Key Competencies

Practical Approaches to Teaching Sustainability

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This project was a joint effort of the Sustainability Curriculum Consortium (SCC) and the Association for the Advancement of Sustainability in Higher Education (AASHE).

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Preface

In response to intensifying and overlapping social and ecological crises, instructors are increasingly called upon to prepare students with competencies necessary to develop and implement solutions.

This important publication - a joint project of the Sustainability Curriculum Consortium (SCC) and the Association for the Advancement of Sustainability in Higher Education (AASHE) - highlights innovative approaches faculty are employing to meet this challenge head on.

Our goal in initiating this project was to provide practical guidance on how to effectively teach sustainability competencies, which are starting to be embedded in institutional learning goals and program accreditation standards. As achieving sustainability will require active engagement of many fields of study and professions, we were particularly interested in stories from outside of sustainability/environmental studies. Encouragingly, the contributions to this book demonstrate clearly that sustainability competencies can indeed be fostered in a wide variety of disciplinary and institutional contexts and via different pedagogies. We hope the stories in this book will provide you with inspiration and ideas for developing sustainability competencies among your students.

We'd like to offer a heartfelt thank you to the contributors for sharing their experiences and knowledge. We are also deeply grateful to the editing team for their leadership in curating this book and helping contributors to express themselves clearly and concisely. This project would not have been possible without their hard work.

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Introduction

Rebecca Potter
University of Dayton

These remarks were transcribed and edited from the online Curriculum Colloquium hosted by SCC and AASHE on June 16, 2021. The session showcased this book project and included case presentations from several of the chapter authors included in this volume.

This was really a pandemic project. After the 2020 online AASHE Conference — which included a curriculum track co-organized by SCC — several of us picked up the conversation to further discuss key issues. We asked the question: how can we capture some of the great ideas and activities happening in sustainability in higher education and frame it in an accessible format?

We decided to focus on what we call "key competencies" in sustainability in higher education. A broad solicitation was well received -- we received a number of queries, and then sufficient abstract proposals to consider doing a second volume. Of course, as a pandemic project, the editors faced a lot of challenges in getting it through the process. The contributors and the editors were pretty passionate about this project and, as we proceeded, it generated many great conversations and interests. For introductory purposes, I have 3 observations that I would like to share from the editorial position that I held in this project:

The first observation was really concerning the broad range of scholars engaging in sustainability education – not just across disciplines within a university or college or community college, but both inside and outside of formal, higher education institutions. Even in higher education institutions, there is a strong focus on what our students are going to do when they leave the university. So, there was a vocational aspect that I think permeated every chapter. In short, what do our students and our graduates need? What do they get from our classrooms? What are we trying to teach them?

The second observation relates to the use of terminology that is prominent in much of the academic literature around key competencies. The established concepts and principles were certainly embedded in the work of many of our contributing authors, but it did not dominate. While there is terminology in some chapters -- like narrative competence, strategic competence, interpersonal competence, and systems thinking -- I think these contributions focus much more on what the authors were doing in the classroom. I suggest that what is emerging here is a type of critical thinking approach that embeds competencies that are particular to sustainability education. Along with these new methods, we are seeing alternatives as to how to assess student learning. I think that we captured a lot of those new pedagogical trends.

The last point, building on that second one, is that the authors deeply engage in student learning as transformative. A strong theme emanating from this project is that our students need to be change agents, as our future demands. Maybe this is not so easily captured in our typical methods of assessment or a typical use of student learning outcomes. And not only with our majors, but also with students who may be new to sustainability and trying to figure out their own pathway.

We are engaged in a really inspirational endeavor. The process of working with authors in the midst of the pandemic pointed out the need, not only for our field of sustainability, but also a need for sustenance for what we do. Sustenance -- that's the nourishment needed to keep something alive and growing -- is a medieval term I see more often as an English scholar. When I come across it, it's usually referring to spiritual sustenance more than bodily sustenance. We need, of course, both. We need book projects like this. And we need organizations like the SCC and AASHE to help bring us together. But figuring out how we are going to sustain what we do is challenging. The fiscal restraints loom large in a new climate of uncertainty. Those challenges will need to be addressed through creativity and innovation and the chapters in this collection are expressing and illustrating those characteristics. Our work is worthy of that kind of sustenance.

SCC — AASHE Curriculum Colloquium

June 16, 2021

Day 1 Session: "Teaching Key Competencies in Sustainability Education"

The agenda for this session included work-in-progress presentations by the editors and several chapter contributors (pictured below) to this SCC-AASHE publication: *Practical Approaches to Teaching Sustainability: Key Competencies*

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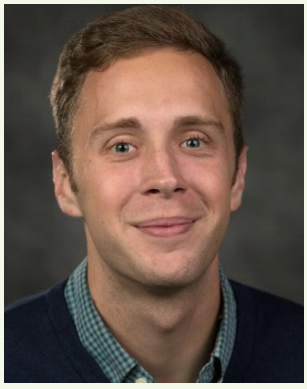

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Laying the groundwork for sustainability competencies: Lessons from a first-year seminar

