in frequency charts by course and totals across all courses.

Table 3.7

Survey Questions Data Analysis Process

RQ	Description of data analysis
#2	Total count of respondents per course were calculate and percentages of respondents per total number of students in the course were calculated
#3, 4, 6 11, 12, 14	Ordinal data- calculated the number of times each likert scale option was selected per statement and displayed in percent frequencies in a table. For Q3 I created a dualism subscale via factor analysis and for Q12 I created a values subscale via factor analysis. I compared these variables with other variables such as sustainability knowledge using chi squared tests (total correct of Q 18-29). I also used regression to look at the relationship between values, dualism, and learning.
# 7,8	Calculated how many times each classroom activity was selected and how helpful the activities were rated and reported total in a table. I looked at the relationship between teaching practices and students perceived learning using a chi squared test of independence. I compared these data with student focus group findings.
# 5, 9, 10	Created a data file with all the open ended question answers and upload it into hyperRESEARCH for analysis with the codes created from the other data sources. I compared this data with student focus group findings.
#18-29	I looked at how many students choose each answer to the knowledge multiple-choice questions; create percent frequency tables with the correct answer highlighted. I calculated a student's test score (how many they answered correctly) and compared mean test score and course type, test score and how many sustainability courses they have taken before, and test score and year entered college, the dualism subscale, perceived learning subscale to see how much those variables are predictive of their test score using regression and chi squared tests where appropriate.

#13, 15, 16, 17	Demographic- I calculated the total number of selections for each category and reported percent frequencies in a table. For Q15 I created a variable for number of course taken to compare with other variables using appropriate tests.
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Together data from all sources were analyzed to gain perspective of the teaching and learning within each class and then data were examined comprehensively to identify patterns and themes for how teaching and learning is happening across UVM's SU courses. To explore within courses, I created a summary table of the course's sustainability content, teaching practices, and assessment strategies (Appendix M). Then I read through the interview, focus group, and survey open-ended questions coded text and updated the course description table considering how the different courses structured and taught the SLOs. Using the survey data, I conducted statistical tests by courses, such as comparing means, chi squared, and cross tabs, to investigate relationships with other variables (helpfulness of teaching practices, perceived student learning, and sustainability knowledge scale scores). To explore patterns across courses, I used the course description table to consider the teaching practices, sustainability content, and assessment strategies that were shared and were different among the courses. I created three different course types (reoriented, new unit, and embedded) after considering compared and contrasted the different course design approaches instructors used to incorporate the SLOs. Using a course type variable in SPSS, I investigated its relationship with other variables (student learning and teaching practice helpfulness). In addition to the quantitative survey findings, I used the coded qualitative data to summarize key themes across all courses. Findings are presented in the following two chapters.

CHAPTER FOUR: SCHOLARLY ARTICLE

A Sustainability General Education Requirement: Exploring Teaching Practices

Nationwide, higher education institutions are increasingly interested in infusing sustainability content into their curricula. This can be accomplished through general education programs. The University of Vermont (UVM) recently established a sustainability general education requirement, which is being addressed through a variety of courses. This new program creates a unique opportunity to explore teaching practices for sustainability content within the context of general education requirement coursework. The purpose of this study was to explore how instructors structured and taught sustainability learning outcomes within courses designed to meet this general education requirement. The variety of data collection methods (online survey, interviews, focus groups, observation, and document review) enabled identification and triangulation of strong themes. Instructors used class discussions, papers, readings, projects, guest speakers, and case studies to teach sustainability. Students reported the following teaching practices particularly helpful: experiencing a real world application, discussing sustainability issues in class, exploring different perspectives, and learning from guest speakers. Findings suggest that learning from case studies, guest speakers, and written papers may be more helpful to students with prior sustainability coursework. Encouraging instructors to reflect upon their teaching experiences and student assessments could further improve future teaching. Recommendations for practice and policies are discussed.

Keywords: General Education; Sustainability-across-the-curriculum; Backwards Design; Education for Sustainability; Teaching Practices

Nationwide, higher education institutions (HEIs) are increasingly interested in incorporating sustainability content into their curricula, but are doing so with limited ability to make recommendations to instructors about how to teach sustainability-related content and skills. Sustainability, as defined at The University of Vermont, is “the pursuit of ecological, social, and economic vitality with the understanding that the needs of the present be met without compromising the ability of future generations to meet their own needs” (Hill & Wang, 2014, p. 4). HEIs have the opportunity to play a critical role in improving future quality of life by graduating students with problem-solving skills and knowledge of the interconnections of economic, ecological, and social dimensions of sustainability issues (AASHE, 2010). Rowe (2002) recommends establishing a general

education requirement as an effective way to infuse sustainability throughout all curricula.

This study draws on the experience of one HEI, The University of Vermont (UVM), and its establishment of a sustainability general education requirement for all undergraduates. UVM's general education programs are a collection of approved learning outcomes, not a list of required courses. Students learn the required outcomes through three pathways; enrolling in a sustainability-designated (SU) major, taking a SU course, or participating in an approved co-curricula program. This study is exploring SU courses; the most commonly used pathway for students to fulfill general education requirements. In April 2015, UVM's Faculty Senate approved the following Sustainability Learning Outcomes (SLOs) as a general education requirement:

- **Learning outcome 1:** Students can have an informed conversation about the multiple dimensions and complexity of sustainability. (knowledge category)
- **Learning outcome 2:** Students can evaluate sustainability using an evidence-based disciplinary approach and integrate economic, ecological, and social perspectives. (skills category)
- **Learning outcome 3:** Students think critically about sustainability across a diversity of cultural values and across multiple scales of relevance from local to global. (values category)
- **Learning outcome 4:** Students, as members of society, can recognize and assess how sustainability impacts their lives and how their actions impact sustainability. (personal domain) (Hill & Wang, 2014, pp. 4-5).

Faculty interested in teaching a course that meets these learning outcomes and fulfills this sustainability requirement are required to apply for designation. The designation process involves explaining how faculty will teach students the SLOs and how they will assess for student learning. UVM has an "embedded" course model for their general education programs because they do not require a distinct course, rather a variety of courses fulfill the requirements.

The purpose of this study was to explore how instructors structured and taught sustainability learning outcomes within courses designed to meet this new general education requirement. Simply developing a number of sustainability courses will not necessarily lead to the desired student learning and skill development. Information is needed about how best to infuse sustainability content and learning into undergraduate curricula. The implementation of this new requirement created a unique opportunity to explore instructors' sustainability-related teaching practices and students' learning experiences in a variety of disciplines. Specifically, this study considered the following two questions: (1) In what ways did instructors structure their teaching to reflect the Sustainability Learning Outcomes (SLOs) in their sustainability-designated (SU) courses? (2) To what extent did students perceive their instructor's teaching practices were more or less helpful to their learning? In answering these questions, this study has potential for contributing to two distinct bodies of literature: (1) how instructors incorporate sustainability learning outcomes into their teaching; and (2) students' perceptions of helpful teaching practices for learning about sustainability.

The remainder of this paper is organized as follows. First, I discuss higher education general education initiatives related to sustainability and this study's context, the UVM sustainability general education requirement. Second, I present existing literature on the education for sustainability framework, sustainability teaching practices, and backwards curriculum design. Third, I provide an overview of the study design and data collection methods. Fourth, I offer a summary of study findings on students' perceptions of learning, instructors' course design approach, teaching practices, and

suggestions for improvements. Finally, I conclude with a discussion of study findings' implications for teaching and institutional practices.

Background

Emerging initiatives call upon HEIs to teach students sustainability content, such as the United Nations' call for universities to revise curricula to include a clear focus on cultivating sustainability knowledge, skills, and values (Tilbury, 2011; Wals, 2014). At this point, in fact, over 700 schools have signed the American College and University President's Climate Commitment (ACUPCC), indicating that they will make sustainability a part of their curricula for *all* students (AASHE, 2010; Hattan, 2009). Numerous HEIs have created distinct sustainability majors or minors while others have increased their sustainability course offerings. These strategies do not necessarily reach all students (Hattan, 2009; Rowe, 2002). In a report providing HEIs guidance for teaching sustainability, the ACUPCC recommends incorporating sustainability in all disciplines rather than isolated courses, with the ultimate goal of full integration throughout the curriculum (Hattan, 2009).

Given general education programs' ability to reach all students, HEIs are increasingly interested in establishing sustainability general education programs. A number of HEIs have added components of their general education programs that align with sustainability principles, such as social responsibility and civic engagement (D. Rowe, personal communication, 2016). Other HEIs established sustainability general education requirements that either require a specific sustainability course or embeds sustainability content into a variety of different courses (Hattan, 2009; Rowe, 2002). Nationally, almost 20 HEIs have implemented sustainability general education

requirements. They fall into two categories of nine institutions each: 1) small (less than 3,000 students) private institutions; and 2) large (more than 10,000 students) public institutions. UVM is an example of a larger public university with an embedded course model for their sustainability general education requirement.

There is a natural affinity between goals for general education programs and goals for sustainability education, particularly given the interdisciplinary nature of sustainability issues and importance of social responsibility and problem solving skills. The big ideas and skill development associated with sustainability education overlap with most disciplines making it possible to widely incorporate sustainability concepts (Hattan, 2009). General education programs were created to prepare all students to become educated citizens and workers with the ability to think critically, problem solve, learn collaboratively, communicate effectively, and cultivate a sense of social responsibility (Gaston, 2015). Sustainability education aims to teach students from a variety disciplinary perspectives problem solving skills because addressing sustainability issues will require a variety of expertise; establishing related general education programs could help achieve this goal (AASHE, 2010).

UVM's Sustainability General Education Requirement

In April 2015, UVM's Faculty Senate approved four sustainability-learning outcomes as a general education requirement. All undergraduate students matriculating to UVM beginning in Fall 2015 are required to satisfy the sustainability requirement to graduate (Kaza, Natkin, & Rowse, 2015). This requirement can be met in various ways, including enrolling in a sustainability-designated (SU) major, taking a SU course, or participating in an approved SU co-curricular program. The launch of UVM's

requirement provided an opportunity to investigate how the defined SLOs, within an embedded course model approach, are being taught. There is also an opportunity to discern how students are learning them within a variety of disciplinary contexts.

UVM's university-wide sustainability curricular requirement was established after six years of a sustainability-focused faculty professional development program. This Sustainability Faculty Fellows (SFF) Program was designed to enhance sustainability education by bringing faculty members from across the University together to expand their knowledge of sustainability concepts and to learn pedagogical strategies for integrating those concepts in curricula (Natkin & Kolbe, 2016). Each year the program accepts 15-20 participants. By 2016, 118 faculty and staff representing 38 departments had completed the SFF program (Natkin & Kolbe, 2016). Program participants are expected to design or enhance a course to integrate sustainability concepts, which was advantageous in supporting course capacity for the SU general education requirement (Kaza, Natkin, & Rowse, 2015).

Conceptual Framework

This section reviews literature about the Education for Sustainability (EfS) framework, sustainability-related teaching practices, and the backwards course design approach. It concludes with a description of this study's conceptual framework.

Education for Sustainability

One framework that might offer guidance to HEIs' instructors teaching sustainability is Education for Sustainability (EfS) (Cirillo & Hoyer, 2015). EfS aims to motivate and transform student learning by linking knowledge, inquiry, and action through innovative pedagogy, such as inquiry-based, project-based, place-based, and

service-learning (Cirillo & Hoyer, 2015). These teaching practices prepare students to think critically, ask critical questions, work collaboratively, and consider their behavior on others now and in the future (Cirillo & Hoyer, 2015). EfS involves teaching practices that stimulate transformative learning, going beyond foundational knowledge to cultivate values and dispositions in students who will support global justice (Sterling, 2004; Walls & Dillon, 2013). Nolet (2016) explains EfS' aim for changing students' worldviews, defining a sustainability worldview as a "way of seeing and engaging with the world through the lens of sustainability" (p.10). There are many key concepts for students to understand when they are cultivating a sustainability worldview, such as the underlying principles that govern complex systems, ecological principles, science of climate change, and social justices issues (Meadows & Wright, 2008; Wessels, 2006). However, it is important to understand that EfS is not a subject to be taught; rather it is a way of thinking to be developed. In other words, it is "not primarily teaching *about* sustainability but teaching *towards* sustainability" (Jenson, 2013, p. 25).

Sustainability Teaching Practices

There are many different recommended EfS teaching approaches for sustainability content. Nolet's (2016) book entitled *Educating for Sustainability: Principles and Practices for Teachers*, provides a concise overview of teaching practices. Using Nolet's book and other resources, I broadly categorized four types of teaching practices: 1) inquiry-based, 2) experiential, 3) collaborative, and 4) reflective (Cirillo & Hoyer, 2015; Holdsworth et al., 2013; Sterling, 2004; Shriberg & MacDonald, 2010; Wals & Dillon, 2013). These practices can be used as stand-alone instructional approaches or in combination with one another. Each practice is described below.

Inquiry-based learning. Nolet (2016) defines inquiry-based learning as instructors facilitating learners as they take responsibility for investigating open-ended questions in a way that is meaningful to them. Two approaches to inquiry-based learning are project-based learning and posing essential questions to students (Cirillo & Hoyler, 2015; Nolet, 2016). Essential questions “serve not only to promote understanding of the content of a unit on a particular topic; they also spark connections and promote transfer of ideas from one setting to others” (Wiggins & McTighe, 2005 p. 107). Project-based learning engages students with a problem, complex question, or challenge for an extended period of time to build skills.

Experiential learning. Experiential learning engages learners in direct experiences to build knowledge and skills (Nolet, 2016). Experiential learning methods engage students with course material that reflect real life applications. Students learn by analyzing case studies, connecting course material to their own lives, or engaging in creative problem solving through applied learning experiences (Holdsworth et al., 2013; Nolet, 2016; Sterling, 2004; Wals & Dillon, 2013). Service-learning is an experiential learning practice where students address real world issues while participating in a service activity (Cirillo & Hoyler, 2015; Nolet, 2016; Shriberg & MacDonald, 2010).

Collaborative learning. Collaborative learning occurs when learners work together to accomplish learning goals (Nolet, 2016). This can happen in many different types of class activities such as discussions, group projects, papers, presentations, or peer review of each other’s work. Collaborative learning experiences challenge students to articulate their understanding to peers while developing social skills (Nolet, 2016; Simon, 2002).

Reflective learning. Reflective learning allows students to analyze and give serious consideration to how their learning experience, new knowledge, and skill development relates to their lives and identity (Nolet, 2016). Nolet (2016) recommends teaching practices that support students and gives them the time, space, and structure to reflect on their own ways of looking at the world and their societies' values, inviting them to question their assumptions, beliefs, and values.

Backwards Course Design Approach

In Fall 2010, UVM started approving learning outcomes as their general education requirements, compared to requiring certain courses. Johnston (2013) advocates for requiring learning outcomes as general education programs because learning goals are clearly defined allowing faculty to figure out how to integrate them. Wiggins and McTighe's (2005) *Understanding by Design* framework that offers a backwards design approach to creating course curricula. The backwards design approach is a three step process beginning with identifying desired results, followed by determining acceptable evidence that students have achieved those results, and concluding with planning the learning experiences.

The backwards design approach challenges instructors to shift their focus from how they will teach to how they will know if students are learning (Wiggins & McTighe, 2005). This approach is particularly helpful to EfS because of its focus on developing student skills rather than content knowledge. UVM's general education learning outcomes identifies the desired learning goals, enabling instructors to use the backwards design approach to create their course curricula. Instructors have the opportunity be intentional about what evidence of learning students will produce to indicate that they are

meeting the desired outcomes, which is an important step in assessing the efficacy of their planned curricula (Wiggins & McTighe, 2005).

Cyclical Process

It is important for instructors to consider how students learn course material so they can make necessary curricular adjustments (Woolson, 2015). Instructors are constantly gathering information about how students are processing their planned curriculum through conversations, student reactions, and course assignments. Assessment is the gathering of data on student learning with the intent to improve teaching practices and student learning (Walvoord, 2010). Establishing learning outcomes can foster instructors' ability to reflect on how students are learning the desired outcomes (Johnston, 2013). Taking time to reflect on how students experience a course curriculum and how the course can be improved enables instructors to make informed future course design decisions. See Figure 4.1 for an illustration of the cyclical process of this form of teaching and learning. Instructors design their course activities, choosing the content and teaching practices they will implement to support student learning. This study explored the four components of the process of teaching and learning in a sample of SU courses.

Figure 4.1. Cyclical process of teaching and learning

Study Overview

As HEIs become more interested in incorporating sustainability into their curricula, information is needed about helpful teaching practices for effective student learning. Overall, there is a shortage of research on how to best structure and teach sustainability and which EfS-associated teaching practices are most common in higher education classrooms (Lundholm, Hopwood, & Rickinson, 2013; Rowe, 2002). Given the lack of information about sustainability teaching practices, the purpose of this study was to explore how instructors structured and taught sustainability learning outcomes within general education courses. Specifically, this study addresses the following two research questions:

1. In what ways did instructors structure their teaching to reflect the Sustainability Learning Outcomes (SLOs) in their SU-designated courses?
2. To what extent did students perceive their instructors' teaching practices were more or less helpful to their learning?

To systematically gather people's perceptions of and experiences with the new general education requirement, I reviewed relevant course material, observed class sessions, led instructor interviews, facilitated student focus groups, and administered an online student survey. Using a variety of methods enabled me to analyze data from a variety of angles triangulating it around identified strong themes. Data were analyzed to explore how instructors designed their courses to teach the SLOs, which teaching practices were used, which teaching practices students found helpful to their learning, and suggestions for course improvement. The following section describes how the research sample was selected and the data were collected and analyzed.

Data and Methods

Course Selection

Eight sustainability-designated courses made up this study's sample. A stratified purposeful sampling strategy was used to select a sample of courses to capture characteristics of interest to facilitate comparisons (Patton, 2002). Selection criterion included sustainability-designated (SU) courses taught in the Spring 2016 semester and representing a variety of disciplines, and a variety of course sizes. Table 4.1 summarizes the eight participating courses' department, enrollment number, instructor rank, and identifying disciplinary code.

Table 4.1.

Participating Course Characteristics

Department	Course Enrollment	Instructor Rank
Geography (GEOG)	106	Lecturer
Natural Resources (NR)	53	Assistant Professor
Economics (ECON)	116	Associate Professor
Elementary Education (EDEL)	14	Assistant Professor
Electrical Engineering (EE)	16	Associate Professor
Environmental Studies (ENVS)	36	Assistant Professor
Nutrition and Food Sciences (NFS)	69	Lecturer
Plant Biology (PBIO)	69	Senior Lecturer

Data sources. Data were collected from instructors and students involved with this study's sample of eight SU- designated courses using the following methods: 1) document review, 2) instructor interviews, 3) classroom observations, 4) student focus groups, and 5) student survey. Table 4.2 provides a description of each data collection procedure.

Table 4.2

Summary of Data Collection Procedures

Procedure	Description
Document Review	Systematic review of course documentation provided information about how instructors structured the sustainability content within their courses. Instructors were asked to submit course materials including: the course syllabus, SU designation application, assignment instructions, exams, and grading rubrics (if any). I synthesized data about course content, teaching practices, and assessment strategies captured from the multiple documents submitted per class onto one protocol form.
SU Course Assessment Matrix	The purpose of this matrix was to understand how instructors assessed students learning the SLOs, what instructors discovered about student learning through their assessments, and how that information informs actions they will take in future courses. This matrix was designed during an assessment workshop at UVM led by Barbara Walvoord (an assessment consultant).
Classroom Observation	One class session per participating SU course was observed and structured field notes were taken according to an observation rubric. The rubric gathered information about the classroom layout and class activities.
Instructor Interviews	One-on-one semi-structured interviews were conducted with instructors. They loosely followed the specific interview protocols. Interviews were digitally recorded for transcription and analysis. Instructors were asked about their teaching experiences in their SU course. Interview lasted approximately 45-60 minutes.
Student Focus Group	The purpose of the focus groups was to learn about students' learning experience in their SU course, particularly, which teaching practices were helpful to them. I facilitated three one-hour semi-structured focus groups: one with 7 students, one with 5 students, and the last one with 4 students. Two representatives from each class participated (n=16). Students received \$20 on their student account for their time. Funding came from UVM's Office of Associate Provost for Teaching and Learning.
Student survey	The purpose of the survey was to assess the extent to which students perceive they learned the sustainability learning outcomes in their SU course. Students were emailed an invitation to complete an online survey towards the end of the semester. The survey took about 12 minutes to complete.