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Abstract

This chapter offers a case study that provides insights and assistance for a wide variety of college instructors that wish to advance key competencies in sustainability education. In particular, I describe the objectives and structure of a first-year seminar that I have been teaching for five years. I also offer suggestions for how educators might adopt elements of this course into their own teaching. For example, I discuss pedagogical approaches and assignments that have been particularly effective in helping first-year students start to develop key competencies like systems-thinking and interpersonal communication. Key competencies are developed through multiple learning opportunities that usually occur over several years. Incorporating active-learning and reflection exercises into a course for entering college students encourages them to connect their ideas and experiences to both the practical and normative aspects of sustainability and increases their capacity to develop anticipatory and strategic competencies in future classes. I also provide ideas on how educators can adjust elements of this class (e.g. place-based learning) to their particular institutional circumstances (class size, location, course level).

Keywords: *Campus sustainability, first-year seminar, student-centered teaching, place-based education, sustainability pedagogy*

1. Introduction

Readers of this volume know that we are living through environmental crises unparalleled in human history, and that as educators and practitioners, we need to help prepare future citizens and leaders with the knowledge, skills, and attitudes that will lead to a sustainable future. We also know that reversing climate change, restoring, protecting, and valuing ecosystems, and safely and equitably managing pollution and waste is difficult, and pushes against the interests of powerful entities that benefit from "business as usual." Fortunately, as Paul Hawken (2007) so eloquently notes, a global groundswell of diverse sustainability actors is emerging that has its own power, and positive change is increasingly possible. Still, how do we as educators modify our practice in a way that will prepare students for these changes, and enable them to contribute to it? I offer practical advice for instructors who wish to develop activities and strategies that challenge and transform students into effective change makers by describing "Campus Sustainability 101," a class that I have offered to entering students at DePauw University for the last five years.

Campus Sustainability 101 is a first-year seminar (FYS), a discussion-based course designed specifically for incoming college students at DePauw University1. At DePauw, FYS courses have a low faculty-to-student ratio (typically 12 - 15 students) and instructors usually serve as the students' first academic advisor. FYS courses are part of the students' general education curriculum and are therefore required. Matriculating students choose a FYS course from between 45 - 50 different options; therefore, the ones who are in my seminar typically have some interest in environmentalism and sustainability. Although half of the students have had some environmental course work (e.g., AP Environmental Science) or were involved in activism in high school, most have only a very shallow understanding of sustainability studies. Further, few, if any, have a deep understanding of the structural causes of social injustice, even those from under-represented populations. Although they tend to be inspired by youth activists (for example, Greta Thunberg), they typically have not thought much about their own agency nor are they well-equipped to handle the existential threat of the climate crisis or the complexity of multiple interconnected and interdependent social and ecological systems. They are *extremely* interested in "doing something" to address the environmental problems that they have heard about their entire lives, but they lack the tools to successfully imagine alternatives to the status quo, much less contribute to changing it. Through this class, which blends theory and applied learning, students equip themselves with the knowledge and skills they will need to comprehend the problems of *un*-sustainability while also developing new paths toward a resilient future.

One unusual feature of Campus Sustainability 101 is that active-learning classes are held at the Ullem Campus Farm and Center for Sustainability on most Fridays throughout the semester. The Ullem Farm serves as a viable model for sustainability principles "in the real world." By working on the farm, students gain practical and applied experience with sustainable farming, enjoy productive physical activity out of doors, and contribute to global environmental solutions. Together with the farm, the Ullem Center supports the academic mission of the University by becoming both a laboratory for scientific and entrepreneurial experimentation and also a sandbox for artistic or sociological exploration.

In this paper, I discuss the basic elements and structure of *Campus Sustainability 101* and how its pedagogical techniques contribute to the advancement of key competencies as defined by academics such as Wiek (2011, 2016) and Evans (2019), and the National Academy of Sciences (2020). Although I describe the specific context for the course that I teach (first-year students in a residential, liberal arts college), I also suggest mechanisms that faculty can use to adapt pedagogy and assignments to better suit their own teaching context.

2. Course Design

Campus Sustainability 101 is a fourteen-week course that is divided into four major sections, designed to introduce students to different sustainability content and also to focus on different kinds of skills and competency development. During each unit, students have daily assignments that might include reading, short response papers, and answering directed questions. Although graded, these are low-stake assignments during which students practice their abilities to synthesize and summarize material and improve their writing and speaking skills. Cumulatively, these assignments are worth 15% of their final grade. Because there are ~ 30 such assignments over the course of the semester, and because I apply extra credit points to this category, poor performance, including a 0, on any given assignment does not have much of an effect on a student's final grade. At the end of each unit, students are asked to complete a major writing assignment that I call "formal papers" to distinguish them from the daily writing assignments and to signal that their style and tone should meet "academic standards,"[2] which

1 DePauw University is a private, residential, four-year institution of higher education in Greencastle, Indiana that serves ~2000 students from all 50 states and ~35 countries.