Survey respondents and instrument. At the end of the semester, students (n=479) enrolled in participating courses were invited to participate in an online survey and a focus group. Of the 479 students, 178 students completed the survey (37 % response rate) (see Appendix N for student response rate by course). The survey was

designed to capture students' perceptions of how the SU course helped expand their skills and knowledge related to the SLOs (see Appendix L for survey instrument). Survey questions were designed to capture students' perception of how the course helped expand their understanding of UVM's SLOs. Given the study's focus on teaching practices within SU courses and complexities associated with measuring students learning, the survey was not designed to measure actual student learning, rather, to measure students' *perceptions* of what they learned in their course.

Analytic approach. Conducting a within-course analysis followed by an across-course analysis, I analyzed information about each course gaining an understanding of that course and then looked across all courses (Bloomberg & Volpe, 2012). To assist my ability to compare and contrast courses, I created a course description table summarizing key characteristics of each courses' teaching practices, sustainability content covered, and assessment methodology into one large table (see Appendix M). Frequency tables were created and analyzed using the online survey data. Independent-samples t-tests were performed to determine if students who have taken prior sustainability-related courses were more likely to find specific teaching practices more or less helpful compared to students without prior sustainability-related courses. Survey data were examined along with coded instructor interview transcripts, course protocols, and transcriptions of student focus group discussions to identify patterns and themes of SLO teaching and learning in UVM's SU courses.

Findings

Findings are organized according to four key topics aligned with the study's research questions: (1) student perceptions of sustainability learning, (2) course design for sustainability, (3) course teaching practices, and (4) instructor and student reflections.

Student Perceptions of Sustainability Learning

Student survey questions were designed to gather students' perceptions about their learning related to UVM's four sustainability-learning outcomes (SLOs). Most students (over three-fourths) reported their course expanded their learning of the SLOs "somewhat" and "to a great extent" (see Table 4.3).

Table 4.3

Extent To Which Student Participation in Their SU Course EXPANDED their Learning of the SLOs (n=178)

	To a great extent (%)	Somewhat (%)	A little (%)	Not at all (%)	Was not covered in class (%)
Knowledge of Sustainability	43.3	41.6	12.4	2.8	0
Ability to have an informed conversation about sustainability	42.1	39.3	12.9	4.5	1.1
Ability to analyze the ecological, economic, and social dimensions of sustainability issues	49.4	38.2	8.4	2.8	1.1
Ability to think critically about the values associated with sustainability issues	48.9	37.6	9.6	3.4	0.6
Ability to understand how local sustainability issues are related to the global community	49.4	36.5	10.7	2.2	1.1
Ability to assess how your life impacts sustainability issues	44.4	34.3	12.9	5.1	3.4
Understanding of the complexity of sustainability issues	51.1	34.3	10.1	2.2	2.2

Courses were most successful in expanding students' understanding of complexity (SLO #1), understanding of how local issues are related to the global community (SLO #3), and their ability to analyze the three dimensions of sustainability issues (SLO #2).

Comparatively, courses were less successful in expanding respondents' knowledge of sustainability (SLO #1), their ability to assess how daily life choices impact sustainability issues (SLO#4), and ability to have an informed conversation (SLO #1). Almost 80 percent of students indicated their course expanded their understanding of the UVM's SLOs "somewhat" or "to a great extent."

Course Design for Sustainability

In this section I describe how the eight courses were designed to teach UVM's SLOs. In general, there were three approaches instructors used to incorporate the SLOs into their coursework. They either re-oriented curricula to incorporate sustainability, designed a new sustainability unit, or embedded sustainability content throughout course activities (Meagher, 2013). The breadth and depth of sustainability-related content also differed among the course design approaches. Based on instructors' course design approach, courses were characterized according to a three-part typology: (1) reoriented courses, (2) new unit courses, and (3) embedded throughout courses. Courses were placed into different types primarily according to their course design approach, but four other key characteristics were also factors: (1) level of sustainability content exposure, (2) range of content, (3) variety of teaching practices, and (4) extent of assessment. Students' exposure to sustainability content varied from introductory too deep and the range of topics varied from narrow to widespread. Instructors used a variety of different teaching practices and assignments to assess student learning related to sustainability

content. Based on this analysis, GEOG, ECON, and PBIO were typed as reoriented courses, EE and EDEL were typed as new unit courses, and ENVS, NR, and NFS were typed as embedded throughout courses. Table 4.4 provides a summary of the five key characteristics by course type.

Table 4.4

Course Level Content, Teaching Practices, and Assignment Characteristics

Content Topics	Teaching Practices	Assessment Strategies
Reoriented Courses- GEOG, ECON, PBIO		
Introductory and widespread exposure		
Systems, agriculture, globalization, trade, pollution, consumption, production, equity issues, climate change, plant biology, economics, green revolution, tragedy of the commons, health, cultural diversity, social responsibility	Inquiry-based- lecture, essential questions Experiential- case studies, guest speakers, films and podcasts, current news articles Collaborative- small group activities, and little class discussion Reflective- readings & <i>(small writing assignments)</i>	Exam questions, quizzes, small writing assignments
New Unit Courses- EE, EDEL		
Deep and narrow exposure		
Systems, renewable energy, health issues, pollution, electric energy, economics, climate change, big ideas of sustainability, ecology, social responsibility, equity issues, citizenship, environmental education	Inquiry-based- lecture, problem based learning, essential questions, & <i>(project assignments)</i> Experiential- class activities, case studies, guest speakers, place-based Collaborative- some class discussion, small group activities Reflective- readings & <i>(reflective journal assignments)</i>	Lab reports, exam questions, group projects, journal reflections, and small writing assignments

Embedded Throughout courses- ENVS, NFS, NR Deep and widespread exposure		
Systems, agriculture, equity issues, place, fair trade, globalization, food production, health issues, climate change, energy production, water quality, consumption, pollution, bio mimicry, eco-effectiveness, efficiency, social responsibility	Inquiry-based- lecture, essential questions, problem based learning, & <i>(project assignments)</i> Experiential- role play activities, guest speakers, films, in class activities, service learning, case studies, place based, current news articles Collaborative- small group projects and presentations, lots of class discussion, small group activities Reflective- readings, & <i>(role play, in class activities, reflective writing assignments)</i>	Reflective essays, argument and research papers, peer review, small writing assignments, projects, group presentations

Reoriented course instructors' (GEOG, PBIO, and ECON) design approach was to reorient key questions and thematic foci to incorporate sustainability. Sustainability concepts were woven throughout existing course curricula, providing students with an introductory and widespread exposure to sustainability related content. The new unit course instructors' (EE and EDEL) created a new unit, consisting of lectures, applied projects, and class activities. Infusing sustainability into a new unit provided students with a deep and narrow exposure to sustainability content applicable to their professional field. The embedded course instructors' (ENVS, NFS, and NR) infused sustainability content throughout course activities and assignments, providing students with a deep and widespread exposure to sustainability content. For example, the NR course syllabi stated that the entire course would be situated within the context of sustainability.

Instructors' assessment of student learning ranged from a few exam questions to multiple papers and projects. Instructors used different approaches to assess student learning that largely corresponded with their course design approach. Reoriented course instructors primarily used exam questions to assess student learning, often due to large

class size. One of these instructors reported having a hard time assessing student learning because exams did not provide enough data. New unit course instructors used lab reports, small group projects, exam questions, and small writing projects as mechanisms for assessing learning. Embedded course instructors used most of the courses' assignments to assess students' learning about sustainability, such as projects, papers, and presentations. Due to the depth of in-class student discussions, embedded course instructors were able to assess how students were processing sustainability content. One embedded instructor shared how helpful the reflective papers were in "gauging how students were processing and their change over time."

Course Teaching Practices

The student survey asked participants to select the class activities they experienced in their sustainability course. Students' (n=178) most commonly selected activities were: class discussion (87%), readings (82%), guest speaker (55%), paper (44%), reflective activity (43%), and case studies (38%). Through analysis of qualitative data from the document review, instructor interviews, and the student survey, teaching practices were aligned with the following four types: (1) inquiry based, (2) experiential, (3) collaborative, and (4) reflective. Table 4.5 describes examples of teaching practices within the four types.

Table 4.5

Examples of Sustainability Teaching Practices and Assignments

Type	Examples
Inquiry-Based	
Pre-lecturer assignment	PBIO- Pre-lecture assignments- students had to answer 2-3 essential questions about the readings before lectures through the online class database. An example: What critical ecological services do pollinating animals provide?
Project	EE- Energy consultant lab- Student teams were hypothetically hired by an developer to choose the type of power plant to be build to generate a certain amount of energy. Using real data, students analyzed natural gas, solar and wind energy and made a recommendation considering environmental impacts.
In class activity	EDEL- World café- During a field trip, small groups of students answered questions on easel paper around the room- What do we want students to care about? What do we want students to know? What do we want students to be able to do? What is our role as educators?
Problem based	ENVS- Final solutions paper- Students had to define a sustainability issue along the three axes of sustainability and propose a solution.
Experiential	
Service-learning	NR- Service-learning- Student groups were assigned topics to prepare an educational activity for the community Day in the Dirt event.
Real world application	NFS- Intergenerational Interview- Students had to interview an elder in their community to find out where their food came from when they were young.
Role play	ENVS- Fred friendly- Groups of 10 students were assigned roles and given hypothetical situations related to a common sustainability issue (i.e. fracking). Each student came prepared to assume their role and discuss the situation in front of the class.
Collaborative	
In class small group activity	NFS-Group role play- Students were given prompts and roles to work on outside of class. In class they gathered in their established small groups to take the perspective of their assigned roles and describe the food system. Example roles: food catering, dietetics, and consumer education.
Group project	NR- Group news critique- Student groups presented a health related popular press news article to the class. They examined the science behind the topic to challenge assumptions. Students provide feedback on the group to instructor.

Class Discussion	NR & ENVS- Sustainability buffet- Students viewed images, policy statements, and quotes reflective of different definitions of sustainability. Individually and in small groups they created a definition of sustainability. Then the entire class discussed the complexities in defining the term sustainability.
Reflective	
Journal	NFS- Reflective journal and final paper- Students wrote four sustainability related journal entries and a final reflective essay explaining how food systems impact their lives and how their actions impact food systems.
Blog posts	PBIO- Plants in the news blog posts- Student had to find three articles from popular or scientific press on topics related to the course and posted summaries of the articles that were visible to the entire class.
Small writing assignment	NR- Free write- Students were asked to do a free write with the following prompts: What role can we play as individuals to minimize the environmental and human health impacts of energy use and production? What does energy look like in a sustainable world?
Project	NR-Sustainability well-being challenge- Students were challenged to take an affect survey (PANAS) and then complete a challenge such as making a new social connection, helping other, participating in a mindfulness practice, and a physical activity and then take the affect survey again. Students wrote follow-up reflection papers.

Helpfulness of teaching practices. Course instructors taught students about sustainability using a variety of teaching practices; however, students did not find them equally helpful. On the survey students indicated the extent to which certain teaching practices were helpful to their learning. Eighty-two percent of students reported class discussion, 74% reported readings, and 59% reported guest speakers as “somewhat” or “to a great extent” helpful to their learning (see Table 4.6).

Table 4.6

Students' Indication of the Helpfulness of Teaching Practices (N=178)

	To a great extent (%)	Somewhat (%)	A little (%)	Not at all (%)	Did not happen in class (%)
Class discussions about sustainability	53.4	28.1	9.6	4.5	4.5
Sustainability related readings	35.2	38.6	11.4	4.5	10.2
Guest speaker about sustainability	34.9	24	4.6	8.6	28
Activities with a real life application	31.8	18.2	2.8	7.4	39.8
Reflective activities about sustainability	31.3	22.7	5.1	8.5	32.4
Case study related to sustainability	28.8	22	5.6	7.9	35.6
Group projects about sustainability	23	14.9	4.6	13.8	43.7
Written paper about sustainability	20.3	24.3	8.5	12.4	34.5

Students were also asked to describe the most helpful sustainability related learning experience in their SU course. Student answers (survey and focus groups) were coded and organized by the types of four teaching practices. Aspects of each teaching practice types were mentioned the following number of times: experiential learning (157), collaborative learning (88), reflective learning (76), and inquiry-based learning (58). The most frequently mentioned specific teaching practices were: (1) using real world examples that apply to their learning, (2) discussing sustainability issues in class, (3) having an opportunity to understand different perspectives, (4) learning with peers, experiencing a sense of agency, and (5) learning from a guest speaker. One student said that “the most helpful learning experience was our in-class discussions where we can debate back and forth beyond just reading and regurgitating information onto a test.”

Another student shared that writing assignments were most helpful “because I had to find evidence to support my claims, and had to analyze that evidence. It gave me a greater depth of understanding surrounding the material I incorporated into my papers.”

To assess students’ exposure of sustainability prior to the spring 2016 semester, students were asked to indicate the number of previous sustainability courses they had taken. For nearly half of the students, the Spring 2016 SU course was their first sustainability-related course at UVM. For one third of the students, the SU course was their second or third sustainability course (see Appendix O for students’ number of previous sustainability-related courses). Students’ perceptions of how helpful certain teaching practices were to their learning varied according to the number of prior sustainability-designated courses they completed. See Table 4.7 for the percentages of students who indicated their courses expanded their understanding of the teaching practices to “somewhat” or “to a great extent” by the number of prior sustainability-related courses (none or more than one). Students with prior coursework were more likely to indicate the following teaching practices were “somewhat” or “to a great extent” helpful in expanding their understanding of sustainability: papers ($p = .004$), guest speakers ($p = .012$), and case studies ($p = .023$). In addition, there was some evidence to suggest that students with prior coursework may have also found course readings ($p = .077$) and reflective activities ($p = .057$) more helpful to their learning; however, the differences between groups were not statistically significant at conventional levels.

Table 4.7

Students' Indication of Helpfulness of Teaching Practices by Number of Prior Courses

Students Responding “Somewhat” or “To a Great Extent”				
Overall N		Number of Prior Sustainability-related Courses		
Teaching Practices		None (%)	> 1 (%)	Significance
Readings	158	76.4	87.2	+
Class discussions	170	80.5	89.2	
Written papers	116	54.7	79.4	**
Guest speakers	126	72.4	89.7	*
Reflective activities	119	71.4	85.7	+
Group projects	98	64.4	69.8	
Case studies	114	68.8	86.4	*
Activities with real life application	106	78.0	86.2	

Note: * $p < .05$; ** $p < .01$; *** $p < .001$; + $p < .10$

Instructor and Student Reflections

Instructors and students were asked to share ideas for improving their teaching and learning experiences in their SU courses. The following subsections summarize their feedback.

Instructor reflections. Instructors filled out an assessment matrix reporting what course activities and assignments they used to assess students' learning the SLOs, what they found out about how students were learning the SLOs, and what actions they planned to take in the future based on that information. Many instructors expressed gratitude for the process of filling out the assessment matrix. One said, "I appreciate being able to go through this process myself, like what worked; what didn't work?" Another instructor said, "I was made aware of the need to develop interactive instruction and be okay with sacrificing some lecture time in order to build in group work." A few

instructors shared the realization that they were unsure of how students were learning the SLOs because they did not design assessment strategies to gather specific evidence of learning. All instructors shared actions they plan to take in the future to enhance learning. Examples include: making better connection between all activities, allowing more time for class discussions, adding a field trip, making changes to assignments, explicitly addressing diversity, values, and lifestyle issues, incorporating small group work, and assigning short essays or free writes to capture data about student learning. Class discussions, journals, and reflective papers were particularly helpful for instructors to assess how students were learning the SLOs.

During their discussion of potential future changes to their courses, a few instructors commented on being completely overwhelmed by the time demands of grading. One instructor expressed a desire for a teaching assistant to help with grading and facilitating small group discussions. Another instructor explained how much easier it is in smaller classes to facilitate discussions and assign papers and projects; “it strikes me that a lot of the SLOs are easier to hit if you’re working in smaller courses.” Other instructors felt frustrated by assessment, one commenting on multiple-choice exams: “It narrows the capacity of what you can actually test. With multiple-choice it’s mostly fact retrieval-style questions; it’s right or wrong. You have no opportunity to really engage the students’ process of thinking through a problem.” Another instructor felt he did not have “time to assess in a deep way, which is particularly necessary with sustainability;” he expressed a desire for assessment related professional development.

Student reflections. Students were asked to share ways their courses could be changed to improve their sustainability learning experience. They suggested learning

more about sustainability, having guest speakers, doing group projects, and getting information about, as one student shared, “Practical ways to incorporate sustainability into lifestyles.” The most common suggestion was more class discussions; students shared reasons such as “hearing more from students about their perspectives on sustainability,” and, “more in depth conversations about the readings.” Students enjoyed having a variety of types of assignments and an ability to choose their topic. They preferred assignments that challenged them to apply what they learned rather than memorizing definitions. They liked reflective writing assignments where they had to pull everything together and said they would rather do projects than exams. One student shared the experience of PBIO’s pre-lecture assignments, “Before every class there is a question from the reading. And it’s open ended, you can write a couple of sentences. It is so simple, but very effective for starting your thought process.” Instructor reflections and student feedback for course improvement tended to mirror each other. Both shared a desire for more class discussion, more sustainability content related to value and lifestyle implications, more writing assignments and projects.

Discussion

This study explored how eight courses at one institution (UVM) structured and taught content and skills to meet sustainability learning outcomes. Findings suggest that sustainability-designated (SU) courses used different approaches to redesigning their courses and a variety of teaching practices. Across all course design approaches a majority of students perceived they learned UVM’s SLOs. Descriptions of teaching practices in this study may serve as examples for other instructors about how they can structure and teach sustainability content within courses. Instructors valued the

opportunity to report how students learned the SLOs in the course and consider future course improvements. Given UVM's learning outcomes approach to general education, the backwards course design approach is a promising strategy for instructors to incorporate desired learning into their curricula. This discussion of findings will focus on two key areas: (1) implications for teaching practices and (2) implications for institutional practices.

Implications for Teaching Practices

Findings suggest that students, in this study's sample, perceived learning the outcomes of UVM's new general education requirement. Eighty percent of students reported their courses expanded their learning of UVM's SLOs "somewhat" or "to a great extent" across all course types. Students' highest rated learning statements were about their ability to think critically about values, to understand how local issues relate to global communities, to analyze ecological, economic, and social dimensions of issues, and understand complexity. EfS aims to teach students to think critically, cultivate values, and understand the complexity interconnections of ecological, economic, and social systems (Cirillo & Hoyer, 2015; Sterling, 2004; Walls & Dillon, 2013). Students reported that UVM's SU courses are expanding their learning of these important skills.

Students indicated their courses were less successful at expanding their ability to have an informed conversation and to assess how their lives impact sustainability issues. Many students expressed a desire for more sustainability content, specifically "practical ways to incorporate sustainability into lifestyles." Students also want more opportunities to discuss issues with their peers and to work together on projects. Given these findings, instructors could consider increasing their use of collaborative and reflective teaching

practices, specifically teaching more about lifestyle considerations and allowing for time for discussions and group work.

Course instructors taught students about sustainability using a variety of teaching practices; however, students did not find them equally helpful. Students most frequently mentioned experiential teaching practices as helpful to their learning, specifically using real world examples to apply their learning and learning from a guest speaker. Using real world examples is a commonly used EfS pedagogical approach (Cirillo & Hoyler, 2015; Holdsworth et al., 2013; Nolet, 2016). All instructors hosted guest speakers and many students reported this as helpful to their learning. EfS literature does not recommend guest lectures as frequently as other teaching practices but these were perceived to be highly successful by UVM students. In an embedded course model for general education, where instructors from a variety of disciplines are encouraged to teach sustainability content, hosting guest speakers may be a way to add less familiar content.

Study findings also suggest that certain instructional methods may be more or less helpful to students with different levels of prior exposure to sustainability. Using case studies, guest speakers, and assigning papers might be more helpful to students who have more prior exposure to sustainability coursework compared to those with less exposure. It is possible that students who are familiar with sustainability concepts may have an easier time grasping related content, and students with less familiarity may need more support and time to accommodate new information (Cranton, 2006). Perhaps students with more confidence and familiarity with sustainability are better able to apply what they know to different contexts, which happens when learning about a case study, listening to a guest

speaker, or writing a paper. This potentially suggests that the teaching practices have a differential effect based on students' degree of prior sustainability exposure.

Implications for Institutional Practice

UVM's embedded course model for its general education program serves as an example for other HEIs. This study's findings support institutions in encouraging instructors to incorporate a variety of teaching practices into their curricula, such as class discussions, guest speakers, and activities that involve real world applications and perspective taking. In addition to specific teaching practice recommendations, this study's findings suggest the importance of instructors reflecting on which teaching practices worked, how students learned, and what changes might be made to strengthen course curricula. Some of the SU course instructors expressed how helpful completing the assessment matrix was for informing future course designs. Encouraging instructors to consider how students are learning course material can be an effective way to improve curricula and student learning (Woolson, 2015). The backwards course design approach helps to shift instructors' focus from content to student learning (Wiggins & McTighe, 2005).

This paper informs policies that inform professional development considerations for other institutions moving forward with designing and implementing their own programs, in particular supporting existing and creating additional assessment and pedagogy related professional development opportunities for instructors. Some students expressed a desire for a diversity of assessment strategies, especially writing assignments and activities that challenge them to apply concepts. Some instructors indicated that they did not have enough time to grade writing assignments and projects, especially in larger

courses. Given these challenges, one strategy other institutions might consider is providing more access to teaching assistants and capping student enrollment to reduce class size as way to support instructors incorporating more class discussion, interactive activities, and written papers.

A few instructors did not know whether their students met the SLO requirement because they did not gather applicable data about student learning. UVM's general education requirement has established desired learning outcomes, enabling instructors to use the backwards design course approach to intentionally aligning their teaching practices with appropriate assessment strategies to collect evidence of learning (Wiggins & McTighe, 2005). The backwards design approach begins with clear learning goals, followed by determining evidence of learning and lastly planning course activities (Wiggins & McTighe, 2005). Professional development opportunities focused on the backwards course design method may help instructors take advantage of the learning outcomes approach to general education programs. Many instructors had difficulty assessing if students were learning about sustainability, enhancing instructors' ability to use the backwards design approach could be a promising strategy to improve their assessment efforts. Finally, this study's design serves as a potential model for using a variety of methods (document review, observation, interviews, and student focus group and survey) to assess higher education teaching practices.

Limitations and Recommendations

This study explores undergraduate student learning at one specific university for a small sample of sustainability-designated (SU) courses; thus the findings are not generalizable to other students at UVM or in other contexts. The unit of analysis was the

SU courses, not individual students, so this study did not measure individual student learning. This research study's lack of a causal design eliminates its ability to make causal statements about what caused students to learn. Frequently the four types of teaching practices described can be used together, which is an important consideration when interpreting findings. It is assumed that the coursework documentation accurately represents what happened in the classroom and that study participants were honest when answering the survey, in the focus groups, and during interviews. To help ensure that participants would be truthful, they were assured their data would be de-identified and kept confidential.

This study describes teaching practices used by a small sample of instructors at one university and reports students' perceptions of their helpfulness; the next step would be to examine concretely whether certain practices have an impact on learning. Future research studies could more deeply explore how students and instructors make sense of the term sustainability. Understanding student cognitive characteristics necessary to learn about sustainability and cause a shift in worldview would be interesting. Exploring students' preferred assessment methods and finding creative ways to assess teaching practices would also be beneficial.

Conclusion

The world is facing a multitude of complex and interconnected issues – such as climate change, a growing population, global health issues, decreasing access to clean water, intensifying social justice concerns – which is creating the need for college graduates with the ability to understand systems, with strong problem solving skills, and with a sense of global citizenship. Education is a powerful mechanism for cultivating

skills and changing people's values, behaviors, and worldviews (Nolet, 2016). HEIs are being called upon to play a key role in graduating informed and engaged citizens. UVM's general education requirement serves as an example of one university's effort to graduate students with sustainability values, skills, and knowledge. This study's findings suggest that establishing a sustainability general education program is a promising strategy for cultivating the desired skills, values, and knowledge among students.

References

- Association for the Advancement of Sustainability in Higher Education (AASHE). (2010). *Sustainability curriculum in higher education: A call to action*. Retrieved from: [http://www.aashe.org/files/A_Call_to_Action_final\(2\).pdf](http://www.aashe.org/files/A_Call_to_Action_final(2).pdf)
- Bloomberg, L. D., & Volpe, M. (2012). *Completing your qualitative dissertation: A road map from beginning to end* (2nd ed). Thousand Oaks, CA: SAGE Publications.
- Cirillo, J., & Hoyler, E. (2015). *The guide to education for sustainability: Shelburne Farms' Sustainable Schools Project*. Shelburne, VT: Shelburne Farms.
- Gaston, P. L. (2015). *General education transformed: How we can, why we must*. Association of American Colleges and Universities.
- Hattan, A. S. (2009). *Education for climate neutrality and sustainability: Guidance for ACUPCC institutions*. Boston, MA: American College and University Presidents' Climate Commitment. Retrieved from: http://sustainability.wfu.edu/wpcontent/uploads/2010/02/EducationforClimateNeutralitySustainability_2009.05.07_.pdf
- Hill, L., & Wang, D. (2014). *Proposal for sustainability learning outcomes for UVM with recommendation for implementation and on-going review and assessment*. Submitted by the Ad-hoc senate committee for sustainability learning outcomes. Retrieved from: https://www.uvm.edu/~facsen/SLO_FacultySenateReport_30Mar2014.pdf
- Holdsworth, S., Thomas, I., & Hegarty, K. (2013). Sustainability education: Theory and practice. In R. B. Stevenson, M. Brody, J. Dillon and A.E.J. Wals (Eds.), *International handbook of research on environmental education* (pp. 349-359). New York, NY: Routledge.
- Jenson, J. (2013). Learning outcomes for sustainability in the humanities. In W. P. Boring, and W. Forbes, *Teaching sustainability perspectives from the humanities and social sciences* (pp. 23-37). Nacogdoches, TX: Stephen R. Austin State University Press.
- Johnston, L. F. (Ed.). (2013). *Higher education for sustainability: Cases, challenges, and opportunities from across the curriculum*. New York, NY: Routledge.
- Kaza, S., Natkin, L. W., & Rowse, T. (2015). Developing sustainability leadership through faculty professional development. *Journal of Environmental Studies and Sciences*, doi 10.1007/s13412-015-0330-0
- Lundholm, C., Hopwood, N., & Rickinson, M. (2013). Environmental learning: Insights from research into the student experience. In R. B. Stevenson, M. Brody, J.

- Dillon, and A.E.J. Wals (Eds.), *International handbook of research on environmental education* (pp. 243-253). New York, NY: Routledge.
- Meadows, D. H., & Wright, D. (2008). *Thinking in systems: A primer*. White River Junction, VT: Chelsea Green Pub.
- Meagher, S. (2013). Building a pedagogical toolbox: The nuts and bolts of infusing sustainability into humanities and social science courses. In W. P. Boring and W. Forbes, (Eds.). *Teaching sustainability perspectives from the humanities and social sciences* (pp. 76-87). Nacogdoches, TX: Stephen R. Austin State University Press.
- Natkin, L.W., & Kolbe, T. (2016). Enhancing sustainability curriculum through faculty learning communities. *International Journal of Sustainability in Higher Education*. 17(4) 540-598.
- Nolet, V. (2016). *Educating for sustainability: Principals and practices for teachers*. New York; NY: Routledge.
- Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.
- Rowe, D. (2002). Environmental literacy and sustainability as core requirements: Success stories and models. In W. Leal Filho (Ed.), *Teaching sustainability at universities*, (pp. 79-103). New York, NY: P. Lang.
- Shriberg, M. (2004). Assessing sustainability: Criteria, tools, and implications. In P. B. Corcoran and A. E. J. Wals (Eds.). *Higher education and the challenge of sustainability: Problematics, promise, and practice* (pp. 71-86). Dordrecht; Boston, MA: Kluwer Academic Publishers.
- Simon, S. (2002). Participatory online environmental education at the Open University UK. In W. L. Filho (Ed.). *Teaching sustainability at universities: Towards curriculum greening* (pp. 121-150). Bruxelles, NY: Peter Lang.
- Sterling, S. (2004). An analysis of the development of sustainability education internationally: Evolution, interpretation and transformative potential. In J. Blewitt and C. Cullingford (Eds.), *The sustainability curriculum: The challenge for higher education* (pp. 43-62). London, UK; Sterling, VA: Earthscan.
- Tilbury, D. (2011). *United nations educational, scientific and cultural organization's education for sustainability development: An expert review of processes and learning*. Paris, France: UNESCO
- Wals, A. E. J., & Dillon, J. (2013). Conventional and emerging learning theories: Implications and choices for educational researchers with a planetary

- consciousness. In R. B. Stevenson, M. Brody, J. Dillon and A. E. J. Wals (Eds.), *International handbook of research on environmental education* (pp. 253-262). New York, NY: Routledge.
- Walvoord, B. E. F. (2010). *Assessment clear and simple: A practical guide for institutions, departments, and general education* (2nd ed.). San Francisco, CA: Jossey-Bass.
- Wessels, T. (2006). *The myth of progress: Toward a sustainable future*. Burlington, VT: Hanover, NH: University of Vermont Press; University Press of New England.
- Wiggins, G. P., & McTighe, J. (2005). *Understanding by design* (Expanded 2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.
- Woolson, M. A. (2015). Sustainability as a pedagogical principle in liberal arts education: Explorations from the foreign language classroom. *The International Journal of Sustainability Education*, 11(3), 23-34.
- Yin, R. K. (2003). *Case study research: design and methods* (3rd ed). Thousand Oaks, CA: Sage Publications.

CHAPTER 5: CONCLUSION

The purpose of this study was to explore how instructors structured and taught the SLOs, how students learned UVM's SLOs, and which teaching practices students found helpful to their learning, within courses designed to meet this general education requirement. Specially, I addressed the following research questions:

1. In what ways are instructors structuring and teaching the SLOs in their SU designated courses?
2. In what ways are instructors assessing whether students are learning the SLOs?
3. To what extent do students perceive they are learning the SLOs in sustainability-designated courses?
4. To what extent do students perceive their instructor's teaching practices influence their learning?

When answering these questions, I aimed to explore how Education for Sustainability (EfS) recommended teaching approaches are occurring in college classrooms. EfS is way of teaching that aims to motivate and transform students to learn by linking knowledge, inquiry, and action through innovative pedagogy, such as inquiry-based, project-based, place-based, and service-learning, where students learn to think critically, work collaboratively, and take action towards a sustainable future (Cirillo & Hoyer, 2015; Nolan, 2016). This study addressed a shortage of research of EfS teaching practices and the extent to which students are learning about sustainability, particularly in higher education contexts (Holdsworth et al., 2013).

Based on the vast nature of the research questions, I conducted a case study research project using a variety of methods (interviews, document review, focus groups,

and a survey) to systematically gather people's perceptions and experiences of the new SU general education requirement. Eight instructors who taught a sustainability-designated course in the Spring 2016 semester participated in this study. All students enrolled in these courses were invited to participate in a focus group (n=16) and complete an online survey (n=178). Through careful analysis of data, this study made the following two important contributions: (1) identified how instructors are incorporating sustainability learning outcomes into their curricula; and (2) students' perceptions of helpful teaching practices for learning about sustainability.

The journal article in this dissertation study presented findings about how instructors designed, structured, and taught sustainability content, how students perceived they learned about sustainability in their courses, and which teaching practices they found most helpful. Courses taught a variety of sustainability topics (agriculture, systems, and implications of consumption) using a variety of teaching practices (discussions, readings, lecturers, guest speakers, papers, group works, projects, and reflective activities). Descriptions of specific teaching activities implemented in the courses are provided. Instructors shared a varying degree of success regarding students learning the SLOs. Through student focus groups and survey questions, students identified the following teaching practices as particularly helpful to their learning: using real world examples that apply their learning, discussing sustainability issues in class, having an opportunity to understand different perspectives, experiencing a sense of agency, and learning from a guest speaker.

The journal article in this dissertation presents some of the data collected by this study. The following section presents a description of additional journal articles to be

written using this study's data. This section concludes with a description of overall limitations to this study, implications from findings, and opportunities for future research.

Additional Journal Articles

This section presents data and findings from this study organized around the three articles to be written: students' transformation learning, assessment methods and reflection, and sustainability general education case study.

Students' Transformative Learning

This potential journal article will present findings from this dissertation study relating to students' characteristics and evidence of learning. Journal options for this article are: *Journal of Transformative Education* or *Teaching in Higher Education*. The article will use the transformative learning framework to report findings.

Transformative learning is focused on "the notion of recreating underlying thoughts and assumptions about the systems, structures, and societies that we are part of" (Moore, 2005, p. 86). To facilitate transformative learning, it is helpful for students to be encouraged to critically reflect on their assumptions, be open to other viewpoints and engage in discourse (Mezirow, 1997). The student survey borrowed items from three existing tools: Seattle University's SUstLit scale (values and attitudes), the Learning Environment Preferences (LEP) instrument (student learning theory), and The Ohio State's Assessment of Sustainability Knowledge (ASK) tool (knowledge). Outlined below are the key findings from the student survey and focus groups that will be incorporated into this journal article.

Sustainability values. The SUstLit scale was designed to measure sustainability knowledge and beliefs (Obermiller & Atwood, 2013; Obermiller & Atwood, 2014). I

chose seven statements (that assess students' attitudes and values related to sustainability issues). To explore student values, students indicated the extent to which they agreed or disagreed with seven values statements. If a student strongly agreed with all seven statements they would earn a score of 35 (highest sustainability values): the survey respondents mean was 30 (n=178, SD=5). Table 5.1 shows extent to which students agree or disagree with each statement.

Table 5.1

Extent to Which Students Agree or Disagree with Each Statement (N=178)

Statement	Strongly disagree (%)	Somewhat disagree (%)	Neither agree nor disagree (%)	Somewhat agree (%)	Strongly agree (%)
What we do today affects the lifestyles of future generations.	2.2	0	6.2	11.8	79.8
Abuses of the environment should not disproportionately affect the lives of the poor.	5.6	3.4	13.5	18.5	59.0
In general, I think social justice issues are among the most important challenges in the world today.	2.8	2.8	20.2	30.9	43.3
Businesses should be concerned about the welfare of their employees and the communities in which they operate.	2.2	2.8	9.6	19.1	66.3
People should be willing to make sacrifices so other people in the world can live better.	1.1	3.9	16.3	30.0	42.7
In general, I think climate change is among the most important challenges in the world today.	1.7	2.8	9.6	22.5	63.5
It is important to preserve plants and animals that are threatened by extinction.	1.1	1.7	10.1	23.6	63.5

Correlations were conducted between students' total score on their agreement with their values statements and their SU knowledge scores, their total indication of perceived learning, and likelihood knowledge will influence their lifestyle. Students with higher values scores were more likely to earn higher sustainability knowledge scores ($r=0.29$, $n=174$, $p < .01$), more likely to perceive that their SU course expanded their learning related to the SLOs ($\rho (164) = 0.26$, $p < .01$), and more likely to indicate that their sustainability knowledge will influence their lifestyle ($\rho (178)=0.35$, $p < .01$) compared to students with lower values scores. This suggests student values might be an important leverage point for transformational learning.

Student dualism scale. Perry characterized nine psychological positions. Most students arrive at college expecting the instructors to be the holders of knowledge, giving them the facts and the answers to questions, and believing in a right and wrong, which Perry characterizes as dualism (Nelson, 2010). The LEP instrument is a tool based on qualitative research done by Perry's intellectual and ethic development model for college students (Moore, 1989). I chose 7 of the 15 statements from the shorter tool to gain an indication of students' dualism level. This theory is applicable to learning about sustainability because if students transition from dualism to multiplicity, they may be more cognitively able to understand complexity, consider different perspectives, and contemplate how differing values complicate global issues. Students were asked to rate the importance of seven statements to their learning. If a student indicated that a learning experience characteristic was "not important" they were coded as a one and if they indicated a characteristic was "extremely important" they were coded as a five. A higher

score correlated to a higher level of dualistic level; the sample mean dualism score was a 24 out of a possible 35 (SD=5).

Sustainability knowledge. Twelve multiple-choice questions assessing students' knowledge of sustainability were taken from the new shortened version of the ASK tool. This tool was designed to assess undergraduate students' sustainability knowledge across the environmental, economics, and social domains. Students who answered all questions correctly would have earned a 12; the student mean was a 7 (SD=3). Table 5.2 shows the percent of students who answered each question correctly.

Table 5.2

Students' Percent Correct Answering Sustainability Knowledge Questions

Sustainability knowledge multiple choice survey question	% Correct
1. Over the past 3 decades, what has happened to the difference between the richest and poorest Americans?	85.2
2. What does ozone protect us from?	83.6
3. Which of the following countries has now passed the U.S. as the biggest emitter of the greenhouse gas carbon dioxide?	83.6
4. Which of the following is the most commonly used definition of sustainable development?	71.8
5. Which of the following is an example of sustainable forest management?	63.8
6. Which of the following is the best example of environmental justice?	59.7
7. What of the following would be considered living in the most environmentally sustainable way?	58.2
8. Many economics argue that electricity prices in the U.S are too low because....	54.2
9. What is the most common cause of pollution of streams and rivers?	53.1
10. Put the following list in order of the activities with the largest environmental impact to those with the smallest environmental impact:	52.6
11. Which of the following is the most commonly used definition of economic sustainability?	37.3
12. Which of the following is the leading cause of depletion of fish stocks in the Atlantic ocean?	32.8

Most students were able to correctly answer questions about the function of the ozone, the growing difference between the richest and poorest Americans, and China surpassing the US as the biggest emitter for carbon dioxide. Fewer students were able to correctly answer questions about the cause of reduced fish stocks, the definition of economic sustainability, and ranking activities to their environmental impact. One question asked students to choose the most common definition of sustainability development, 127 students answered correctly, 25 students answered incorrectly, and 25 students did not know the answer. Students' answers to these questions could be explored more deeply across course type, course discipline, dualism score, and prior exposure to sustainability for this future journal article.

One of the survey's open-ended questions asked students to share what sustainability means to them. This question asks students to share their sense making process of this term; sense making is how a person constructs and interprets new information. Everyone interprets the world through their unique lens, which is cultivated by their cumulative experiences, emotions, values, and beliefs (Spillane, 2004). Table 5.3 shows the most frequent codes for students' definition of sustainability.

Students' Sustainability Definition Code Frequency (N=178)

Figure 5.1 is a Wordle (word cloud) representation of the 60 most commonly used words in sustainability definitions.

- Sustainability is concerned with the equitable distribution and of efficient allocation of natural resources, ensuring the wellbeing of all people. This term

describes a state where the people of today are served while protecting the wellbeing of people in the future.

- Sustainability is being able to provide for society's needs today while preserving resources for future societies as well. It encompasses environmental, social, and economic sustainability.
- To me sustainability means an understanding of how to make the planet we live on more habitable for other organisms/animals than it currently is, reduce the type of industrial and corporate activity that results in massive amounts of pollution and generally making sure that we as human beings are doing all we can to make this world healthier.
- Sustainability to me, from an ecological economics perspective, is the ability to produce and maintain a steady-state economy that does not abuse resources that are nonrenewable.
- Sustainability is depending more on local food systems that support your own community rather than being dependent on large scale businesses and food from far destinations.
- Essentially balance; the ability of a society or system to exist without the overuse of materials and resources in a way so that the trend can continue for generations to come with resources still available.
- Living in a way that reduces impact on the world around me.

Personal domain. To explore the possibility that students learning about sustainability may impact their lifestyle. Students were asked through the survey to indicate the likelihood that their sustainability knowledge will influence their lifestyle.

Over half of the respondents indicated information about sustainability would be “likely” or “extremely likely” to influence their lifestyle (see Table 5.4).

Table 5.4

Likelihood of Sustainability Knowledge Influencing Student Lifestyles (N=178)

	Extremely unlikely (%)	Unlikely (%)	Neutral (%)	Likely (%)	Extremely likely (%)
Lifestyle influence likelihood	3	7	31	41	18

Prior student knowledge. To assess students’ understanding of sustainability prior to the Spring 2016 semester, students were asked to rate their familiarity with sustainability and indicate the number of previous sustainability courses they have taken. Over two-thirds of survey respondents felt they were “somewhat,” “moderately,” or “extremely” familiar with sustainability prior to this course. (See Table 5.5)

Table 5.5

Student Rating of Their Familiarity with Sustainability Before This Semester (N=178)

	Not at all familiar (%)	Slightly familiar (%)	Somewhat familiar (%)	Moderately familiar (%)	Extremely familiar (%)
Familiarity before course	8	19	30	30	13

Student feedback about teaching practices could also be explored for potential threshold concepts. Students explained why certain teaching practices were more or less helpful. Potential student quotes include:

- “It wasn’t until we ran the numbers that I connected everything and did the analysis on which of these three methods would be the most

sustainable that you get the chance to actually think about it and look at data. I think it's more real world so I appreciate that."

- "The most helpful learning experience was having guest speakers come into the class because it helped me understand the real life connection to the concepts discussed in class."
- "I think the most helpful thing we did was a series of basically mini debates where we take a topic and students are given a variety of perspectives on that and then we debate about that."
- "Writing about sustainability as assignments were the most helpful because I had to find evidence to support my claims, and had to analyze that evidence. It gave me a greater depth of understanding surrounding the material I incorporated into my papers."