2 Recently, many equity-minded scholars have commented on the coded language of the academy that alienates traditionally marginalized students; the term "academic standards" is especially fraught within this context. It is therefore important to me to note that these papers are not a hoop to jump through, but rather the opportunity for each student to further explore their passions or interests. Additionally, there are many styles of good writing that they may choose to use. The most important factor in a quality paper is that a student has something compelling to say. More often than not, simply paraphrasing a student's thesis statement back to them helps them identify for themself whether or not what they have said hits the mark.

is a required part of the curriculum for all FYS. Table 1 provides an overview of each section, including their length of the session, the specific objectives and outcomes of each, the content covered, and pedagogical tools and methods used.

Holding class at the Ullem Center, and engaging in farm activities, hold two primary benefits. First, and most importantly, they collapse the false dichotomy between college and "the real world" and challenge the notion that classrooms are the only place where learning happens on campus. From plant identification to food systems, campus farms provide endless possibilities for intellectual growth (LaCharite, 2016). Specifically, Campus Sustainability 101 emphasizes the growing cycle (planting seeds, transplanting young plants, weeding, and harvesting), sustainable farming methods (using tarps for weed control, cover crops for soil health, and adapting ecological pest management practices to eliminate chemicals), and the connection between land health and human health. Secondly, it provides students with the opportunity to build community with both their classmates and also the broader campus system. Farm work is physically hard, and many tasks, such as moving 5000 sq ft tarps, requires the coordinated effort of a team. By working together, students can literally see how the contributions that they make as individuals add to the greater good, a lesson that transfers to sustainability quite well. Farm work is also often uncomfortable - many students were pushed outside of their comfort zone at some point during the semester. However, because everyone is engaged in the activities (including me), students develop emotional intelligence by witnessing how others deal with challenges and perseverance skills by pushing through the discomfort. There are also subtle rewards to teaching this way, including the opportunity to talk with students in a more casual way and being able to use particular group experiences as metaphors or examples in the traditional classroom (Roberts, 2013; Monaghan et al., 2017).

2.1. Section 1: Introduction to Sustainability Studies

I have found that the first three weeks of any course are critical; this is a time to establish a rapport with students and to share what I expect of them and what they can expect from me. For incoming students, it is a time to demonstrate the difference between high school and college learning, most notably in rigor and style. The academic discipline of sustainability studies is especially conducive to this transition because it is comfortable and familiar - nearly all students understand the perils of environmental collapse and that we need to find a different way - while also containing a plethora of rich content, both theoretical and applied, that is new - and awe-inspiring - to beginning students. Section one of this course, which introduces different constructions of sustainability, describes its history, and establishes foundational concepts in ecological and human systems, demonstrates how college classes serve the interests of individuals and the broader community.

The course begins by centering each student in the conversation about sustainability. From day one, students are called to bring forth their ideas and experiences as a means to examine and compare their own thoughts to those of their peers and those presented in texts. For example, before discussing the syllabus or class logistics, students are asked to respond to the question "what is sustainability?" in a three-minute freewrite. I explain that the only "rule" for freewrites is that they must keep their pens or pencils moving for the entire period, which requires writing down whatever is in one's head. Students are then invited to share what they have written, either by reading their response or summarizing it, while I record, and sometimes clarify key phrases on a whiteboard. Inevitably, there will be both similarities and contrasts, and some responses will contain a greater degree of detail than others, and these differences form the basis of the conversation through which I guide the class to build a collective, albeit introductory, understanding of sustainability as a concept. From there, students are asked to read the introductory chapter of a text and complete a low-stakes reflective writing assignment before the second class period. Some class time is spent considering course logistics, and students often take me up on the invitation to stay after to discuss any questions or concerns, but by focusing on sustainability content and establishing that learning is reflexive - the process happens through putting out and taking in ideas - students immediately *experience* the pedagogical goals of the course.

During the remainder of section one, students learn foundational terms and concepts, and their learning is evaluated through a formal writing assignment. I rely on Margaret Robertson's 2017 textbook to introduce terms, ideas, and definitions and ask students to complete reflective writing homework assignments to assess their comprehension of the reading. This helps me understand where the class is

as a whole, and whether I need to address collective issues during class. In this way, we move through content relatively quickly, covering a chapter a week, with students learning: different understandings and definitions of sustainability, the three pillars/three "e's" model (environment, equity, economy), the Anthropocene, and systems thinking (chapter 1); the development of sustainability concepts over the last 200 years, including the transition from early conservation efforts to the development of ecological science, the beginnings of the environmental movement, the development of US environmental laws, an introduction to environmental ethics, and an introduction to environmental justice (chapter 2); introduction to the biosphere, including flows of energy and matter, earth systems science, and the importance of living systems (chapter 3); introduction to the human sphere, including our impact on environmental systems and basic concepts in economics, sociology, and political science (chapter 4). During class, I clarify misconceptions, demonstrate connections between different ideas, and reinforce important concepts. Most days, students complete and discuss freewrites with a partner or the whole class and practice using terms and concepts by answering questions or providing examples. I encourage their active engagement with class content by explicitly describing when and how to take notes in class because most do not know how to effectively record their experience in a discussion-based course that has little by way of traditional lecture.