Student characteristics' data can be presented in an article using the transformative learning and sense making frameworks to more deeply explore how students are learning about sustainability.

Assessment Methods and Reflection

Using the data from this dissertation, I plan to write a journal article presenting the methods of this study as a model for a holistic approach to assess teaching practices within the higher education context. I will highlight the use of the assessment matrix. This article will include feedback on assessment strategies at the institution level and classroom level. Possible journals for the article include: *Assessment and Evaluation in Higher Education* or *Teaching in Higher Education*.

Assessment is the gathering data on student learning with the intent to improve teaching practices and student learning (Walvoord, 2010). HEIs increasingly experience pressure to account for how effectively they teach students (Nusche, 2008). Due to the wide range of course content and learning goals, higher education lacks a universal way to assess the quality of classroom instruction. Since no consistent college-level assessment measures exist, most HEIs use end of the semester student assessment of teaching quality, where students provide feedback on an instructor's subject matter expertise, preparedness, and overall effectiveness (Spooren et al., 2013; Stark & Freishtat, 2014).

Student assessments are popular due to their low class time investment and their ease of administration and data interpretation (Spooren et al., 2013). However, many people have noted serious shortcomings. Stark and Freishtat (2014) point out several flaws for relying on student teaching evaluation scores to measure teaching effectiveness including: differences between non-responders and responders; variables beyond instructors control (i.e., time or location of class, class size, course content); students' concerns about anonymity; statistical concerns with averaging ordinal categorical variables; and concerns about how instructor's gender, ethnicity and age influence data. A key informant explained:

So if you're a faculty person that puts themselves out there and is doing something that makes students feel uncomfortable in the classroom, even asking them for taking more responsibility for their own learning; not sit-lecturing, then you might get dinged on your course evaluations, and depending where you are within the institutional hierarchy, that's going to affect your life here, and it could affect it in a very negative way. So there has to be a different mechanism, a more holistic mechanism for how faculty performance, for lack of a better word, is evaluated.

The key informant further explained the importance of re-working how instructors are assessed on their teaching because it is “risky enough for faculty to integrate content into their course and the next step for them to experiment with pedagogies that are more congruent with education for sustainability (EfS) principles.” Some of the EfS teaching practices may be different from what students are used to or be more challenging, which would negatively affect their feedback about their course.

This study used a variety of methods to comprehensively assess how teaching practices were helping students learn and offers a model to more holistically assess course effectiveness. I gathered information about topics covered in the course, assignments, and assessment information through a document review process. I observed in the classroom and conducted interviews with instructors about their experience teaching and then they completed an assessment matrix. Students participated in focus groups about their learning experience and completed an online survey asking about their perceived learning and how helpful they found the instructor’s teaching practices.

The matrix asks instructors to outline their evidence for student learning (assessment method), describe what they learned about students learning the SLOs, and share actions they will take based on findings. Examples of actions instructors plan to take include: revisiting sustainability definitions at the end of class, facilitating more discussions, talking more about values, presenting current events and making real world applications, being more explicit about sustainability and connecting assignments more intentionally, hosting more guest speakers, tweaking assignments or assigning more assignments (reflection papers, free writes, and essay), and incorporating more activities. One instructor shared, “In filling that matrix out, I was made aware of the need to

development interactive instruction. It is also about being okay with sacrificing some of my lectures for group work.” Another instructor shared her experiencing filling out the matrix form as; “I appreciate being able to go through this process myself, like what worked and what did not work.” One instructor experienced difficulties filling out the matrix, realizing that she needed to add more assessment mechanisms related to sustainability. All of these changes will likely lead to improved student learning.

There were two types of assessment that happened in classrooms: formative and summative. Both types of assessment involved gathering information about student learning but they had different purposes. Formative assessment is for improving learning (usually conducted during a learning experience) and summative assessment is for making a judgment about students’ performance or competence (usually conducted after a learning experience) (Chappuis et al., 2012; Gardner, 2011; Patton, 2002). Instructors used a variety of in-time or formative assessment strategies. They include: i-clicker questions, exit tickets asking students what they learned in class that day, pop quizzes that served as extra credit on exams, and short written reflections handed in the middle of class for the instructor to quickly survey. As for summative assessment, four of the courses relied heavy on exams and four of the courses relied on papers and projects for calculating student grades. Students shared the following about assessment preferences: enjoying a combination of assignments, being able to choose their paper topic, being able to apply their understanding compared to memorizing definitions, and having the opportunity to share their viewpoints. Students described writing as an opportunity to pull everything they learned together to form an argument.

Instructors shared challenges they experience with assessment. One instructor did not like having to quantify students' performances on assignments, as he felt they were subjective. A couple of instructors shared the nature of sustainability as being something so complex that it requires deep assessment and they struggled with time and their ability to do that. Two instructors expressed a desire for a way to assess student conversations about sustainability. One instructor expressed: "If we were having a signature sort of sustainability discussion in class that I would have a sense of a way to – and maybe it is taping it and going back and analyzing – a way of interpreting that conversation with assessment and the SLOs in mind." The other instructor described a quick and dirty tool that she could check off boxes correlating to topics that students discussed that suggested they were understanding sustainability. These suggestions and feedback provide valuable implications for policy and practice.

Sustainability General Education Case Study

In my final journal article I will provide a detailed description of UVM's Sustainability General Education creation and implementation process. This article could be submitted to the *Higher Education Policy* journal.

The Faculty Senate is responsible for creating general education requirements, as faculty control the curricula. There was resistance among faculty towards adding more general education requirements, especially from professional programs. There was concern about adding required courses without any institutional mechanism for ensuring that courses were helping students learn. In Fall 2010, UVM established a learning outcomes approach to its general education requirements, creating a variety of pathways (course, curriculum, and co-curricular) to meet requirements.

Creating an outcomes-based approach to general education helped to address these areas of resistance because students could meet the outcomes in a variety of different ways and the outcomes articulated the desired student learning making it easier to measure. “The trick here will be to articulate what it is we aspire to for all our students, what is the minimum bar here we aspire for all of our students and then how it is that units meet that. It goes back to assessment, in terms of how do we know that they are achieving we hope,” explains a key informant. Establishing learning outcomes enables departments to tweak their course to address the outcomes so their students do not need to take additional courses. The outcomes based approach helped the Faculty Senate begin to consider general education requirements.

In 2009, when the University, under direction from the Provost, started to explore creating a general education curriculum, a committee of deans and faculty members was created. To identify potential areas of general education a faculty survey was administered. Six areas were identified as the most popular areas for general education and the Faculty Senate approved them in principle in May 2011. A key informant described, “and they were passed in concept by the Faculty Senate and the debate in the Faculty Senate was do we really have to have a general education program, we have never had one before, we do not care that we are the only land grant in New England that does not have one and we do not care that our accreditors think we should have one.” There is a 40-year history of trying to establish a general education curriculum, with the first report happening in 1970.

With the six areas of potential general education program identified, a committee was established to create learning outcomes and an implementation plan for the most

popular requirement – writing and information literacy. A pilot study demonstrated a change in students who participated in the coursework; it improved their writing skills. This helped the requirement gain approval because “one of the criticisms about proceeding with general education is how do we know it will make a difference – where is the assessment plan,” explained a key informant.

In March 2010, UVM’s Student Government Association (SGA) submitted a resolution supporting the creation of a university-wide sustainability curricular requirement for all undergraduate students. A majority of students indicated their support of this resolution in a student survey. In response to UVM’s SGA’s resolution, an ad-hoc Sustainability General Education Committee was formed in Fall 2012 with the responsibility of creating sustainability learning outcomes. A member of the committee shared, “We talked about structure at first and then we developed learning outcomes. And we continually presented this to the faculty senate; this is what we are doing, this is what we have done, here are our outcomes, and give us feedback.” Assessing the political atmosphere, the committee decided to not try to get the requirement approved, rather get the learning outcomes approved. The learning outcomes were approved in April 2014. A key informant shared, “I think it passed because there were a lot of people reading the politics very well. It could have so easily been drowned forever.”

In March 2015, UVM’s Faculty Senate approved Sustainability Learning Outcomes (SLOs) as a general education requirement for all undergraduate students. Having passionate and dedicated leaders, having a SGA resolution, and having registrar numbers showing that capacity could be met for the incoming class, all contributed positively to sustainability general education gaining approval. Having the course

capacity information was critical and was possible because of six previous years of a successful professional learning community program, the Sustainability Faculty Fellows (SFF) program. The SFF program is committed to integrating sustainability into the curriculum. “I think it rode on the strength of some of the faculty who had a passion and an interest in doing this,” shared a key informant. Learning from this experience, the strategy for establishing the next possible general education requirement will be identified and will motivate faculty champions.

Having an institution-wide general education curriculum gives UVM an identity – it is a unifying educational process where every student at UVM learns certain things. It helps the university move away from functioning as many separate colleges – “across all schools and colleges, this is what we aspire for our graduates to have. They are going to have sensitivity around diversity, equity, and social justice; they are going to know something about sustainability. They are going to be confident writers; they are going to know how to find information and be able to evaluate the credibility of the sources,” shared a key informant. However, now that there are three general education requirements, with the possibility of more, there needs to be a way of unifying the process and implementations of them. A key informant explains, “We need to figure out what kind of oversight is in general education. You do not really want three or four things functioning independently with each other. You need to have some kind of a commonality both for policy and procedure but also for visioning.”

As general education requirements are being approved, the next step is establishing an institution wide assessment process. The provost office understands this need and funded a pilot project to explore how to effectively and efficiently create

assessment process. This funding brought Barbara Walvoord, an expert higher education assessment consultant, to campus for a series of workshops. General education coordinators have been appointed for each of the requirements. One key informant shared, “What I hope we get from this is that we have assessment that actually informs curriculum, that you do the assessment, and that it’s robust enough that it actually tells you something about what you are doing well and what you could do better.” The goal for having assessment mechanisms in place is making better educational experience for our students as data is collected about what works and what does not. Another key informant recommended UVM create an office of assessment, as many universities have.

I interviewed a key informant that is working closely with the creation of a general education assessment process. When discussing the assessment efforts, they shared, “Information is power, and that power should be used to transform practice.” The assessment process will remain close to what is happening in the classroom. “Faculty are at the point of contact in terms of gathering evidence and providing their perspectives on how well or not well students are meeting those outcomes,” the informant explained. In order to do this successfully the assessment coordinators need to create “a climate of a learning community, really a learning organization,” said the informant. The goal of the sustainability general education requirement is to graduate students “who have the skills to make an impact in their world. So if we keep the conversation at that level – a call to action level, rather than looking at how you are performing as a teacher in our classroom – then I think we can get a lot more support and buy-in from faculty.” Gaining faculty support will be critical to the success of the assessment efforts.

Many students expressed a preference for the sustainability requirement to be integrated into their department's core curriculum. They suggested connecting it with other general education requirements, such as diversity. A couple of students expressed a desire for sustainability-designated courses to also be service-learning courses. They would like an increased variety of departments offering SU courses. One student shared, "I think it would be super cool to take a sustainable artwork course. I definitely hope for the future that it is really made up of all different types of disciplines." In addition to coursework, students wanted campus wide opportunities to engage in sustainability, like a picking up trash event. One student in a focus group talked about her desire for UVM to model their commitment to sustainability through digesting in fossil fuels. Another student said, "Model what you are teaching us because it is kind of disgusting that I have hundreds of pieces of paper from college. But I'm supposed to be practicing sustainability things?"

Faculty echoed students' suggestion of explicitly making connections between all of the general education requirements. A key informant expressed her hope that this requirement would result in more core classes with sustainability content. Another informant shared, "I think it legitimizes sustainability as a shared value across colleges. It provides a way to reward faculty teaching courses with sustainability content. And with the Incentive Based Budgeting (IBB) model, I think that faculty will benefit from pursuing a designation." Hopefully, the requirement increases support for faculty and experiential learning opportunities for students. Instructors expressed a desire for internship programs related to sustainability, opportunities for students to participate in faculty research projects, and a sustainability career hub.

A couple of instructors wanted opportunities for panels of faculty to model how to have an informed conversation about sustainability – from a variety of disciplines. They would like to explore the meaning of the term and the historical and theoretical origin. One instructor expressed her desire for the community to model how to be a healthy community. An instructor proposed an interesting idea for a 500 person semester course that was taught by 15 different faculty from all different disciplines to teach how their disciplines interacts with sustainability issues. With IBB, this course would give faculty the opportunity to get students interested in their department.

Most instructors expressed concerns over accountability mechanisms, to ensure that SU courses are teaching students the SLOs. Faculty suggested better communication with students about sustainability being a general education requirement and asking for their feedback on the learning outcomes. One instructor explained, “I think we need as a university to look more closely at what we are asking with those SLOs to see if they are actually feasible. So I would say that during assessment, it is not a bad idea to revisit the learning outcomes.” Another instructor shared:

I think the university can just engage the faculty and engage the students more in what general education is and what sustainability is and make it not just oh, I take this and check, I’m done. Bring it to the university level, we are the University of Vermont, we have this general education requirement, this is why, what is what, this is how. Just bringing it more to the overarching theme of the university regardless of major and disciplines.

This instructor was echoing a key informant’s vision of the general education curricula unifying the campus.

Limitations

This study explored undergraduate student learning at one specific university for a small sample of SU courses. The findings are not generalizable to other students in other

contexts, with their own culture or to other UVM courses. My unit of analysis was the SU courses, not individual students, so I did not attempt to measure students' cognitive capacity. This study's lack of a causal design eliminates its ability to make causal statements. It cannot make claims about what caused students to learn about sustainability. My research study was a development project exploring a new initiative that may contribute to what we know about how to teach students about sustainability, hopefully its findings will lead to future research with a larger scale and scope.

Sustainability is a complex construct that is not easily measured, especially by a multiple-choice test, so the tool was limited in its ability to measure sustainability knowledge. Multiple-choice tests have been criticized for testing lower levels of understanding, not appropriate for measuring problem solving skills (Brady, 2005). It was assumed that the coursework documentation accurately represented what happened in the classroom. It also assumed that study participants were honest when answering the survey questions and during the focus group and interview conversations. To help ensure that participants were able to truthful, they were reassured that data would be kept confidential. Finally, it is important to note that participation in the study was voluntary, so all instructors and students may have had different reasons to participate, which may have biased results.

Implications

The David Orr quote introducing this dissertation highlights the educational challenge of transforming student's minds, perceptions, and values to prepare them to live in a world with finite resources. This dissertation study's findings suggest that UVM's Sustainability General Education requirement is influencing instructor's teaching

practices and student learning in ways that could lead to transformational learning. Given the shortage of research on which teaching practices help students learn sustainability content, this study highlights several implications for practice. An example is supporting professional development opportunities that encourage instructors to try teaching practices that align with Education for Sustainability's principles.

Since 2009, UVM's SFF program has been cultivating a sustainability-focused faculty learning community where faculty participants become part of a faculty network committed to learning how to incorporate sustainability concepts into their curriculum and teaching. A key informant, who is the co-creator of the SFF program shared:

So we can't create a paradigm shift without shifting our teaching. And that's risky, and it takes time and practice and feedback, from not only students but also your peers. So my vision for what could be the next generation of a fellow's program, would be more of a supportive community that would have peer teaching consultations; where you could go and visit your peer's classroom and be able to provide feedback and support them when they are trying new practices in their classroom.

This change to the SFF program represents great ways to support faculty to trying new teaching practices, especially those identified by students as helpful to their learning. Students most frequently mentioned the following teaching activities as helpful to their learning: using real world examples that apply their learning, discussing sustainability issues in class, having an opportunity to understand different perspectives, experiencing a sense of agency, and learning from a guest speaker.

There is a culture of faculty owning the curricula; pairing faculty together to support one another is a great approach to curricular change. A few instructors mentioned their desire for a way to assess student conversations about sustainability. I wonder if there is a way to have instructors work on this together. The Sustainability Curriculum

Review Committee posts exceptional models of SU course applications on their website; maybe there is a way to share experiences after courses have been taught. They could serve as models for how to integrate the SLOs and sustainability content into courses. The SLOs are not about content specific, but I think at minimum students should be able to identify the most common definition of sustainability. Showcasing how instructors were able to address in their course may help other instructors to do the same. It may be helpful to establish a person on campus who specializes in sustainability education. This person could support instructor's efforts to integrate sustainability into their curriculum and act as a bridge for all sustainability-related and sustainability general education initiatives.

Offering professional development opportunities teaching about reflecting on instructional experiences can be very helpful to curricular change, as evidenced by the instructors in this study's experience. As an institution, I recommend encouraging instructors to take the time to reflect on what teaching practices worked, how well did students learn, and what changes can be made to course curriculum – perhaps using this study's assessment matrix. UVM's Center for Teaching and Learning offers many great professional development opportunities; maybe there are ways institutionally to encourage more participation through departments or faculty evaluations. Given some instructor feedback, I think having professional development around assessment strategies related to sustainability content would be beneficial. A key informant shared:

The other thing, I think that needs to change is, really at an institutional level if we really want faculty to experiment in some of these pedagogies, is a different way than course evaluations to assess faculty teaching. Because some of the teaching methods that I think will be effective in the long run are also very uncomfortable for students, because they're not acculturated in those types of pedagogies.

This study's design serves as a model for using a variety of methods to assess teaching practices and highlights the helpfulness of reflecting on teaching experiences to creating change in curricula. It models holistically evaluating teaching practices in the classroom; it does not rely solely on students' feedback. I interviewed instructors about their teaching practices I observed in the classroom, I reviewed course documents, and I talked with and surveyed students about their learning experience. I looked holistically at all of the data, triangulating themes. Through the student focus groups I was able to ask students to clarify their feedback; this was a very helpful way to gather information from students about their learning experience.

If the general education curriculum is a priority at UVM, changing institutional mechanisms for assessing faculty teaching should align with this value. This research study shows that the most helpful teaching practices for students learning the sustainability learning outcomes may require some support for instructors. The institution could create incentive structure to encourage instructors to try new methods. Instructors shared their desire for more support with grading through lower class sizes or teaching assistants, and this is another way the university could support changes in curricula. Creating an office of assessment, common at many other HEIs, could help organize, empower, and centralize assessment initiatives happening at UVM.

Future Research Recommendations

There are many interesting directions for future research based on this dissertation's findings. Examples include: taking a deeper look at the relationship between dualistic thinking and learning about sustainability, exploring threshold concepts and transformative learning of UVM's SLOs, examining how a larger sample of students

and instructors are making sense of the term sustainability, comparing UVM's students' scores on the sustainability knowledge survey tool to students at other HEIs, and analyzing the individual course and student characteristics in relation to student learning. This study describes teaching practices used by a small sample of instructors at one-university and reports students' perceptions of their helpfulness. The next step would be to more concretely examine whether certain practices have an impact on learning.

REFERENCES

- Association for the Advancement of Sustainability in Higher Education (AASHE). (n.d.) Sustainability tracking, assessment & rating system (STARS) content display AC-6. Retrieved from <https://stars.aashe.org/>
- Association for the Advancement of Sustainability in Higher Education (AASHE). (2010). *Sustainability curriculum in higher education: A call to action*. Retrieved from: [http://www.aashe.org/files/A_Call_to_Action_final\(2\).pdf](http://www.aashe.org/files/A_Call_to_Action_final(2).pdf)
- Barlett, P. F., & Chase, G. W. (2012). Curricular innovation for sustainability: The Piedmont/Ponderosa model of faculty development. *Liberal Educ*, 98(4), 14–21.
- Barlett, P. F., & Rappaport, A. (2009). Long-term impacts of faculty development programs: The experience of Teli and Piedmont. *College Teaching*, 57(2), 73–82.
- Barth, M., Godemann, J., Rieckmann, M., & Stoltenberg, U. (2007). Developing key competencies for sustainable development in higher education. *International Journal of Sustainability in Higher Education*, 8(4), 416–430. <http://doi.org/10.1108/14676370710823582>
- Beleche, T., Fairris, D., & Marks, M. (2012). Do course evaluations truly reflect student learning? Evidence from an objectively graded post-test. *Economics of Education Review*, 31(5), 709–719. <http://doi.org/10.1016/j.econedurev.2012.05.001>
- Benton, S. L., Duchon, D., & Pallett, W. H. (2013). Validity of student self-reported ratings of learning. *Assessment & Evaluation in Higher Education*, 38(4), 377–388. <http://doi.org/10.1080/02602938.2011.636799>
- Bloomberg, L. D., & Volpe, M. (2012). *Completing your qualitative dissertation: A road map from beginning to end* (2nd ed). Thousand Oaks, CA: SAGE Publications.
- Brady, A. M. (2005). Assessment of learning with multiple-choice questions. *Nurse Education in Practice*, 5(4), 238–242. <http://doi.org/10.1016/j.nepr.2004.12.005>
- Bradshaw, L. K., & Glatthorn, A. A. (2001). *Teacher evaluation for better learning*. Lancaster, PA: Pro>Active Publications.
- Capra, F. (2005). Speaking nature's language: Principles for sustainability. In M.K. Stone and Z. Barlow, *Ecological literacy*, (pp. 18-30), San Francisco, CA: Sierra Club Books.
- Chalkley, B. (2006). Education for sustainable development: Continuation. *Journal of Geography in Higher Education*, 30(2), 235–236. <http://doi.org/10.1080/03098260600717307>

- Chappuis, J., Stiggins, R., Chappuis, S., & Arter, J. (2012). *Classroom assessment for student learning: Doing it right -- doing it well* (2nd ed). Boston, MA: Pearson.
- Christie, B. A., Miller, K. K., Cooke, R., & White, J. G. (2013). Environmental sustainability in higher education: How do academics teach? *Environmental Education Research*, 19(3), 385–414.
<http://doi.org/10.1080/13504622.2012.698598>
- Cirillo, J., & Hoyler, E. (2015). *The guide to education for sustainability: Shelburne Farms' Sustainable Schools Project*. Shelburne, VT: Shelburne Farms.
- Cox, M. D. (1999). Peer consultation and faculty learning communities. *New Directions for Teaching and Learning*, 1999(79), 39–49.
- Cranton, P. (2006). *Understanding and promoting transformative learning: A guide for educators of adults* (2nd ed). San Francisco, CA: Jossey-Bass.
- Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed). Los Angeles, CA: SAGE Publications.
- Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed). Los Angeles, CA: SAGE Publications.
- Desha, C., & Hargroves, K. (2014). *Higher education and sustainable development: a model for curriculum renewal* (1st ed.). London, UK ; New York, NY: Routledge, Taylor & Francis Group.
- Dillman, D. A., Smyth, J. D., & Christian, L. M. (2009). *Internet, mail, and mixed-mode surveys: The tailored design method* (3rd ed). Hoboken, NJ: Wiley & Sons.
- Fowler, F. J. (1995). *Improving survey questions: Design and evaluation*. Thousand Oaks, CA: Sage Publications.
- Galgano, F., & Rosier, P. C. (2013). Multi-disciplinary approaches to sustainability education. In W.P. Boring and W. Forbes, *Teaching sustainability perspectives from the humanities and social sciences* (pp. 116-128). Nacogdoches, TX: Stephen R. Austin State University Press.
- Gardner, J. (2011). *Assessment and learning* (2nd ed). Thousand Oaks, CA: Sage Publications.
- Gaston, P. L. (2015). *General education transformed: How we can, why we must*. Association of American Colleges and Universities.
- Glesne, C. (2011). *Becoming qualitative researchers: An introduction* (4th ed.). Boston< MA: Pearson.

- Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis, 11*(3), 255–274.
- Hattan, A. S. (2009). *Education for climate neutrality and sustainability: Guidance for ACUPCC institutions*. Boston, MA: American College and University Presidents' Climate Commitment. Retrieved from: http://sustainability.wfu.edu/wpcontent/uploads/2010/02/EducationforClimateNeutralitySustainability_2009.05.07_.pdf
- Hill, L., & Wang, D. (2014). *Proposal for sustainability learning outcomes for UVM with recommendation for implementation and on-going review and assessment*. Submitted by the Ad-hoc senate committee for sustainability learning outcomes. Retrieved from: https://www.uvm.edu/~facsen/SLO_FacultySenateReport_30Mar2014.pdf
- Holdsworth, S., Thomas, I., & Hegarty, K. (2013). Sustainability education: Theory and practice. In R. B. Stevenson, M. Brody, J. Dillon and A.E.J. Wals (Eds.), *International handbook of research on environmental education* (pp. 349-359). New York, NY: Routledge.
- Jenson, J. (2013). Learning outcomes for sustainability in the humanities. In W. P. Boring, and W. Forbes, *Teaching sustainability perspectives from the humanities and social sciences* (pp. 23-37). Nacogdoches, TX: Stephen R. Austin State University Press.
- Johnston, L. F. (Ed.). (2013). *Higher education for sustainability: Cases, challenges, and opportunities from across the curriculum*. New York, NY: Routledge.
- Jones, P., Trier, C. J., & Richards, J. P. (2008). Embedding education for sustainable development in higher education: A case study examining common challenges and opportunities for undergraduate programmes. *International Journal of Educational Research, 47*(6), 341–350.
- Kaza, S., Natkin, L. W., & Rowse, T. (2015). Developing sustainability leadership through faculty professional development. *Journal of Environmental Studies and Sciences*, doi 10.1007/s13412-015-0330-0
- Lotz-Sisitka, H., Fien, J., & Kethoilwe, M. (2013). Traditions and new niches: An overview of environmental education curriculum and learning research. In R. B. Stevenson, M. Brody, J. Dillon, and A.E.J. Wals (Eds.), *International handbook of research on environmental education* (pp. 194-205). New York, NY: Routledge.
- Leal Filho, W. (Ed.). (2009). *Sustainability at universities: Opportunities, challenges, and trends*. Frankfurt am Main ; New York, NY: P. Lang.

- Lundholm, C., Hopwood, N., & Rickinson, M. (2013). Environmental learning: Insights from research into the student experience. In R. B. Stevenson, M. Brody, J. Dillon, and A.E.J. Wals (Eds.), *International handbook of research on environmental education* (pp. 243-253). New York, NY: Routledge.
- Maki, P., Schneider, C. G., & Association of American Colleges and Universities. (2015). *Assessment that works: A national call, a twenty-first-century response*.
- Meadows, D. H., & Wright, D. (2008). *Thinking in systems: A primer*. White River Junction, VT: Chelsea Green Pub.
- Meagher, S. (2013). Building a pedagogical toolbox: The nuts and bolts of infusing sustainability into humanities and social science courses. In W. P. Boring and W. Forbes, (Eds.). *Teaching sustainability perspectives from the humanities and social sciences* (pp. 76-87). Nacogdoches, TX: Stephen R. Austin State University Press.
- Meyer, J. H. F., & Land, R. (2005). Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning. *Higher Education*, 49(3), 373–388. <http://doi.org/10.1007/s10734-004-6779-5>
- Mezirow, J. (1997). Transformative learning: Theory to practice. *New Directions for Adult and Continuing Education*, 1997(74), 5–12.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage Publications.
- Moore, J. (1989). The learning environment preferences: Exploring the construct validity of an objective measure of the Perry scheme of intellectual development. *Journal of College Student Development*, 11(30), 504-514.
- Moore, J. (2005). Is higher education ready for transformative learning?: A question explored in the study of sustainability. *Journal of Transformative Education*, 3(1), 76–91. <http://doi.org/10.1177/1541344604270862>
- Morfei, M. (2013). Psychology, sustainability, and sense of place. In W. P. Boring, and W. Forbes (Eds.), *Teaching sustainability perspectives from the humanities and social sciences* (pp. 144-151). Nacogdoches, TX: Stephen R. Austin State University Press.
- Myers, O. E., & Beringer, A. (2010). Sustainability in higher education: Psychological research for effective pedagogy. *Canadian Journal of Higher Education*, 40(2), 51–77.

- Natkin, L.W., & Kolbe, T. (2016). Enhancing sustainability curriculum through faculty learning communities. *International Journal of Sustainability in Higher Education*. 17(4) 540-598.
- Nelson, C. E. (2010). Effective education for environmental literacy. In J. Blewitt, and C. Cullingford (Eds.). (2004). *The sustainability curriculum: The challenge for higher education*. London, UK; Sterling, VA: Earthscan.
- Nolan, C. (2012). *Shaping the education of tomorrow 2012 report on the UN decade of education for sustainable development, abridged*. Paris, FR: UNESCO.
- Nolet, V. (2016). *Educating for sustainability: Principals and practices for teachers*. New York, NY: Routledge.
- Nusche, D. (2008). *Assessment of learning outcomes in higher education* (OECD Education Working Papers No. 15). Retrieved from http://www.oecd-ilibrary.org/education/assessment-of-learning-outcomes-in-higher-education_244257272573
- Nulty, D. (2008). The adequacy of response rates to online and paper surveys: What can be done? *Assessment & Evaluation in Higher Education*, 33(3), 301–314. <http://doi.org/10.1080/02602930701293231>
- Obermiller, C., & Atwood, A. (2013). Sustainability literacy: Scale development. Association for the advancement of sustainability in higher education bulletin post. Retrieved from: <http://fac-staff.seattleu.edu/carlo/WEB/sustlit.aashebull.pdf>
- Obermiller, C., & Atwood, A. (2014). Measuring sustainability literacy: Scale development. *Journal of Jesuit Business Education*, 5(1), 105–128.
- Orr, D. W. (2004). *Earth in mind: On education, environment, and the human prospect* (10th anniversary ed.). Washington, DC: Island Press.
- Paolini, A. (2015). Enhancing teaching effectiveness and student learning outcomes. *The Journal of Effective Teaching*, 20.
- Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.
- Popham, J. W. (2013). *Evaluating America's teachers*. Thousand Oaks, CA: Corwin.
- Pounder, J. S. (2007). Is student evaluation of teaching worthwhile?: An analytical framework for answering the question. *Quality Assurance in Education*, 15(2), 178–191. <http://doi.org/10.1108/09684880710748938>

- Raworth, K. (2012). A safe and just space for humanity: Can we live within the doughnut. *Oxfam Policy and Practice: Climate Change and Resilience*, 8(1), 1–26.
- Richards, J. C., & Farrell, T. S. C. (2011). *Practice teaching: A reflective approach*. Cambridge, MA: Cambridge University Press. Retrieved from <http://ebooks.cambridge.org/ref/id/CBO9781139151535>
- Rowe, D. (2002). Environmental literacy and sustainability as core requirements: Success stories and models. In W. Leal Filho (Ed.), *Teaching sustainability at universities*, (pp. 79-103). New York, NY: P. Lang.
- Rowe, D., & Johnston, L.F. (2013). Learning outcomes: An international comparison of countries and declarations. In L. F. Johnston (Ed.), *Higher education for sustainability: Cases, challenges, and opportunities from across the curriculum*, (pp. 45- 60). New York, NY: Routledge.
- Sandri, O. J. (2013). Threshold concepts, systems and learning for sustainability. *Environmental Education Research*, 19(6), 810–822. <http://doi.org/10.1080/13504622.2012.753413>
- Shepard, K. (2008). Higher education for sustainability: Seeking affective learning outcomes. *International Journal of Sustainability in Higher Education*, 9(1), 87–98.
- Shriberg, M. (2004). Assessing sustainability: Criteria, tools, and implications. In P. B. Corcoran and A. E. J. Wals (Eds.), *Higher education and the challenge of sustainability: Problematics, promise, and practice* (pp. 71-86). Dordrecht; Boston, MA: Kluwer Academic Publishers.
- Simon, S. (2002). Participatory online environmental education at the Open University UK. In W. L. Filho (Ed.). *Teaching sustainability at universities: Towards curriculum greening* (pp. 121-150). Bruxelles, NY: Peter Lang.
- Spillane, J. P. (2004). *Standards deviation: How schools misunderstand education policy / James P. Spillane*. Cambridge, MA: Harvard University Press.
- Spillane, J. P., Reiser, B. J., & Gomez, L. M. (2006). Policy implementation and cognition. *New Directions in Educational Policy Implementation*, 47–64.
- Spooren, P., Brockx, B., & Mortelmans, D. (2013). On the validity of student evaluation of teaching the state of the art. *Review of Educational Research*, 83(4), 598–642.
- Stake, R. E. (1994). Case studies. In N.K. Denzin and Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 236-247). Thousand Oaks, CA: Sage

- Stark, P. B., & Freishtat, R. (2014). An evaluation of course evaluations: "F." *ScienceOpen Research*. <http://doi.org/10.14293/S2199-1006.1.SOR-EDU.AOFRQA.v1>
- Sterling, S. (2004a). An analysis of the development of sustainability education internationally: Evolution, interpretation and transformative potential. In J. Blewitt and C. Cullingford (Eds.), *The sustainability curriculum: The challenge for higher education* (pp. 43-62). London, UK; Sterling, VA: Earthscan.
- Sterling, S. (2004b). Higher education, sustainability, and the role of systemic learning. In P. B. Corcoran and A. E. J. Wals (Eds.), *Higher education and the challenge of sustainability: Problematics, promise, and practice* (pp.47-70). Dordrecht; Boston, MA: Kluwer Academic Publishers.
- Sterling, S. (2009). Ecological intelligence: viewing the world relationally. In A. Stibbe, and H. Luna (Eds.), *The handbook of sustainability literacy: Skills for a changing world* (pp. 77-83). Devon, UK: Green Books Ltd.
- Stigall, L., & Blincoe, S. (2015). Student and instructor use of the teacher behavior checklist. *Teaching of Psychology*, 42(4), 299–306. <http://doi.org/10.1177/0098628315603061>
- Struyven, K., Dochy, F., & Janssens, S. (2008). Students' likes and dislikes regarding student-activating and lecture-based educational settings: Consequences for students' perceptions of the learning environment, student learning and performance. *European Journal of Psychology of Education*, 23(3), 295–317.
- Svanström, M., Lozano-García, F. J., & Rowe, D. (2008). Learning outcomes for sustainable development in higher education. *International Journal of Sustainability in Higher Education*, 9(3), 339–351. <http://doi.org/10.1108/14676370810885925>
- Tam, M. (2014). Outcomes-based approach to quality assessment and curriculum improvement in higher education. *Quality Assurance in Education*, 22(2), 158–168. <https://doi.org/10.1108/QAE-09-2011-0059>
- Tilbury, D. (2011). *United nations educational, scientific and cultural organization's education for sustainability development: An expert review of processes and learning*. Paris, France: UNESCO
- Wals, A. E. J. (2014). Sustainability in higher education in the context of the UN DEFS: A review of learning and institutionalization processes. *Journal of Cleaner Production*, 62, 8–15. <http://doi.org/10.1016/j.jclepro.2013.06.007>
- Wals, A. E. J., & Dillon, J. (2013). Conventional and emerging learning theories: Implications and choices for educational researchers with a planetary

- consciousness. In R. B. Stevenson, M. Brody, J. Dillon and A. E. J. Wals (Eds.), *International handbook of research on environmental education* (pp. 253-262). New York, NY: Routledge.
- Walvoord, B. E. F. (2010). *Assessment clear and simple: A practical guide for institutions, departments, and general education* (2nd ed.). San Francisco, CA: Jossey-Bass.
- Wessels, T. (2006). *The myth of progress: Toward a sustainable future*. Burlington, VT: Hanover, NH: University of Vermont Press ; University Press of New England.
- Wiek, A., Farioli, F., Fukushi, K., & Yarime, M. (2012). Sustainability science: Bridging the gap between science and society. *Sustainability Science*, 7(S1), 1–4.
- Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science*, 6(2), 203–218. <http://doi.org/10.1007/s11625-011-0132-6>
- Wiggins, G. P., & McTighe, J. (2005). *Understanding by design* (Expanded 2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.
- Woolson, M. A. (2015). Sustainability as a pedagogical principle in liberal arts education: Explorations from the foreign language classroom. *The International Journal of Sustainability Education*, 11(3), 23-34.
- Wright, T. (2004). The evolution of sustainability declarations in higher education. In P. B. Corcoran and A. E. J. Wals (Eds.), *Higher education and the challenge of sustainability: Problematics, promise, and practice* (pp. 7-20). Dordrecht; Boston, MA: Kluwer Academic Publishers.
- Yin, R. K. (2003). *Applications of case study research* (2nd ed.). Thousand Oaks, CA: Sage Publications.
- Yin, R. K. (2003). *Case study research: design and methods* (3rd ed). Thousand Oaks, CA: Sage Publications.
- Zulauf, C. A. (2007). Learning to think systemically: What does it take? *The Learning Organization*, 14(6), 489–498. <http://doi.org/10.1108/09696470710825105>
- Zwickle, A., Koontz, T., Slagle, K., & Bruskotter, J. (2014). Assessing sustainability knowledge of a student population: Developing a tool to measure knowledge in the environmental, economic and social domains. *International Journal of Sustainability in Higher Education*, 15(4), 375–389. <http://doi.org/10.1108/IJSHE-01-2013-0008>

Appendices

- A.** List of HEIs with sustainability general education programs
- B.** Instructors Recruitment Letter
- C.** Instructors Consent Form
- D.** Key Informant Consent Form
- E.** Focus Group Consent Form
- F.** Document Review Protocol
- G.** SU Course Assessment Matrix
- H.** Classroom Observation Protocol
- I.** Key Informant Protocol
- J.** Instructors Interview Protocol
- K.** Focus Group Protocol
- L.** Student Survey
- M.** Course Description Table
- N.** Student Survey Response Rate by Course
- O.** Number of Sustainability Courses Student Have Taken at UVM

Appendix A: Higher Education Institutions (HEIs): Sustainability General Ed Requirements

HEIs with Explicit Sustainability General Education Requirements			
<i>Institution Name</i>	<i># of Students</i>	<i>Public/Private</i>	<i>Location</i>
Babson College	3,000	Private	Massachusetts
Ball State University	21,000	Public	Indiana
Bucknell University	4,000	Private	Pennsylvania
University of Colorado- Colorado Springs	11,000	Public	Colorado
St. Lawrence University	2,500	Private	New York
California State University Chico	18,000	Public	California
California State University Monterey Bay	7,000	Public	California
Central College	1,400	Private; Christian	Iowa
Chatham University	2,100	Private	Pennsylvania
Florida Gulf Coast University	15,000	Public	Florida
Green Mountain College	700	Private	Vermont
Kankakee Community College		Two-year	Illinois
Oberlin College	3,000	Private	Ohio
Portland State University	28,000	Public	Oregon
Sterling College	125	Private	Vermont
Unity College	600	Private	Maine
University of Wisconsin Green Bay	6,500	Public	Wisconsin
University of Wisconsin Stevens Point	10,000	Public	Wisconsin
University of Vermont	10,000	Public	Vermont
Whatcom Community College	11,000	Two-year	Washington
HEIs with Sustainability Related Concepts Embedded within General Education Requirements			
<i>Institution Name</i>	<i># of Students</i>	<i>Public/Private</i>	<i>Location</i>
Appalachian State University	18,000	Public	North Carolina
Bentley University	5,500	Private	Massachusetts
California State University Sacramento	30,000	Public	California
Calvin College	4,000	Private-Christian	Michigan
Clarkson University	4,300	Private	New York
Elon University	6,600	Private	North Carolina
Florida International University	55,000	Public	Florida
Florida Gulf Coast University	15,000	Public	Florida
Furman University	3,000	Private	South Carolina
George Mason University	34,000	Public	Virginia
Goucher College	2,000	Private	Maryland
Indiana University Bloomington	40,000	Public	Indiana

Loyola University Chicago	16,000	Private Catholic	Illinois
Minnesota State University Moorhead	7,000	Public	Minnesota
Pittsburg State University	7,500	Public	Kansas
Saint Joseph's College	3,000	Private Catholic	Maine
Stetson University	4,000	Private	Florida
SUNY College of Environmental Science and Forestry	3,000	Public	New York
University of Kansas	28,000	Public	Kansas
University of Nebraska-Lincoln	25,000	Public	Nebraska
University of North Carolina-Pembroke	6,500	Public	North Carolina
University of Wisconsin Oshkosh	14,000	Public	Wisconsin
University of Wisconsin- Eau Claire	11,000	Public	Wisconsin
Wartburg College	1,500	Private- Christian	Iowa
Washington State University	30,000	Public	Washington

Websites:

Appalachian State

<http://generaleducation.appstate.edu/general-education-program-goals-1>

Babson College

<http://www.babson.edu/academics/undergraduate/Pages/learning-goals.aspx>

Ball State University

<https://cms.bsu.edu/Academics/CollegesandDepartments/Distance/Academics/Programs/Undergrad/Bachelors/GenStudies/Requirements/ucc/wiser.aspx>

Bentley University

<http://www.bentley.edu/academics/departments/learning-goals-and-objectives>

Bucknell University

<http://www.eg.bucknell.edu/physics/astronomy/ladd/CCCLearningGoals.html>

California State University Sacramento

<http://catalog.csus.edu/12-14/first%20100%20pages/ge.html>

Calvin College

<https://www.calvin.edu/admin/provost/documents/core-curriculum.pdf>

California State University Monterey Bay

<https://csumb.edu/tla/institutional-learning-outcomes>

California State University Chico

<http://www.csuchico.edu/ge/features/slo.shtml>

University of Colorado- Colorado Springs

<http://www.uccs.edu/assess/general-education/core-goals.html>

Chatham University

<http://www.chatham.edu/academics/catalog/undergraduatestudies/generaleducation.cfm>