2.2. Section 2: Sustainability Problems and Solutions

Having developed a working understanding of the theory of sustainability in the first section, the goal of this section is to provide students with some detailed knowledge of the contemporary and future challenges that must be addressed to achieve the normative goals of sustainability. In the chapters covered in this section, students read about the unsustainable status quo and some approaches that are being developed to shift practices towards at least a smaller environmental footprint, if not entirely regenerative processes.

The text presents numerous topics in a way that is thorough but concise and accessible to entry-level students while also providing valuable content and further resources for more advanced students, but I do not expect all students to learn detailed information on all of the subjects presented. Instead, I use a modified "think - pair - share" (Kaddoura, 2013) to divide the students into three groups, each one of which is tasked to learn and then present information from a particular chapter. For example, during the first two-weeks of this section, students learn about challenges associated with human engagement and management of natural systems by considering either water, ecosystems and habitat, or climate change. Each topic is assigned to a group consisting of four or five students who are expected to teach their assigned chapter, collectively answer end-of-the-chapter questions, prepare a brief class handout for their peers, and give a short oral presentation. During the second two-weeks of this section, students repeat the process in new groups covering food, energy, and waste management.

Two weeks is not enough time for students to learn detailed information about three different sustainability issues, but it is enough time for them to engage deeply with one. Thus, during the four weeks of section two, students have the opportunity to learn, in detail, about important challenges as well as some ways that society has begun to address them. They also hear from their peers about four additional topics, and while their comprehension of this information will not be as deep as if they had studied it directly, they nevertheless hear information that goes beyond the popular media coverage to which they have been previously exposed.

Although peer-to-peer teaching has many benefits, it is important to note that it is unreasonable to expect the same level of presentation from student groups that a professional scholar would be able to deliver, and therefore instructors should consider how they will effectively facilitate post-presentation discussion. Expect that presentations will have errors or misconceptions that will have to be corrected, but remember that most students feel some degree of anxiety when presenting, and care should be taken to avoid embarrassing or alienating students. Instructors will inevitably also need to deepen the presentation. This can be done through guiding questions, where either the presenters or audience can weigh in, by summarizing the presentation while adding small amounts of new information, or simply adding more information once the presenters are done. One should also be reasonable about the amount of information that one expects to be discussed; as sustainability scholars know, "more" does not always equal "better." Finally, instructors should reinforce connections between topics and other course materials

that students will only rarely recognize on their own. For example, although "climate systems" and "energy production and use" are topics considered at different times during this section, they are clearly intricately connected, and the instructor can provide ways for students to consider them as different parts of a connected sustainability issue.

2.3. Section 3: Campus Projects

The heart of this class, and the one that is easiest to adapt to nearly any setting, is the five weeks during which students are directed to identify a sustainability problem and develop or implement a sustainability solution by applying what they have learned in the course up to that point in the semester. "Problems" are defined as any boundary or obstacle that interferes with making a campus sustainable, and "solutions" are defined as a set of activities that at least partially address the problem and are "doable," meaning that they are possible to be designed if not implemented during the semester in which the course takes place. The scope of this section is left deliberately vague, and initially, students are frequently confused or overwhelmed by the prospect. However, through a series of facilitated small- and large-group brainstorming sessions, as well as individual or group reflection assignments, all the classes that have engaged in this pedagogical method have quickly identified specific and concrete ideas for projects.

Throughout this section, students work collectively and iteratively to define projects. I ensure that all students contribute to this process through both in-class facilitation and responses to out of class homework assignments. Students have a choice in both the topic that they address (for example, contributing to a permaculture garden) and the solution that they generate (for example, interactive educational signage for the garden). Groups must generate a product as a part of their work, even if that product is a proposal of how another group might implement their ideas, though the best projects are those that are developed to the point of implementation during the semester. In addition to these applied projects, students complete a group report, give a group presentation, and write an individual reflection paper.

2.4. Section 4: Sustainability & You

The final section of the semester, which occurs during the last two weeks of the term, is focused on the assimilation of class content and activities at the level of the individual. Though students will have been thinking about broad contexts - global or local - while in groups during most of the semester, the conclusion of the course calls on them to make meaning on a personal level. To do this, students must reflect on what they learned over the course of the semester, including what it means to them with respect to their personally held values, and then demonstrate how their academic experiences have helped them grow, socially, cognitively, and morally through a final paper. Because students have been working on reflective writing all semester, they are generally comfortable responding to directed questions that ask them to articulate specific ways that a class idea or activity either deepened previous knowledge or challenged it in a way that brought forth new insight.