Clarkson University

http://www.clarkson.edu/common_experience/documents/CCE_catalog.pdf

Elon University

http://www.elon.edu/e-web/academics/core_curriculum/default.xhtml

Florida Gulf Coast University

<http://www.fgcu.edu/Catalog/regdetail.asp?FMID=Registration+and+Records&page=20>

Florida Gulf Coast University

<http://www.fgcu.edu/Colloquium/>

Florida International University

<https://global.fiu.edu/courses/>

Furman

<http://www.furman.edu/academics/academics/academic-resources/Pages/General-Education-Requirements.aspx>

George Mason University

<http://chss.gmu.edu/general-education/all-requirements>

Goucher University

http://www.goucher.edu/Documents/Records/GERCERS_14FA.pdf
Green Mountain College
<http://www.greenmtn.edu/academics/ela/learning-outcomes.aspx>
Indiana University Bloomington
<http://bulletins.iu.edu/iub/general-education/2015-2016/gened-pdf.pdf>
Kankakee Community College
<http://www.kcc.edu/students/academics/Pages/academiccatalog.aspx>
Loyola University Chicago
<http://luc.edu/core/coreknowledge-first.shtml>
Minnesota State University Moorhead
<http://www.mnstate.edu/records/lasc-courses/goal-10.aspx>
Oberlin College
<https://new.oberlin.edu/arts-and-sciences/academics/learning-goals.dot>
Pittsburg State University
<http://www.pittstate.edu/office/registrar/general-education-degree-requirements-starting-fall-2005.dot>
Portland State University
<http://www.pdx.edu/sustainability/sustainability-education>
Sterling College
<http://www.sterlingcollege.edu/academics/academic-philosophy/>
Stetson University
<http://catalog.stetson.edu/undergraduate/general-education/>
SUNY College of Environmental Science and Forestry
<http://www.esf.edu/provost/gened.htm>
Unity College
<https://www.unity.edu/sites/default/files/imce/basic/academics/files/CollegeWideLearningOutcomes.pdf>
University of Kansas
<http://kucore.ku.edu/goal4>
University of Nebraska-Lincoln
<http://ace.unl.edu/about/outcomes>
University of North Carolina- Pembroke
http://www.uncp.edu/sites/default/files/Images_Docs/Academics/catalog/pdf/UNCPCatalog15.pdf
University of Wisconsin Green Bay
<http://catalog.uwgb.edu/undergraduate/planning/general-education/-text>
University of Wisconsin Eau Claire
<https://www.uwec.edu/ULEC/Liberal-Education-Framework-Learning-Outcome-and-Rubrics.htm>
University of Wisconsin Oshkosh
<http://www.uwosh.edu/usp/for-faculty-and-staff/learning-outcomes/uw-oshkosh-essential-learning-outcomes>
University of Wisconsin Stevens Point
<http://www.uwsp.edu/acadaff/Pages/generalEducation.aspx>
Wartburg College
<http://www.wartburg.edu/academics/learnoutcomes.aspx>
Whatcom Community College
http://www.greetings.whatcom.ctc.edu/emag/201617_WCC_Catalog/index.html-1/
Washington State University
<http://ugr.wsu.edu/students/categoriesandcourses.html>

Appendix B: Instructor Recruitment Letter

Title of the Research Project: Education for Sustainability: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

Dear XXXXX,

I am inviting you to participate in my research study because you are teaching, XXXXX, which is a sustainability (SU) designated course in the Spring 2016 semester. The purpose of this case study is to explore the relationship between professor's teaching practices and students learning the sustainability learning outcomes. My dissertation for the Educational Leadership and Policy Studies Doctoral program is addressing a need for more research on effective and efficient teaching practices related to sustainability curricula.

If you volunteer to participate in my study, you will be asked to do five things:

- 1) Submit course documentation (syllabi, course assignments narratives, and grading rubrics)
- 2) Schedule one course session for me to observe, preferably when you are teaching sustainability content
- 3) Complete the SU Course Assessment Matrix
- 4) One interview (~45 minutes) towards the end of the semester
- 5) Provide student email addresses

The interview and classroom observation will be scheduled at your convenience. By volunteering, I hope you will gain some insight into your teaching practices and its influence on student learning. I anticipate the information gained from this study will contribute to sustainability teaching practices in higher education. If you volunteer, you may discontinue your participation in this study at any time.

Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used. To minimize the risks to confidentiality, I will de-identified all data by using pseudonyms and all data files will be kept on a password-protected computer.

Please let me know if you have any questions or concerns. I really appreciate your consideration to participate in my dissertation research. Your time and input will be greatly appreciated. If you are interested please send me an email or call (802-999-5416), and I will send you a consent form to review and sign.

Thank you,
Lisa Watts Natkin

Appendix C: Instructor Consent to Participate in Research

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

You are being invited to participate in this research study because you are teaching an SU (sustainability) Designated course at the University of Vermont in the Spring 2016 semester.

Why is This Research Study Being Conducted?

I am conducting this study as part my dissertation for the Educational Leadership and Policy Studies Doctoral program. The purpose of this case study is to explore the relationship between professor's teaching practices and the extent of students' understanding of UVM's four SLOs. Of particular interest is how faculty structure and teach sustainability-designated (SU) courses and what students report as helpful teaching practices in SU courses, as required by the University's general education requirement initiative. I encourage you to ask questions and take this opportunity to discuss the study with anybody you think can help you make your decision to participate.

How many People Will Take Part In The Study?

Eight faculty members will have the opportunity to participate in this study. Students (n=974) who are enrolled in courses with faculty who have volunteered to participate will be invited to take a survey and volunteer for a one of two focus groups (16 students).

What Is Involved In The Study?

If you volunteer to be participate in this research study you will be asked to do five things: 1) submit course materials (syllabi, course assignments narratives, and grading rubrics); 2) recommend a course for the PI to observe, preferably one where the course content is related to sustainability; 3) fill out the SU course assessment matrix; 4) participate in one semi-structured interview towards the end of the semester; 5) supply the PI will a list of student email addresses. All of these tasks will take a total of approximately 4 hours spread throughout the semester. All interviews (lasting no longer than 60 minutes) will be scheduled at your convenience, in a convenient location, and will be digitally voice recorded. The other tasks will occur in your classroom and through email. A sample interview question: Please describe how you redesigned your course to fulfill the SU course designation. A sample focus group questions: What was most helpful in your learning about sustainability in your recent SU designated course?

What Are The Benefits of Participating In The Study?

There is no direct benefit to you anticipated from participating in this study. However, you may gain some insight about your teaching practices and its influence on your students learning. It is hoped that the information gained from this study will help support the sustainability general education requirement at UVM.

What the Risks and Discomforts Of The Study?

Your participation in this study does not involve any physical or emotional risk to you beyond that of everyday life.

Are There Any Costs or Compensation?

There are no costs or compensation involved with participating in this research study.

Can You Withdraw or Be Withdrawn From This Study?

You may discontinue your participation in this study at any time. There are no consequences for discontinuing this study and will in no way impact your relationship with anyone at UVM. If you choose to discontinue your participation in this study, please send an email asking that you be removed from the study. All collected information including audio digital files will be deleted.

What About Confidentiality?

Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used. To minimize the risks to confidentiality: I will avoid using your name during the interview, I will de-identified the interview audio recording transcription, and the file linking your name with your pseudonym and all data files will be kept on a password-protected computer. All original documents containing identifying information, such as consent forms, will be kept in a filing cabinet if in hard copy or on my password protected computer if electronic, both are stored in a locked office only accessible by the researcher.

The Institutional Review Board and regulatory authorities will be granted direct access to your original research records for verification of research procedures and/or data. Please note that email communication is neither private nor secure. Though we are taking precautions to protect your privacy, you should be aware that a third party could read information sent through email. A private consulting firm will be hired to transcribe the de-identified audio file of the interview to text and will sign a confidentiality contract.

When the research is completed, I may save the study data for use in future research done by others or myself. I will retain this study information for up to 5 years after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

Contact Information

You may contact Lisa Watts Natkin, the investigator in charge of this study at 802-999-5416 for more information about this study. If you have any questions about your rights as a participant in a research project or for more information on how to proceed should you believe that you have been injured as a result of your participation in this study you should contact the Director of Research Protections Office at the University of Vermont at 802-656-5040.

Statement of Consent

You have been given and have read a summary of this research study. Should you have any further questions about the research, you may contact the person conducting the study at the telephone number given. Your participation is voluntary and you may refuse to participate or withdraw at any time without penalty or prejudice.

You agree to participate in this study and you understand that you will receive a signed copy of this form.

Signature of Subject

Date

Name of Subject Printed

This form is valid only if the Committees on Human Research's current stamp of approval is shown below.

Signature of Principal Investigator or Designee

Date

Name of Principal Investigator or Designee Printed

Name of Principal Investigator: Lisa Natkin

Address: lnatkin@uvm.edu

Telephone Number: 802-999-5416

Name of Faculty Sponsor: Dr. Tammy G Kolbe

Address: 499 Waterman, University of Vermont

85 South Prospect Street Burlington, VT 05401

Telephone Number: 802-656-0174

Appendix D: Key Informant Consent to Participate in Research

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

You are being invited to participate in this research study because you were involved in the creation of the sustainability general education requirement at the University of Vermont.

Why is This Research Study Being Conducted?

I am conducting this study as part my dissertation for the Educational Leadership and Policy Studies Doctoral program. The purpose of this case study is to explore the relationship between professor's teaching practices and the extent of students' understanding of UVM's four SLOs. Of particular interest is how faculty structure and teach sustainability-designated (SU) courses and what students report as helpful teaching practices in SU courses, as required by the University's general education requirement initiative. I encourage you to ask questions and take this opportunity to discuss the study with anybody you think can help you make your decision to participate.

How Many People Will Take Part In The Study?

Eight faculty members will have the opportunity to participate in this study. Students (n=974) who are enrolled in courses with faculty who have volunteered to participate will be invited to take a survey and volunteer for a one of two focus groups (16 students). Four key informants will be interviewed to provide information about the context of this case study, UVM's sustainability general education requirement.

What Is Involved In The Study?

If you volunteer to participate in this research study your interview (lasting no longer than 60 minutes) will be scheduled at your convenience, in a convenient location, and will be digitally voice recorded. A sample interview question: Please explain your role at the university and how it relates to the creation of the sustainability general education requirement. I will be conducting several different types of research methods: interviews, focus groups, classroom observations, survey, and document review.

What Are The Benefits of Participating In The Study?

There is no direct benefit to you anticipated from participating in this study. It is hoped that the information gained from this study will help support the sustainability general education requirement at UVM.

What the Risks and Discomforts Of The Study?

Your participation in this study does not involve any physical or emotional risk to you beyond that of everyday life.

Are There Any Costs or Compensation?

There are no costs or compensation involved with participating in this research study.

Can You Withdraw or Be Withdrawn From This Study?

You may discontinue your participation in this study at any time. There are no consequences for discontinuing this study and will in no way impact your relationship with anyone at UVM. If you choose to discontinue your participation in this study, please send an email asking that you be removed from the study. All collected information including audio digital files will be deleted.

What About Confidentiality?

Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used. To minimize the risks to confidentiality: I will avoid using your name during the interview, I will de-identified the interview audio recording transcription, and the file linking your name with your pseudonym and all data files will be kept on a password-protected computer. All original documents containing identifying information, such as consent forms, will be kept in a filing cabinet if in hard copy or on my password protected computer if electronic, both are stored in a locked office only accessible by the researcher.

The Institutional Review Board and regulatory authorities will be granted direct access to your original research records for verification of research procedures and/or data. Please note that email communication is neither private nor secure. Though we are taking precautions to protect your privacy, you should be aware that a third party could read information sent through email. A private consulting firm will be hired to transcribe the de-identified audio file of the interview to text and will sign a confidentiality contract.

When the research is completed, I may save the study data for use in future research done by others or myself. I will retain this study information for up to 5 years after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

Contact Information

You may contact Lisa Watts Natkin, the investigator in charge of this study at 802-999-5416 for more information about this study. If you have any questions about your rights as a participant in a research project or for more information on how to proceed should you believe that you have been injured as a result of your participation in this study you should contact the Director of Research Protections Office at the University of Vermont at 802-656-5040.

Statement of Consent

You have been given and have read a summary of this research study. Should you have any further questions about the research, you may contact the person conducting the study at the telephone number given. Your participation is voluntary and you may refuse to participate or withdraw at any time without penalty or prejudice.

You agree to participate in this study and you understand that you will receive a signed copy of this form.

Signature of Subject

Date

Name of Subject Printed

This form is valid only if the Committees on Human Research's current stamp of approval is shown below.

Signature of Principal Investigator or Designee

Date

Name of Principal Investigator or Designee Printed

Name of Principal Investigator: Lisa Natkin

Address: lnatkin@uvm.edu

Telephone Number: 802-999-5416

Name of Faculty Sponsor: Dr. Tammy G Kolbe

Address: 499 Waterman, University of Vermont

85 South Prospect Street Burlington, VT 05401

Telephone Number: 802-656-0174

Appendix E: Student Focus Group Consent to Participate in Research

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

You are being invited to participate in this research study because you enrolled in an SU (sustainability) Designated course at the University of Vermont in the Spring 2016 semester.

Why is This Research Study Being Conducted?

I am conducting this study as part my dissertation for the Educational Leadership and Policy Studies Doctoral program. The purpose of this case study is to explore the relationship between professor's teaching practices and the extent of students' understanding of UVM's four SLOs. Of particular interest is how faculty structure and teach sustainability-designated (SU) courses and what students report as helpful teaching practices in SU courses, as required by the University's general education requirement initiative. I encourage you to ask questions and take this opportunity to discuss the study with anybody you think can help you make your decision to participate.

How Many People Will Take Part In The Study?

Eight faculty members will have the opportunity to participate in this study. Students (n=974) who are enrolled in courses with faculty who have volunteered to participate will be invited to take a survey and volunteer for a one of two focus groups (16 students).

What Is Involved In The Study?

All students who are taking an SU course with a faculty member participating in this research study will be emailed inviting them to volunteer for one of two focus groups. Up to eight students will comprise one focus group. The two students per course to email the PI will be given instructions for participating. Focus groups will be approximately one hour and will happen in a reserved room in the student center. The PI will ask that everyone in the group not repeat what they have heard others say, but there is always the chance that someone will repeat what you have said. Everything you say will be kept confidential by the researchers. Focus groups questions are directed to the group, not to individuals. You have the right to: (a) not answer a question, (b) terminate the interview, or (c) withdraw from the study at any time in the process.

What Are The Benefits of Participating In The Study?

There is no direct benefit to you anticipated from participating in this study. However you may gain some insight about your learning process. It is hoped that the information gained from this study will help support sustainability education at UVM.

What the Risks and Discomforts Of The Study?

Your participation in this study does not involve any physical or emotional risk to you beyond that of everyday life.

Are There Any Costs or Compensation?

It does not cost any money to participate. Students will be compensated for their time and travel through a \$20 gift card to their student CATS scratch account.

Can You Withdraw or Be Withdrawn From This Study?

You may discontinue your participation in this study at any time. There are no consequences for discontinuing this study and will in no way impact your relationship with anyone at UVM. If you choose to discontinue your participation in this study, please send an email asking that you be removed from the study.

What About Confidentiality?

Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used. To minimize the risks to confidentiality, the transcription will not include people's names. The focus group will be digitally audio recorded, during transcription process voices will be given an number, such as student #1, #2, etc... All data files will be kept on a password-protected computer. All original documents containing identifying information (consent forms) will be kept in a filing cabinet, in a locked office only accessible by the researcher. The consent forms will never be associated with the transcription.

The Institutional Review Board and regulatory authorities will be granted direct access to your original research records for verification of research procedures and/or data. Please note that email communication is neither private nor secure. Though we are taking precautions to protect your privacy, you should be aware that a third party could read information sent through email. A private consulting firm will be hired to transcribe the de-identified audio file of the interview to text and will sign a confidentiality contract.

When the research is completed, I may save the study data for use in future research done by others or myself. I will retain this study information for up to 5 years after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

Contact Information

You may contact Lisa Watts Natkin, the investigator in charge of this study at 802-999-5416 for more information about this study. If you have any questions about your rights as a participant in a research project or for more information on how to proceed should you believe that you have been injured as a result of your participation in this study you should contact the Director of Research Protections Office at the University of Vermont at 802-656-5040.

Statement of Consent

You have been given and have read a summary of this research study. Should you have any further questions about the research, you may contact the person conducting the

study at the telephone number given. Your participation is voluntary and you may refuse to participate or withdraw at any time without penalty or prejudice.

You agree to participate in this study and you understand that you will receive a signed copy of this form.

Signature of Subject

Date

Name of Subject Printed

This form is valid only if the Committees on Human Research's current stamp of approval is shown below.

Signature of Principal Investigator or Designee

Date

Name of Principal Investigator or Designee Printed

Name of Principal Investigator: Lisa Natkin

Address: lnatkin@uvm.edu

Telephone Number: 802-999-5416

Name of Faculty Sponsor: Dr. Tammy G Kolbe

Address: 499 Waterman, University of Vermont

85 South Prospect Street Burlington, VT 05401

Telephone Number: 802-656-0174

Appendix F: Document Review Protocol

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

Purpose

The purpose of the document review is to gather information about the structure of the SU courses. Course materials include the course syllabus, SU designation application, assignment instructions, and grading rubrics.

Administration

After a faculty members volunteers to participate in this research study, they will asked to submit course materials (syllabus, SU application, assignments, and rubrics). Course material will be reviewed by the PI using this protocol document as a template.

Course ID:

Instructional Practices

Type of Activity	Description and notes	Document (syllabi, assignment, etc..)
Inquiry Based Learning: investigating open ended questions or or problem-based activities or Project based		
Collaborative Learning: learners work together to accomplish learning goals Group projects or presentations or small discussion groups		
Experiential Learning: Place-based, connect material to student lives, use of case studies or role playing Service Learning-meaningful community-based		

service		
Reflective Learning: Activities that ask students to think about how the course material is connected, question assumptions, or critique opinions		

Sustainability Content:

Topic (Ecological Principles, systems, climate change science, place, equity, agency)	Description and notes	Document (syllabi, assignment, etc..)

Assessment Strategies:

Assessment type	Description and notes	Document (syllabi, assignment, etc..)
List of grading structure-what assignment/activities make up grades		

Appendix G: SU Course Assessment Matrix

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

Course ID:

Purpose: The purpose of this form is to gather information about how students are learning the sustainability learning outcomes. This matrix was conceived during an assessment workshop held by Barbara Walvoord, an assessment consultant hired by UVM to assist in the creation of a university wide assessment plan, with special focus on the general education requirements. She recommended asking instructors to fill out a matrix to indicate their assessment method, what they found out about how students are learning the individual learning outcomes, what actions they can take to address those findings, and what actions the university can take to support the SLOs. Data from this matrix will gather information about how instructors approach student assessment, how that information informs their teaching practices, and what things could be happening at the university to support students as they fulfill the sustainability general education requirement?

Instructions: Please fill out this form describing your methods for assessing student learning the following sustainability learning outcomes (SLOs), your impressions of how students are learning the SLOs, what actions you may take based on what you learned, and share any suggestions you have for supporting general education learning outcomes. This matrix is a reflective process for instructors to document their assessment process; it is not intended to be a comprehensive measurement of student learning rather an indication of how instructors think students learned the indicated learning outcomes. This form may become part of the overall general education assessment process.

Sustainability Learning Outcomes (SLOs):

- Learning outcome 1: Students can have an informed conversation about the multiple dimensions and complexity of sustainability. (knowledge category)
- Learning outcome 2: Students can evaluate sustainability using an evidence-based disciplinary approach and integrate economic, ecological, and social perspectives. (skills category)
- Learning outcome 3: Students think critically about sustainability across a diversity of cultural values and across multiple scales of relevance from local to global. (values category)
- Learning outcome 4: Students, as members of society, can recognize and assess how sustainability impacts their lives and how their actions impact sustainability. (personal domain)

LOs	Regarding your assessment of SLOs, please describe what tasks or assignments students completed related to the SLOs. These may have been graded or ungraded.	When thinking about the evidence you collected, what did you find out about how the students are learning the SLOs?	Given what you learned through assessing students, identify actions that you may take in the future to enhance learning to meet the outcomes.
1			
2			
3			
4			

Given that the SLOs are general education learning outcomes, what other things could be happening at the university to support students as they fulfill the sustainability general education requirement?

Appendix H: Classroom Observation Protocol

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

Purpose: The purpose of these classroom observations is to gather data about higher education teaching practices and curricula related to the topic of sustainability. Observations will take place during regular class sessions in March or April of 2016. This protocol will be used to take detailed field notes related to the teaching practices, teacher actions, and student actions.

Course ID:

Date:

Time:

Length of Observation:

Description of Classroom Layout- lecture hall, fixed seats, circle, standard classroom,

Outline of Major Class Activities- lecture, discussion, movie, etc
1.

General Narrative Notes
Description of what is happening in class

Inquiry Based Learning: facilitating learners as they take responsibility for investigating open ended questions in a way that is meaningful to them <ul style="list-style-type: none">• Pose questions to class• Problem-based activities where students are encouraged to creatively solve a problem• Project based (engaging students with a problem, complex question, or challenge for an extended period of time to build skills)
Description of what is happening in class

Collaborative Learning: learners work together to accomplish learning goals
--

<ul style="list-style-type: none"> • Students helping and learning from one another • Group activities • Small discussion groups
Description of what is happening in class

<p>Experiential Learning: Engaging learners in direct experiences to build knowledge and skill, while facilitating reflections about their experience</p> <ul style="list-style-type: none"> • Place-based (using local place as a way to connect material to student lives to enhance • Use of case studies or role playing • Service Learning- meaningful community-based service
Description of what is happening in class

<p>Reflective Learning: allowing students to analyze how their learning experience is related to their lives</p> <ul style="list-style-type: none"> • Activities that ask students to think about their thoughts, their learning, or how the course material is connected to their life; journals, free write, paper, or posing a question and give students a few minute to consider it • Activities that challenge students to question assumptions, critique opinions, judge credibility of sources, applying criterion to make judgments, or look at an issue from contradicting values to develop critical thinking skills
Description of what is happening in class

<p style="text-align: center;">Assessment Strategies</p> <ul style="list-style-type: none"> • Activities where instructors monitor student engagement and/or learning, ask students to explain their interpretation of new material, give an example, use i-clicker to gauge student understanding
Description of what is happening in class

<p>Reflective Memo: written right after observation to record general impressions, questions, surprises, and thoughts</p>

Appendix I: Key Informant Interview Protocol

Title of the Research Project: Education for Sustainability: Teaching Practices Influencing Student Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

Purpose

The purpose of these interviews is to learn more about how the UVM sustainability general education requirement came to fruition. Interviewing the key informants to gain their perspectives and role in the creation of the general education requirement, helping to create a detailed understanding of the context of this case study.

Procedure

Verify that the interviewee has signed the consent form and verify that they are willing to participate in this study. To protect interviewee's confidentiality I will avoid saying their name. After gaining permission to record the interview, I will turn on my recording device. Interviews will be audiotaped and transcribed for later analysis. The interview protocol consists of a set of open-ended questions. Follow-up questions may be added at the researcher's discretion, both to pursue related topics and to probe for more elaborated responses.

Directions: I'd like to ask you some questions about the your experience with the Sustainability General Education requirement. I will be audiotaping this interview so that I can review your responses later, but all information will be kept confidential, and your name will not be used in any communication, presentation, or publication. Your participation is entirely voluntary, and you have the right to stop participating at any time and for any reason.

1. Please explain your role at the university and how it relates to the creation of the sustainability general education requirement.
2. Describe the process for sustainability becoming a general education requirement.
3. In your opinion, what role did Sustainability Faculty Fellows program play in creating the sustainability general education requirement.
4. In what ways do you hope the SU general education requirement will change teaching and learning at UVM?
5. In your opinion, what are successful sustainability teaching practices?
6. Describe ways in which assessment will move the SU Gen Ed forward?
7. Is there anything else you would like to add?

Appendix J: Instructor Interview Protocol

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

Purpose

The purpose of these interviews is to learn more about faculty members teaching practices in their recently taught sustainability-designated (SU) course. Of particular interest is how faculty members structured and taught their SU course. These interviews will help the researcher understand faculty members experience teaching their SU course.

Procedure

Verify that the faculty member has signed the consent form and verify that they are willing participant in this study. To protect interviewee's confidentiality I will avoid using their name. After gaining permission to record the interview, I will turn on my recording device. Interviews will be audiotaped and transcribed for later analysis. The interview protocol consists of a set of open-ended questions. Follow-up questions may be added at the researcher's discretion, both to pursue related topics and to probe for more elaborated responses.

Directions: I'd like to ask you some questions about the your experience teaching your SU course. I will be audiotaping this interview so that I can review your responses later, but all information will be kept confidential, and your name will not be used in any communication, presentation, or publication. Your participation is entirely voluntary, and you have the right to stop participating at any time and for any reason.

1. How did you conceptualize sustainability within your course content?
2. Please describe one or two highlights of your experience teaching the sustainability related activities.
3. Please describe any changes you made to your course to fulfill the sustainability course designation requirements.
4. What motivated to select those activities?
5. In what ways did teaching sustainability content change how you teach?
6. How did you assess students' learning related to the sustainability content?
7. Please describe what you learned from filling out the student assessment matrix and what actions you plan to take resulting from what you learned.
8. What do you think the UVM sustainability general education initiative needs to be working on to improve students learning the sustainability learning outcomes?
9. Is there anything else you would like to add?

Appendix K: Focus Group Protocol

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

Purpose

The purpose of these focus groups is to learn more about students learning experience in the sustainability-designated (SU) courses. Of particular interest is in what ways student report teaching practices as helpful to their learning process. These focus groups will help the researcher understand students learning experience in their recent SU course.

Procedure

Focus groups will be for approximately one hour and will occur in the student center. Two focus group consent forms will be given to each student. I will encourage students to ask questions or discuss concerns. I will invite students to sign two consent forms, I will sign the forms, I will keep one and the student will keep the other. After gaining permission to record the focus group, I will turn on my audio recording device. Focus groups will be audiotaped and transcribed for later analysis. The focus group protocol consists of a set of open-ended questions. Follow-up questions may be added at the researcher's discretion, both to pursue related topics and to probe for more elaborated responses. I will ask that everyone in the group not repeat what they have heard others say, but there is always the chance that someone will repeat what you have said. Everything you say will be kept confidential by the researchers. Your names will be not transcribed. Focus groups questions are directed to the group, not to individuals. You have the right to: (a) not answer a question, (b) terminate the interview, or (c) withdraw from the study at any time in the process.

Directions: I'd like to ask you some questions about the your learning experience in your recent SU course. I will be audiotaping this interview so that I can review your responses later, but all information will be kept confidential, and your name will not be used in any communication, presentation, or publication. Your participation is entirely voluntary, and you have the right to stop participating at any time and for any reason.

1. Describe your favorite learning experience in your recent SU designated course.
2. What aspects of your course helped you with your learning? Why were they helpful?
3. What changes to the curriculum or classroom strategies could help you better achieve learning about sustainability?
4. In what ways did your course address the complexities surrounding sustainability issues? What were some of those complexities?
5. Do you feel you could have an informed conversation about sustainability with other adults and young adults?
6. What is your sense of how your own actions impact sustainability of global environmental and social systems?
7. What actions could the university take to support the sustainability general education requirement?

8. Is there anything you would like to add?

Appendix L: Student Survey

Title of the Research Project: Education for Sustainability Development: Teaching Practices Influencing Studies Learning in Higher Education

Principal Investigator: Lisa Watts Natkin

Faculty Sponsor: Tammy Kolbe, Leadership and Development Sciences

Introduction

You are invited to take this survey about your experience in the sustainability-designated course at the University of Vermont. This is part of my dissertation exploring the relationship between teaching practices and student learning. It should take you 7 MINUTES to complete. If you take it on a mobile device the question numbering will be repetitive.

As thanks for your participation, you will be able to enter a drawing for 4 STUDENTS TO WIN \$20 OF CATSCRATCH. At the end of the survey, you will be given directions for entering the drawing.

You are not asked to provide your name and your survey answers will be kept confidential. Entering to win the \$20 compensation will be separate from your survey responses. Your participation is NOT required. There will be no negative consequences if you do not participate. By taking this survey, you are giving your consent to participate in my dissertation research. I hope you take this opportunity to share your experiences of professor's teaching practices.

1) Are you 18 years old or older?

- ☐ Yes
- ☐ No

2) Please select the name of the Sustainability Designated course you are currently enrolled in from the pull down menu of course titles.

- ☐ EE 113- Electric Energy Systems
- ☐ GEO 50- World Regional Geography
- ☐ NFS 73- Contemporary Food Systems
- ☐ PBIO 6- The Green World
- ☐ EC 40- Economics of Globalization
- ☐ ENVS 188- Sustainability Science
- ☐ NR 107- Human Health and the Environment
- ☐ EDEL 157 Social Education Studies

3) Please rate the following statements in terms of its importance to your learning.

My ideal learning environment.....

	Not important	Somewhat important	Moderately important	Very important	Extremely important
Would emphasize basic facts and definitions	()	()	()	()	()
Would focus more on having the right answers than on discussing methods or solving problems	()	()	()	()	()
Would involve the professor teaching me all the information I am supposed to learn	()	()	()	()	()
Would involve taking good notes in class so I can reproduce that information on the test	()	()	()	()	()
Would involve the teacher giving clear directions and expectations for assignments.	()	()	()	()	()
Would consist of lectures because I can get all the facts I need to know more efficiently that way	()	()	()	()	()
Would consist of objective-style tests because they have clear-cut right or wrong answers	()	()	()	()	()

4) How would you rate your familiarity with sustainability BEFORE this semester?

- ☐ Not at all familiar
☐ Slightly familiar
☐ Somewhat familiar
☐ Moderately familiar
☐ Extremely familiar

5) Please share a brief definition or explanation of what sustainability is/means to you. If you are having trouble writing a definition, share key sustainability concepts.

6) To what extent did your participation in this sustainability designated course EXPAND your....

	Not at all	A little	Some what	To a great extent	Was not covered in class
Knowledge of sustainability	☐	☐	☐	☐	☐
Ability to have an informed conversation about sustainability	☐	☐	☐	☐	☐
Ability to analyze the ecological, economic, and social dimensions of sustainability issues	☐	☐	☐	☐	☐
Ability to think critically about the values associated with sustainability issues	☐	☐	☐	☐	☐
Ability to understand how local sustainability issues are related to the global community	☐	☐	☐	☐	☐
Ability to assess how your life impacts sustainability issues	☐	☐	☐	☐	☐
Understanding of the complexity of sustainability issues	☐	☐	☐	☐	☐

7) Please select all of the class activities that happened in your recent sustainability designated course: (Check all that apply)

☐ Sustainability related readings

- ☐ Class discussions about sustainability
- ☐ Written paper about sustainability
- ☐ Guest speaker about sustainability
- ☐ Reflective activity about sustainability
- ☐ Group project about sustainability
- ☐ Case study related to sustainability
- ☐ Activities that had a focus on a real life application (i.e. service learning)
- ☐ Other - Write In: _____

8) Please indicate the extent to which these activities were helpful in your learning about sustainability.

	Not at all	A little	Somewhat	To a great extent	Did not happen in class
Sustainability related readings	()	()	()	()	()
Class discussion about sustainability	()	()	()	()	()
Written paper about sustainability	()	()	()	()	()
Guest speaker about sustainability	()	()	()	()	()
Reflective activities about sustainability	()	()	()	()	()
Group projects about sustainability	()	()	()	()	()
Case study related to sustainability	()	()	()	()	()
Activities with a real life application	()	()	()	()	()

9) Describe the most helpful sustainability related learning experience in your class and explain why it was helpful.

10) What changes to the course's teaching methods could help improve your learning about sustainability?

11) Please indicate how likely the information you learned about sustainability issues will influence your lifestyle.

() Extremely UNlikely () UNlikely () Neutral () Likely () Extremely Likely

12) Please indicate the extent to which you agree or disagree with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
What we do today affects the lifestyles of future generations.	()	()	()	()	()
Abuses of the environment should not disproportionately affect the lives of the poor.	()	()	()	()	()
My decisions and actions affect my community, not other people or places around the globe.	()	()	()	()	()
In general, I think social justice issues are among the most important challenges in the world today.	()	()	()	()	()
Businesses should be concerned about the	()	()	()	()	()

welfare of their employees and the communities in which they operate.					
People should be willing to make sacrifices so other people in the world can live better.	☐	☐	☐	☐	☐
In general, I think climate change is among the most important challenges in the world today.	☐	☐	☐	☐	☐
It is important to preserve plants and animals that are threatened by extinction.	☐	☐	☐	☐	☐

13) What is your major?

14) Please indicate that likelihood you will apply sustainability content learned in this course to other courses within your major.

☐ Extremely UNlikely ☐ UNlikely ☐ Neutral ☐ Likely ☐ Extremely likely

15) During your time at UVM how many courses have you taken that teach sustainability topics?

- ☐ First one
☐ 1-2
☐ 3-5
☐ 6 or more

16) Gender

- ☐ Male
☐ Female
☐ Other

17) Year Entered College

- ☐ 2012
☐ 2013
☐ 2014

☐ 2015

☐ Other - Write In: _____

Knowledge Questions

The survey ends with a few multiple choice questions used by other universities to assess sustainability knowledge. It is alright if your course did not cover this content, simply select the DON'T KNOW answer.

18) What is the most common cause of pollution of streams and rivers?

- ☐ Dumping of garbage by cities
- ☐ Surface water running off yards, city streets, paved lots, and farm fields
- ☐ Litter near streams and rivers
- ☐ Waste dumped by factories
- ☐ Don't know

19) Ozone forms a protective layer in the earth's upper atmosphere. What does ozone protect us from?

- ☐ Acid rain
- ☐ Climate change
- ☐ Sudden changes in temperature
- ☐ Harmful UV rays
- ☐ Don't know

20) Which of the following is an example of sustainable forest management?

- ☐ Setting aside forests to be off limits to the public
- ☐ Never harvesting more than what the forest produces in new growth
- ☐ Producing lumber nearby communities to build affordable housing
- ☐ Putting the local communities in charge of forest resources
- ☐ Don't know

21) Of the following, which would be considered living in the most environmentally sustainable way?

- ☐ Recycling all recyclable packaging
- ☐ Reducing consumption of all products
- ☐ Buying products labeled "eco" or "green"
- ☐ Buying the newest products available
- ☐ Don't know

22) Over the past 3 decades, what has happened to the difference between the wealth of the richest and poorest Americans?

- ☐ The difference has increased
- ☐ The difference has stayed about the same
- ☐ The difference has decreased
- ☐ Don't know

23) Which of the following is the most commonly used definition of sustainable development?

- ☐ Creating a government welfare system that ensures universal access to education, health care, and social services
- ☐ Setting aside resources for preservation, never to be used
- ☐ Meeting the needs of the present without compromising the ability of future generations to meet their own needs
- ☐ Building a neighborhood that is both socio-demographically and economically diverse
- ☐ Don't know

24) Many economists argue that electricity prices in the U.S. are too low because...

- ☐ They do not reflect the costs of pollution from generating the electricity
- ☐ Too many suppliers go out of business
- ☐ Electric companies have a monopoly in their service area
- ☐ Consumers spend only a small part of their income on energy
- ☐ Don't know

25) Which of the following is the most commonly used definition of economic sustainability?

- ☐ Maximizing the share price of a company's stock
- ☐ Long term profitability
- ☐ When costs equal revenue
- ☐ Continually expanding market share
- ☐ Don't know

26) Which of the following is the best example of environmental justice?

- ☐ Urban citizens win a bill to have toxic wastes taken to rural communities
- ☐ The government dams a river, flooding Native American tribal lands to create hydro-power for large cities
- ☐ All stakeholders from an indigenous community are involved in setting a quota for the amount of wood they can take from a protected forest next to their village
- ☐ Multi-national corporations build factories in developing countries where environmental laws are less strict
- ☐ Don't know

27) Which of the following is a leading cause of the depletion of fish stocks in the Atlantic Ocean?

- ☐ Fisherman seeking to maximize their catch
- ☐ Reduced fish fertility due to genetic hybridization
- ☐ Ocean pollution
- ☐ Global climate change
- ☐ Don't know

28) Which of the following countries has now passed the U.S. as the biggest emitter of the greenhouse gas carbon dioxide?

- ☐ China

- ☐ Sweden
- ☐ Brazil
- ☐ Japan
- ☐ Don't know

29) Put the following list in order of the activities with the largest environmental impact to those with the smallest environmental impact:

- A. Keeping a cell phone charger plugged into an electrical outlet for 12 hours
 - B. Producing one McDonald's quarter-pound hamburger
 - C. Producing one McDonald's chicken sandwich
 - D. Flying in a commercial airplane from Washington D.C. to China
- ☐ A, C, B, D
 - ☐ D, A, B, C
 - ☐ D, C, B, A
 - ☐ D, B, C, A
 - ☐ Don't know

Thank you so much for taking the time to fill out this survey. In appreciation for your time completing this survey, you can enter a drawing for 4 STUDENTS TO WIN \$20 ADDED TO YOUR CATSCRATCH ACCOUNT. FOUR students will randomly be selected and notified that they won. To enter the drawing please email me, Lisa Natkin, at lnakin@uvm.edu I am asking you to email me instead entering your name into the survey to ensure that your name is not connected to your survey responses.

Thank YOU! Thank you! Thank you!

Appendix M: Course Description Table

Course Curriculum	Illustrative Quote
Geography	
<p>Conceptualization: Bringing together physical geography, climate, ecology, culture, politics, history, economics to learn about world regions- empathizing the complexity and diversity of the world</p> <p>Topics: Systems Economic, political, and environmental connections between regions Politicization of agriculture and ideology Understanding agriculture as a system Environmental justice Environmental disaster- Chernobyl Traditional knowledge- agriculture Global economics and the problem of pollution Biotech and bio-piracy Colonialism, neoliberalism, and Green Revolution Complex connection between consumption, extraction, and production</p>	<p>“My approach...has really been to take a world systems approach and to look at how things like political stability or environmental degradation are produced, what are the histories that are built behind these things, how do those histories continue to manifest themselves in the present through systems like agriculture or through things like regional specific or content specific things like poaching.”</p>
<p align="center">Instructional Practices</p> <p>Inquiry-based- Lecture guide- positives and criticisms of the green revolution. Poses lots of essential questions throughout lecture. Systems- understanding relationships</p> <p>Collaborative</p> <p>Experiential-case studies (the case of neem, true cost of ivory) Guest lecture, film (bitter seeds), attend a lecture and write up about it, helped to realize amount of on campus resources</p> <p>Reflective- ask students to contemplate the ethics behind green revolution</p>	<p>“Now, what I do have students do is I have a required writing assignment, a three to four page essay. They have to go out to a special campus lecture event and that is probably relevant to this course. It deals with politics, economics, environment or some sort of combination of those things in a basic kind of report.”</p>
<p align="center">Assessment</p> <p>Several questions about SU on exam in both multiple choice and short answer format 4 exams Map Quizzes Mastering geography modules- by textbook interactive learning experiences and deeper insights into material Writing assignment (attend a lecture and write paper)</p>	<p>“It’s something else when you’re teaching in North America at the most expensive public institution in the country. What does it mean to get students comfortable with modes of critique? Many of whom of those students were raised accepting capitalism as second nature. What does it mean say that? Like, to teach them to be okay with modes of</p>

Attendance	critique that challenged the very foundations of their comfort? That's a tricky move."
Economics	
<p>Conceptualization: Economics of globalization... climate change and global environmental issues and infused sustainability through all modules- environmental issues are related to trade, offshoring, and outsourcing.</p> <p>Topics: Exporting pollution Equity issues Tragedy of the commons- hard to get consensus Development and environment- climate change Globalization Trade and the environment Offshoring, outsourcing, and environmental issues Global population issues Sustainability Development Goals- International Development Culture influences on economic issues (Japanese population)</p>	<p>"After attending the Sustainability Fellows Program, I realized that it was better to incorporate sustainability concepts within each module. For example, how does trade affect environmental quality across countries? If we are importing from China, do we basically end up exporting our pollution to China? So rather than saving everything in the end, I realized it will have a greater impact... But my best barometer is how they react in class, and if they ask questions; and they have been asking a lot of questions and giving their reactions."</p>
<p>Instructional Practices</p> <p>Inquiry-based- observation posed question- why is climate change the ultimate transboundary pollution? Can economics rise as emissions fall? Lecture is outlined by essential questions. Each reading assignment is structure with main questions and key concepts.</p> <p>Collaborative- Observation- lots of class discussion and questions, students from china were able to give personal accounts of things discussed</p> <p>Experiential- observation- interpreting graph and lots of recent new york times articles. Takes textbook concepts and connects them with news paper articles for the real world application, videos and podcasts. Real world applications of current events.</p> <p>Reflective- consumption and ethical issues of iphones and working conditions abroad. Transporting pollutions and waste.</p>	<p>"Here, definitely yes, because, again, it goes back to that; rather doing it as a separate globalization topic, it is something that permeates a lot of the economic decisions that we make, whether it's finance or trade or whatever, that the environmental impact is there, the sustainability is there. So, yes, it did really change the way I structure the course, rather than being saved at the last three weeks of the semester... And what involves a lot of work for me is to identify NPR, New York Times articles that can illustrate, in almost the same terms as their textbook, show an excerpt from it. And then ask them which concept in class explains this excerpt? So that's what I wanted to do more of."</p>
<p>Assessment 3 exams</p>	<p>"I want to institute some of this short essay on those small pop</p>