The final assignment for this section, which is also the final for the course, is a writing assignment entitled "My Sustainability Journey,":

> *Over the course of the semester, you have read, researched, and discussed the principles of sustainability, including specific environmental problems (e.g., food insecurity) and potential sustainable solutions (e.g., local farms). You have also engaged with the practice of sustainability by working on the Ullem Farm and developing your ideas to improve this space. What was it all for? That is, what have you gained through your intellectual, interpersonal, and physical labor?*
> *For your final paper in this class, I would like you to reflect on these questions and describe your relationship to sustainability. Your paper should describe how the course deepened your understanding of the theory and application of sustainability in the real world. Please provide detailed examples of the specific content (class material) and skills (writing, working in a group) that you have developed over the course of the semester*

Synthesis of a semester's worth of complex information is challenging, so class time and assignments in this section again use scaffolding processes to help students build towards their final paper. The think-pair-share pedagogy (Mahmoud, 2013) that I use throughout the semester is particularly effective during this

section. For example, I might start a class with a reflective question like "what were significant take-aways from each section of the course" and give them a few minutes to freewrite their ideas. It is completely fine if students initially don't even remember different sections, because once they start writing, memories and associated thoughts will return. Sometimes, when class energy is particularly low because students are tired, I might ask them to think about a particular class day or activity that stands out, to describe it, and then describe how that connected to the rest of the course. Inevitably, this will be hard for some students to do, but this is fine because other students will be able to provide good models. After students have written for a short period of time, I will ask each to share a particular thought or detail that they wrote about while I summarize them on the board. Usually, themes emerge, and I will create small groups to further discuss their writing with each other. Sometimes, I put students into groups to develop contrasts, sometimes to develop synergies; both have value because student peers will provide perspectives that each individual can hear and process. In addition to discussing the prompt, groups are tasked to identify specific evidence to support the general observations that they will then share with the class. This evidence may come in the form of linking the class discussion or activity with something from the text or recurring ideas that I have emphasized, or it might focus on how a particular activity provided specific insight. For example, one student remarked that it was hard for her to understand the importance of water scarcity until she worked in the Ullem Farm to clean produce that was going to the campus dining hall. For her, the experience became visceral because she was repeatedly plunging her hands into a bath of "gross" dirty water because doing so could get the vast majority of the Indiana clay off of the produce, thus saving the huge quality of flowing water that most people use in their kitchen. It was surprising, but important, to her that she could keep using the same water to remove soil, but that the carrots came out clean after a final light rinse. Asking students to report these kinds of details becomes important because doing so helps them link their lived experiences with class content in a way that becomes personally meaningful, and thus developmentally impactful.

3. Adopting class elements for another campus

The course described above is one that has been developed to fit the needs of my campus. Recognizing that courses can rarely be plucked from one setting and inserted into another, I add the following thoughts for colleagues who are considering implementing particular elements from "*Campus Sustainability 101*."

Course size/number of students

As a small, residential liberal arts college, DePauw is fortunate to be able to have a low student-to-faculty ratio such that the enrollment in this course is capped at 15 students. However, many of the course objectives and pedagogies described above can be adapted to be effective in courses with much higher enrollments. In particular, the number of issues taught in section two - Sustainability Problems and Solutions - can be easily increased to allow for more groups. Additionally, the course structure and pedagogies can be implemented independently of each other to allow for greater modification. For example, both the flow of the course and many of its objectives can be realized using traditional, lecture-based teaching methods. It is also possible to shorten the introductory problems and solutions to allow for more time with the campus projects or one of the other sections. (It would be challenging to complete a meaningful campus-based project through the pedagogy of discovery in less than five weeks). And, as discussed elsewhere, active-learning strategies such as the pedagogies described here are effective in numerous settings and at a variety of scales.

Course Logistics

The course meets for one hour three times a week (MWF); there is no lab or recitation session. I am the sole instructor of the course and do not have teaching or graduate assistants, though I do regularly connect with other faculty and staff for special in and out of class projects (see below). I am also the sole evaluator in this class, which, despite the large volume of feedback that I provide, is manageable because of the small number of students. Recognizing that the course logistics are fairly standard in higher education, the schedule should be easy to implement in most settings. Additional time or staff resources could be very beneficial for instructors who have them. An instructor can require more than three hours in

class, the extra time could be helpful, especially if one or more groups require the focused attention of the instructor. In my course, there have been many occasions when I have wished for 5 - 15 minutes (or more) of class time to round off the group work and subsequent discussion. Additionally, an assistant who could provide responses to low-stakes assignments would be helpful for instructors with larger class sizes.

Course Management

Student-centered pedagogical methods that focus on learning *processes* more than specific content outcomes are important for developing key competencies in sustainability (Weimer, 2012). This paper provides a number of example elements that could be incorporated into virtually any course to help develop students' competencies and adopting even a few of these into a course can help support an overall shift in students' perceptions of themselves as change makers. It is important to note that these methods involve a process of discovery for both students and instructors. While the rewards can be great, it is understandable that engaging in an unfamiliar process where the outcome is unknown can be unsettling for both parties. For students, it may be hard to understand what they are expected to do, which can be unnerving. For faculty, giving up a sense of control or venturing outside of one's area of intellectual expertise can be uncomfortable. However, with a concrete framework for the projects that are clearly communicated, students develop skills that can't otherwise be obtained through a traditional lecture format.

Campus Resources

Vitally important to the success of this course, especially the applied group project work, are the connections that I have developed with staff in a variety of offices across campus. In particular, staff in the Office of Sustainability and in Facilities Management are often charged to manage the very topics that students are studying (decreasing the environmental impact of the campus, managing campus systems including energy, water, etc.). Depending on the nature of changes that students want to implement on campus, it is also important to involve offices such as Residential Life/Housing, Admissions, and the Business/Finance offices. Additionally, university offices that connect to an individual's identity (e.g., Diversity, Equity, and Inclusion, Spiritual Life, Community Engagement or Service) can help emphasize how the often-under-resourced social pillar of sustainability helps contribute to positive change on campus. Further, working with these or other offices and departments helps break down barriers that can artificially separate academic experiences from the rest of a student's life. Systems thinking is an important sustainability competency, and each college campus can be thought of as an open system, complete with operational nodes, resource flow, and feedback loops.

4. Conclusion

Scholars are increasingly recognizing that sustainability, as an academic discipline and a societal intention, requires "a functionally-linked complex of knowledge, skills, and attitudes that enable successful task performance and problem solving" (Wiek, 2011). Although the precise structure or form that such a complex might take, and a set of collectively recognized terminology to describe either the complex or its elements continues to develop, certain kinds of knowledge, skills, and attitudes are widely recognized as important. Ideally, scholars and the community of practice will soon develop and implement intentional, carefully assessed, and accessible sustainability programs that will invite students and professionals alike to engage in the important work of transition towards a sustainable future. As this process unfolds, interested parties can contribute to it even in the absence of a formal or university-wide academic sustainability program. As this paper describes, student-centered pedagogies that challenge students to engage in the development of sustainability solutions can begin as early as a student's first semester and through a general education curriculum. Like a sustainable future itself, developing or implementing pedagogical changes can be daunting, but the effort is worthwhile, and necessary.

Author Bio

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Tackling Wicked Problems Through Transparent Teaching

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Abstract

Transparent teaching methods are linked to increased academic success, improved retention rates, and sense of belonging for all students, with significant outcomes for traditionally underserved and excluded students (Winkelmes, 2016). In this chapter, I discuss my experience as part of a faculty learning community dedicated to (re)designing curriculum and student experience for inclusive excellence, and the application of this work at two different institutions, both minority serving institutions (MSIs) with twenty-five percent or more of the student body being the first in their family to attend college. I discuss how I used these new strategies to create more inclusive classroom environments and give examples of my work to create a more transparent student learning experience and assessment design. The learning module described is an example of student engagement with the key sustainability competencies of systems thinking, and values thinking. Sharing where and how I made "transparent" revisions to a learning module focused on the United Nations Sustainable Development Goals (UNSDGs) and wicked problems, I reflect on how these changes created greater opportunities for student engagement, and positive outcomes in student assessments and evaluations. Overall, I argue that emphasis on transparent teaching can be one part of an equity-informed action plan to remove barriers to success and inclusion for diverse student communities in this discipline.

Keywords: *Transparent teaching, inclusive teaching methods, wicked problems*

1. Introduction

As a sustainability educator, my primary goals for teaching are for my students to see themselves and their communities represented in the pursuit of sustainability, to actively (re)connect the tissues of sustainability and social justice, and to encourage them to become lifelong holistic practitioners and advocates. Regardless if these goals are viewed as reasonable or lofty, the teaching and learning of sustainability is complicated by its simultaneity as a form of governance, development pathway, academic discipline(s), organizing platform, and community pursuit. These multiple standpoints produce multiple vocabularies, occasional competing value frames, and at the point of student experience, can muddle their understanding of the foundational pillars of equity and living within ecological limits (Thiele, 2016). Moreover, the diffusion of sustainability (and its jargon) through spheres of business and government without congruent accountability metrics has resulted in justified claims of "greenwashing," (Boykoff and Mascarenhas, 2016) wherein for example, products and services offer simplistic means to achieve emissions reductions but do not deal with the politics of consumption or the socioecological inequities borne by frontline communities—more accurately this could be described as green and white-washing.

Yet teaching sustainability isn't just about the difficulties; this is a space for co-creating resilient communities, for moving toward a just future, and for critically disrupting narratives of race, class, gender, and epistemic privilege that so often accompany sustainability, environmental science and studies, and their adjacent fields. Across my courses, I am focused on how to increase the representation of diverse and historically marginalized identities and perspectives of the learners and content explored in my classroom through the use of lived experience, inclusive authorial representation, and open conversations (and invitations to collaborate) with my students on syllabic construction . My framework for teaching draws from critical place-based and engaged pedagogies (Gruenewald, 2003; hooks, 2014), with a commitment to student engagement through experiential learning and civic action, and the meaningful incorporation of Indigenous and marginalized knowledges. This is a good starting point for the teaching and learning of just sustainabilities, defined as "The need to ensure a better quality of life for all, now and into the future, in a just and equitable manner, whilst living within the limits of supporting ecosystems" (Agyeman, et al., 2003, 5). However, after my experience as a member of the Transparent Teaching Faculty Learning Community (TTFLC) at Pacific University, located in Forest Grove, Oregon, I came away with additional practical, and transformative approaches that strengthened my teaching, supported the exchange of student centered diverse ideas, and based on formal student evaluations, positively impacted learning outcomes.