<p>Online assignments & Online quizzes- multiple choice on BB- both available after discussed in class</p> <p>In time- students use a piece of paper to write down answer to multiple choice question- extra credit on exam. Another one- open ended- what concept best captures this example?</p> <p><i>Note-</i> no essays because it is too much work for TA</p>	<p>quizzes in class, because right now it's almost like a multiple choice; I already gave them the answer and they choose. So it's easy for my TA to grade. But any short essay question, one to two sentences, will be easy."</p>
<p style="text-align: center;">Nutrition and Food Systems</p>	
<p>Conceptualization: to create a food system that can feed us all without destroying the ability of future generations to feed themselves.</p> <p>Notes: systems oriented, Cultural, Political, and economic forces influencing the chain of production from farm to table. (Components of food system are economic, social, and biological)</p> <p>Topics:</p> <p>Place</p> <p>Politics of agriculture</p> <p>Food justice issues</p> <p>Pest Control (unintended consequences)</p> <p>Industrialization</p> <p>Globalization</p> <p>Scale- Global to local</p> <p>Fair trade</p> <p>Food labeling</p>	<p>"Scale being another concept; I think that idea of being able to go from local to global. Well, I think I said in here, like, household to global, you know, really starting with the family meal to how are families on the other side of the world eating and why; so similar sort of concept that's related to systems."</p> <p>"Values are core to sustainability education"</p>
<p style="text-align: center;">Instructional Practices</p> <p>Inquiry-based- lots of essential questioning... How did this system develop? Systems thinking diagram- big systems focus</p> <p>Collaborative- small group debates and activities in class (one that required them to look at multiple perspectives on a food system issue) Peer review of papers.</p> <p>Experiential- role play (viewing multiple perspectives within the contemporary food systems) activities have assigned roles (speaker, note taker- same students in groups each class), films, guest lecturer, case studies, intergenerational interview, place-based (story of sugar), class activity the <i>Hungry Planet</i>, optional field trips (service learning component- picking bugs)</p> <p>Reflective- short essay (6 short papers arguing a</p>	<p>"What do I like about field trips? Well, I like the fact that they're learning directly from other people. And then I become more of a facilitator of learning, where it's like, okay, let's discuss concepts, maybe not in the moment, maybe in the moment. Then it might be afterwards and we sit down and we talk about the trip and kind of get a sense of what they're learning. And it closely relates back to the reflection piece, too; like, that kind of reflection and then putting it in writing and kind of developing ideas. "</p>

<p>position), final essay. Reflective journal- define sustainable food systems in your own terms- impact your life and your actions impacting food systems. Lecture used questions for reflection. Final Reflection paper- key SU issue related to key issues in food systems, from socioeconomic, political, and environmental lenses, and own lives (<i>Note</i>: Students checked all of the boxes for methods and they struggled with unstructured nature of reflective essay)</p>	
<p>Assessment Short response papers- using evidence to form an argument around a claim about values, ex. The global food industry has positively impacted human health and nutrition. Sustainability journal reflections (Intergenerational interview, addressing industrialization of the food system via Kitchen literacy) Final exam (key terms, short answer and essays) Final reflection paper Small group class activities</p>	<p>“really linking more of the values that are explored through case studies in the class, and linking that back to your own personal experience, that are connecting some of – there’s a lot of in-class activities...wouldn’t it be great if I really bridge that activity to another activity or to their journals, and in more sort of like...”</p>
Natural Resources	
<p>Conceptualization: sustainability is achieved by creating a balance between ecological flourishing and human well-being, and that health is a primary component of well-being. Key Topics: Vulnerable populations Environmental justice Energy production Food production and access Epidemiology Toxicology Risk management Well being Environmental disasters Climate change Water quality and access Waste management</p>	<p>“So how do they analyze those, how do they critically think about what are all the pieces that are coming into play here to start thinking in systems; so really a systems based approach. Don’t just listen to it and be like, wow that was mind blowing just to hear about that holy cow! There’s this crazy chemical, oh my god, but to be like okay, why is that chemical there, what are the different social factors that are governing the movement of that chemical. So trying to just help them to begin critically analyzing what they see, what they are understanding out there in the world.”</p>
<p>Instructional Practices Inquiry based- service learning project, groups new critique, posing questions to a small group, posing questions to the entire class, sustainability</p>	<p>“Yeah, like the informed conversation, I think we did okay with that because of the service learning component. Because in this</p>

<p>buffet, short essay topic: to describe the problem of nature deficit disorder, review social, economic, and environmental aspects of issue.</p> <p>Collaborative-group news critique students groups lead the class discussion about their news topic. Small group discussions, entire class discussions, small group class activities</p> <p>Experiential- service learning project and sustainability well being challenge (social, lifelong, helping others, physical), case study, fracking video, service learning project they had to teach community members about their topic, place based talking about lead paint issues in the north end</p> <p>Reflective- group news critique prompts: challenge assumptions about material, lead a free write during class- what does energy look like in a sustainable world? Posed question to class- What role can we play as individuals to minimize the environmental and human health impacts of energy use and production? Sustainability well being challenge and service learning project included a final reflection paper. Free write about energy, Donella Meadows film reflective visualizing activity. After sustainability buffet students created their own definition of sustainability and how it includes health</p>	<p>class, the students were broken up into groups; about six students each. And they had to create an activity that they shared with the public at this one-day event for community gardening. And the goal that I set forth for them, and this is in the matrix, but it's like – you need to learn your topic so well that you can teach it to someone else. And you need to be able to teach it to someone who's five years old and somebody who's 95 years old. But you have to be able to take it down to the basic level so that someone else can understand it. And to do that, you need to understand it.”</p>
<p style="text-align: center;">Assessment</p> <p>Weekly assignments</p> <p>Sustainability well being challenge (final reflection paper)</p> <p>Complexity Env Health challenges (read/watch article, write response why it is complex)</p> <p>Group news critique</p> <p>Service learning project (students designed public education activity for Day in the Dirt)& final reflection paper</p> <p>Final learning assessment (take home exam and reflection paper on how personal definition of sustainability changed)</p> <p>Attendance and engagement- just in time teaching for short written reflections (SLO3) topics food systems, climate, health, energy, waste- discussed vulnerable populations</p> <p><i>Note</i>- provided rubrics and examples for all assignments</p>	<p>“There were surprisingly a lot of different things, when I sat down and started thinking about, what were all the different things that we did that helped them accomplish that; there were a lot of different things. But the thing that, this has been a really helpful process first thinking through, because I'm teaching the same course again in the fall. But I need to allow time in class for the discussion. ... I appreciate being able to go through this process myself, like what worked; what didn't work? ... And a reflection about how did it go– there was not depth in those conversations because I didn't build it into the course for having that depth of</p>

	conversation.
Plant Biology	
<p>Conceptualization: Have all three components of sustainability- the course focuses on the ecology of the system. For the social we talk about the impact of society on agriculture and plant use, and we talk about ecological economics.</p> <p>Topics: Sustainability definition (complexity) Basic plant biology Conservation and Biodiversity Plants and human affairs Plants, the Environment, and Sustainability Origins of agriculture Socio-economic systems of coffee- Case study of the Irish potato famine (ex. monoculture) & Corn Farming Ecosystem services Carrying capacity Green revolution Nitrogen and carbon cycle Climate change Systems (Capra) Second law of thermodynamics Paul Ehrlich's solutions Ecological Principles (biotic, habitat selection, mutualism) Sugaring- related to climate change in the ecological and economic sense</p>	<p>“So we had an existing ecological and social – we had all of the components of sustainability in the course already. The focus was on just the ecology of the system, because it’s a basic plant biology course. Really, ecology is pretty much the second part of the course. The social component comes in when we talk about the impacts of past societies and current societies on how we grow food, how plants have been used. So we have a whole plants and society component where we go into some history, the historical context of certain plants. That was already existing there. And then we did a bit of ecological economics at the end, where we talked about the economy and the economic impacts.”</p>
<p style="text-align: center;">Instructional Practices</p> <p>Inquiry-based- Essential questions in lecture (observation) What does sustainability mean? Made connections to earlier curriculum. In observation taught about systems</p> <p>Collaborative- small group and large group discussions, after i-clicker questions students had to get up and talk to each other, Blog posts are visible to entire community on blackboard, so students can learn from each other</p> <p>Experiential- guest lecturers, field trip to greenhouse (event map, answer questions, and illustration), optional field trips to natural areas, podcast (How do you put a price tag on nature?), placed based- maple industry guest speaker, ecosystems services guest speaker, PBS video</p>	<p>“Yeah, and then we talked about the Green Revolution. And I revisited that today with Norman Borlaug, and we talked about population growth. And I saved some of these things for today, to revisit those. So I used agriculture as a lens, like, as a case study throughout the second part of the semester, to evaluate sustainable and unsustainable practices. So it was a real touchdown for me. And Taylor Ricketts came in and talked on Thursday about ecosystem services as related to pollination.”</p>

<p>Botany of Desire, Greening the desert video</p> <p>Reflective- Plant in the news- reflective aspect of blog. Observation- talked about Capra and tried to get students to move from linear to systems thinking- perspective taking- humans have only been around for a short geological time</p>	
<p style="text-align: center;">Assessment</p> <p>Exams</p> <p>Final exam (?’s on ecosystem services related to sustainability)</p> <p>Weekly quizzes-BB</p> <p>Pre-lectures assignments (2-3 short answer) one was about Capra’s article</p> <p>In-class concept tests (i-clicker)</p> <p>Plants in the new Blog Posts- explore connection between plants, human culture, and the environment</p>	<p>“Because there’s one right answer, and there’s never just one right answer. You can write a good multiple-choice question, but it still narrows the capacity of what you can actually test. With multiple-choice questions, it’s mostly fact retrieval-style. So it’s less ambiguity; it’s right or wrong. You have no opportunity to really engage the students’ process of thinking through a problem or a question, you miss all of that.”</p>
Electrical Engineering	
<p>Conceptualization: A sustainable system is one which survives or persists</p> <p style="text-align: center;">Topics:</p> <p>Health impacts of electric power production</p> <p>Renewable energy development</p> <p>Pollution</p> <p>Electric utilities</p> <p>Manufacturers</p> <p>Supply, delivery, and consumption of electric energy</p> <p>Efficiency and capacity factors</p>	<p>“I think one of the exams had a question that was kind of similar in style. I’d probably include something similar in the final just to test their ability to reason in that way. But what I’m really trying to do is to get them to think about the different dimensions of sustainability because it’s not just one thing, there’s lots of things that are involved and the health impacts are very different than the finiteness and the resource. So coal and natural gas are really good for this one because there’s a lot of coal but the health impacts are enormous. Whereas, there’s a less natural gas under the ground but the health impact are quite less relative to coal. And both of them require the use of finite resources.”</p>
<p style="text-align: center;">Instructional Practices</p> <p>Inquiry-based- all applied, problem based homework and lab assignments, Observation- one big problem posed and students were taking</p>	<p>“– a developer comes to you as a hypothetical consultant and you want to help the developer choose what type of power plant to build</p>

<p>notes to solve it, instructor drew picture of circuit and class discussed- Lab 3 asking students to conduct calculations and make a energy source recommendation.</p> <p>Collaborative- Group work through labs and homework- Observation- lots of discussion and asking questions in class</p> <p>Experiential- Field trip to McNeil, Observation- gave example of a conversation with Green Mountain Power (real world application)- practical real world class activities and homework</p> <p>Reflective- There was a question in lab 3- why they choose that energy source and they could have reflected on their values. Some students mentioned land use issues with solar or wind or mountain destruction with wind energy, pollution with natural gas and being a fossil fuel. Encouraging students to think about different dimensions and perspective- rather than good or bad.</p>	<p>and the developer knows how much energy they want to produce or the average amount of power that they want to produce, but they're kind of agnostic about the technologies. And so the goal is to do an engineering and economics analysis of a natural gas, a solar and a wind plant using real data. So the economic analysis, I think, works pretty well for the wind plant in this particular one and that's maybe just an artifact of the data that we have – or the natural gas plant depending on how you do it. So most student kind of came to the conclusion that either natural gas or the wind plant were the best options.”</p>
<p>Assessment</p> <p>2 exams Homework and quizzes Lab reports Note- SU Exam question & one reading response- read an article and write a 1 page response</p>	<p>“I think a number of them have demonstrated that they have – with labs for example, when they had to actually do this data analysis, they developed a much more sophisticated understanding of how the economics and the engineering kind of interacts and they understand key concepts, like efficiency, capacity factor and these things that help them really understand how the system works. So I hope that this prepared them to be better decision makers going forward.”</p>
<p>Education</p>	
<p>Conceptualization: Series of big ideas/concepts that bridge the natural world and the social worlds. Oriented in the history of the sustainability development movement, environment education orientation- vinn diagram of three legs. The big idea with sustainability development is that economies can continue to grow and develop and social needs can be met without sacrificing the environment.</p> <p>Topics:</p>	<p>“But in this particular one, when we go there the questions are really open-ended and designed to get students thinking about the kind of educational system that they think is most valuable. And it may not be the kind of educational system that we have today or may have some attributes of that. So basically what we do is you have some white paper</p>

<p>Economy and ecology- how to teach economics to elementary school students</p> <p>Case study- sugaring framing it as natural resources, capital resources, and human resources</p> <p>Vermont social studies standards</p> <p>Integrating sustainability into lesson plans</p> <p>Community, change, and place- concern for common good lecture</p> <p>Social justice, multicultural and ecological perspectives</p> <p>Teaching teachers about EfS pedagogy & Values</p>	<p>and you break into groups and you answer. On the white paper are questions like, what do you want your students to care about? You know, something like that. Like five questions, I can't remember. They're written down here but – so what do you want them to care about?</p> <p>Students break up the end of the groups and go around and basically talk about it and you end up with a document.”</p>
<p>Instructional Practices</p> <p>Inquiry-based- lots of essential questions, questions for real aloud assignment, map activity with their students</p> <p>Collaborative-small group discussions and large group report outs- common classroom technique, small group project developing a sustainability and social studies learning projects, Observation- students walked around in pairs looking at childhood maps looking for commonalities and differences</p> <p>Experiential- field trip to Shelburne Farms and Fleming Museum, place based education emphasis (focus on hands on and real world learning experiences), builds ties to community</p> <p>Reflective- journal reflections. Observation- students shared their aha moment from their field placement, framework for citizenship- reflect on what knowledge, skills, and dispositions make a good citizen. World Café protocol- what do what students to know, care about and be able to do. David Sobel- cultivating valuing nature before facts about climate change</p>	<p>“The way I understand these protocol-based activities is that school change can be really messy and unproductive, I think, particularly talking about it if you don't have some sort of guide and sort of structure to the conversation. And so the world café is just a protocol, it's a way for getting people talking about things that's are important to them and there are certain kinds of questions that work well within it.”</p>
<p>Assessment</p> <p>Participation and attendance</p> <p>Journal reflections (about readings and social studies journal articles)</p> <p>Read loud</p> <p>Small group lesson plan project</p> <p>Webquest</p> <p>Observation- exit ticket- what have you learned today and how has today's class improved your understanding of sustainability?</p>	<p>“I'm really inclined to do fieldtrips, I mean, I was already doing that but I think that thinking about sustainability and teaching about sustainability has made me much more confident about out of school experiences, field-based experiences. I think the universities emphasis on it has made me feel more secure in doing some of those things, feeling like I can justify and</p>

	rationalize it, you know that I have support for it because it's under the rubric of sustainability and it's a GenEd requirements."
Environmental Studies	
<p>Conceptualization: Human wellbeing and ecosystem health are core goals of Su. LO- understand the utility of the systems framework and the inherently complex nature of SU</p> <p><i>Important student goals:</i> developing critical thinking skills & written skills & collaboration in problem solving & evidence based measures of effectiveness and decision making, ability to craft an argument</p> <p>Topics:</p> <p>Tragedy of the commons</p> <p>Systems thinking and complexity</p> <p>Sustainability definitions and principles</p> <p>Emerging science and technology</p> <p>Climate change</p> <p>Food production- conventional vs. organic</p> <p>Metrics and indicators of sustainability</p> <p>Consumption</p> <p>Biomimicry</p> <p>Emerging vales and future of sustainability science</p> <p>Eco-effectiveness and efficiency</p>	<p>"These are the facts of the case. I'm not going over them in class, because that's not the interesting, cool stuff. The cool stuff is how do you make decisions on top of the facts and how does policy work and how does the science policy interface work and what does society care about and community? This is the stuff you need to know underneath all that."</p> <p>"But for me, if we graduate students who can't craft an argument, then we've done a disservice to them and a disservice to environmental studies and sustainability."</p>
<p>Instructional Practices</p> <p>Inquiry-based- Solutions research paper- final paper stacked submission- Take a sustainability issue and define it along three axes of SU. Suggest a solution. Essential questions regarding bio mimicry- How equitable are the solutions? How doe they address long term well being? In class observation, he used essential questions to get students to discuss readings and make connections and systems thinking language throughout lecture. Systems- wolf, moose and high snow fall- all the ecological impacts... Sustainability buffet, personal definition, and small group creation of SU definitions</p> <p>Collaborative- lots of class discussion, group work to define sustainability, Fred Friendly- groups of students participant in a role play activity. Peer review of papers. Group project design project- individual come up with a project</p>	<p>They have to go home, they have to think about these things, they write it up and then, they come to class and they share it in a small group. And then, they discuss it and t try to either-- synthesize, choose one and then, they have to stand up and talk about it as a group. So, there's four of us, we had four different ideas. Can we blend them together, or can we like, "Oh, I really like Janice's idea. But if we add this..." And then, so they built, co-build something and then, they stand up. And at the end of class, each group gets to amount to one. So, the one that stuck out the most was – so, we're working in small groups. The one that stuck out the most was two</p>

<p>and work on them together or pick one.</p> <p>Experiential- guest speakers, case studies, Fred Friendly (role play an issue with assigned roles, moderator, and actively participating audience-examining issue from an ecological, economic & social perspectives),</p> <p>Reflective- Palm oil lecture- personal behavior considerations. Consumption- reflective questions about next item they will buy from a cradle to cradle perspective. Observation- opened lecture with asking students if they did anything sustainable today. Talking about values is important in conservation issues because implementing policies and decision making is rarely a win-win</p>	<p>guys who got together and talked about a soccer ball that, of course, is made of local materials and biodegrades back into the earth or whatever, but also within it, had something that captures kinetic energy. And then, you could plug in your cell phone at the end of your soccer game to get a little charge out of it. So, for use in, say, rural Africa.</p>
<p style="text-align: center;">Assessment</p> <p>4 stacked assignments for final papers 2 research papers- life cycle and solutions 1 take home final Attendance and participation In class tests Timeline of sustainability- create map of milestone from history of SU; Systems thinking- summarize complex systems and draw the system; Boundaries- summarize China's air pollution problem- use cradle to cradle concepts to propose solution.</p>	<p>If we have students that go out there that are either: 1) espousing unfounded activist approaches – so, that's the science part of it – and 2) doing their advocacy or their work in a very poorly communicated way, then I think we've really let them down, which stinks, especially given how expensive college is.</p>

Appendix N: Student survey response rate by course

Course Name	Total Emailed	Survey Responses	Response Rate (%)
Geography (GEOG)	106	44	42
Natural Resources (NR)	53	22	42
Economics (ECON)	116	31	27
Education (EDEL)	14	7	50
Electrical Engineering (EE)	16	7	44
Environmental Studies (ENVS)	36	11	31
Nutrition and Food Systems (NFS)	69	30	44
Plant Biology (PBIO)	69	26	38
Total	479	178	

**Appendix O: Number of Sustainability Courses Student Have Taken at UVM
(N=178)**

	First one (%)	1-2 courses (%)	3-5 courses (%)	6 or more courses (%)
Number of courses	47	34	10	10