In this chapter, I will draw on my learning as a member of the TTFLC, a community founded in tandem with Pacific's designation as an Asian Pacific Islander Serving Institution (APISI); and my experience integrating transparent teaching methods into courses at Pacific University, and at my current institution, Fort Lewis College. Pacific University is a private liberal arts college, with an undergraduate population of approximately 2000 students; 25% of the student community are the first in their family to attend college. Fort Lewis College, in Durango, Colorado is a public institution of approximately 3400 students; 58% of the learning community are students of color, 42% of students are Native American or Alaskan Native, and 46% are first-generation students. Previous research (Winkelmes et. al, 2016) has linked transparent teaching with increased learning outcomes for all students; and significant benefits for traditionally underrepresented or excluded student communities. At Pacific, part of our work was in (re)designing curriculum and student experience for inclusive excellence, with an eye to how transparent teaching could improve the performance, retention, and sense of belonging/confidence for the entire student body. As an Assistant Professor of Environment and Sustainability at Fort Lewis College, approximately 50% of my teaching is concentrated in courses for first year (and transfer) students; given the rate of first generation students at the college more deeply incorporating these methods into my teaching is paramount.

Throughout, I discuss how I used these new strategies to create more inclusive classroom environments and give examples of my work to create a more transparent student learning experience and assessment design. The learning module described herein was constructed at Pacific University, and later replicated at Fort Lewis College. It is an example of student engagement with the key sustainability competencies of systems thinking (Wiek, Withycombe, and Redman, 2011) and values thinking (Brundier, Barth, and Cebrián et al., 2021); student teams work through a research and sustainability solution design exercise that includes stakeholder role plays, varying geographies, and collective learning cycles. Emphasizing transparency in this module led to more dynamic conversations on transnational experiences of (un) sustainability, engagement rather than memorization of the United Nations Sustainable Development Goals (UNSDGs), and positive reflection from students when learning about wicked problems and sustainability solutions (Whyte and Thompson, 2012). This last point is critical and connects to a broader conversation of how to operationalize the learning of key competencies— at once abstract and essential— across sustainability curricula (Brundier, Barth, and Cebrián et al., 2021).

2. What does it mean to TILT?

Transparent Teaching, or TILT (Transparency in Learning and Teaching) originated and championed by Winkelmes (2013), is a pedagogical approach and tool-kit that cross-pollinates with frameworks of universal design (King-Sears, 2009), trauma informed teaching (Crosby, Howell, and Thomas 2018), engaged and social justice pedagogies (hooks, 2014), among others. In this way, when I began my own training in TILT many of the methods made intuitive sense, and I found that I was already practicing some level of transparent instruction in my classes.

Critically, in TILT, the focus is on explicit, rather than implicit communication from the teacher to the students about the purpose of the learning activity (what will they learn and how can this be applied in other spheres of their life), what the learning task at hand is and how it can be constructed or executed, what criteria will be used to grade student performance with opportunities for students to self-assess, and classroom conversations on grading and possible improvement trajectories. (Winkelmes, Boyd, and Tapp 2019). Common entry points of TILT intervention are in redesigning syllabi, explaining the choice of course content, modeling assignment structures, engaging students in course planning and agenda setting, and the use of rubrics. Throughout this cycle of purpose, task, and criteria, there is emphasis on reinforcing how skills and concepts can be applied to course content and assessments, to other academic endeavors, and eventual entry in the workforce. As a learner, this latter point made me think of the popular acronym "WIFFM" or "What's In It For Me". Clarity for students on why they are learning something, combined with how this learning can help them is at the heart of metacognitive skill development and awareness, a touchstone of TILT (Winkelmes, Boyd, and Tapp 2019).

Numerous studies have shown that students enrolled in courses with transparent design and instruction have statistically significant higher academic performance, and can articulate a direct connection between their college learning experiences and their application to/performance in the workforce (Kuh et. al, 2014). At an institutional level, TILT is also associated with higher rates of retention and persistence. Of most interest to me, and in my own development as an educator, are the reported enhanced connections between cultivating a sense of belonging/sense of confidence and transparent teaching (Winkelmes et. al, 2016); critical factors in retaining diverse and traditionally excluded students in environmental science and studies (Taylor, 2018). Transparent teaching methods support accessibility and equity in the classroom by demystifying what "learning" is, and "how to do it". As a first-generation student myself, I can vividly remember being confused and insecure during my undergraduate experience– I didn't know what I didn't know.

Working with the TTFLC, I decided to first design an intervention at the module level—approximately three weeks of course instruction— that would emphasize modeling what learning artifacts could look like, engaging students in planning and scope of work, explicitly sharing the post learning reflection assessment questions, and discussing how the skills they would be practicing could be transferred across their undergraduate curriculum and to their own professional development. Intentional transparency takes time and careful planning; by starting with a module that I had already developed, I could compare student work to previous semesters, and focus my time on transparency rather than new content.

3. The Module

My teaching at Pacific was focused within the Applied Sustainability major, and also included several general education courses on sustainability (every Pacific undergraduate must take two credits of sustainability designated coursework to graduate). I chose my "Frameworks for Sustainability" class— heavily populated by non-sustainability majors— for my transparent intervention. For Pacific University this is a large course (36 students), and for the majority of students who enroll it will be their most in-depth experience with sustainability studies. As detailed above, sustainability can be a muddled concept for those not immersed in the field. As an instructor I was challenged with how to make sustainability relevant to non-majors who are enrolled in the course as a graduation requirement, and to balance the urgency of sustainability with space for them to imagine innovative and just solutions. Knowing I had an opportunity to reach a relatively large cohort of students, who may have some misconceptions of sustainability theory and praxis, this course seemed like an impactful place to increase student clarity on the importance of class content to their lives. A central theme of this class was helping students to think through the tensions and possibilities in how we operationalize sustainability at varying geographic and governance levels, and how many of today's most pressing sustainability issues are wicked (Whyte and Thompson, 2012). The wicked problem framework understands sustainability issues as having a multiplicity of stakeholders, with no one size fits all solution (rather, good, better, or best), influenced by a constellation of complex sociopolitical factors, and context dependent. Using a wicked problems framework to learn about and discuss sustainability challenges and opportunities is a common educational practice-- for me it also gives explicit space for students to interrogate which stakeholder voices are the loudest, which voices are often silenced and/or excluded, and in what ways we can develop pathways to amplify the latter. As a class,

we engaged with questions such as, "What is sustainable? For whom is a policy or practice sustainable? Why is sustainability valuable? How do we implement sustainable practices?"

The module I decided to revise focused on student engagement with the UN Sustainable Development Goals through a stakeholder roleplay and the collective learning cycle (Brown, 2010). The purpose of this multi-week experience is to help students to engage with the plurality of sustainability through their selection and exploration of diverse stakeholder worldviews, to connect sustainability problem sets with lived experience, and using the collective learning cycle, work through the questions such as "What Could and Should Be?" The latter questions give students the opportunity to focus on ideals and imagination; applying their learning on frameworks of environmental justice and constructing potential solution pathways. Teams of 4-5 students first select one of the SDGs (or a target within a goal) to research, with the only limitation that there are no replicates Their first task is to develop an understanding of the ecological, social, and economic complexities of relevant indicators (how did we get here, and where do we need to go?). Second, adopting a geography and scale (local, regional, nation-state) of their choosing to identify who the relevant stakeholder/decision-makers are, and to develop talking points for each role (e.g. what questions/concerns would a local elected official have about increasing sustainable agriculture production in their region, or as a member of a Small Island Developing State, what do you wish international decision-makers understood about the daily impacts of climate change?). After completing two weeks of this research, teams come together over a third week in a roundtable dialogue to discuss solution pathways toward sustainable outcomes, and to represent the needs and interests of their developed stakeholder role. This entire experience is nested within a section of the course where students explore the wickedness of many sustainability issues— and how solutions must draw from multiple knowledges, be responsive to local cultural context, and require creative, transdisciplinary thinking.

Table 1 contains the four questions of collective learning, adapted from Brown (2010). Student teams move through these questions after their roundtable dialogue session to dream and design just and sustainable solutions. Depending on the role students chose to represent, discussion may reflect both their own ideas and viewpoints, and the complexities/creativities of their stakeholder communities. Solution pathways are later shared to the entire class for feedback.

Table 1

Collective Learning Questions (adapted and revised from Brown (2010)
Step 1: What should be? • What is the ideal solution to the wicked problem? • How would your stakeholder position frame their ideal solution?
Step 2: What is? • Where are we now, what is happening, what is the issue—try to represent your stakeholder point of view? • Where are the barriers and opportunities to you (and your group) achieving the ideal from Step 1?
Step 3: What could be? • What ideas do you have that could make progress toward the goal? These can be your own ideas, or things you found in your research. These can/should be imaginative, because wicked problems don't have neat solutions...
Step 4: What can be? • What specific action steps/plans can be derived from your imaginings in Step 3? • How can we harness these ideas for momentum?

4. Where I TILT-ed

TILT-ing can take many forms, including, but not limited to clarity of learning purpose and its applications to other life skills, explicit grading criteria and rubrics, and sharing of material examples that take the mystery out of what "good" looks like. However, transparent teaching (like other inclusive pedagogies) is also focused on co-construction of course activities and co-learning. Thus, for me, the most significant TILT to this module was having students take control over the development of stakeholder roles. In previous years, I had crafted "characters" for students to pick from and included guiding information on concerns connected to Goals 2, 6, 7, 13, and 14. When making an assignment or experience more transparent, Winkelmes et. al., (2019) offer a self-guided checklist (pg 47) that encourages (and challenges) instructors to develop purpose statements that specify the knowledge and skills students will gain through completion of the learning experience, and how these skills may be applied elsewhere. As I was drafting my purpose statement for this learning experience, I realized that by providing stakeholder sketches I could be preventing my students from bringing in their own diverse experiences that might inform who they thought should be at the table.

Moreover, some of the skills I described as the purpose for this experience were an ability for students, "to learn from one another through deliberative dialogue, to share objectives, thoughts, and informed opinions, to seek to better understand what others are thinking, and create collaborative plans." I characterized these skills as ones that could be useful in their careers when leading teams, holding community meetings, or trying to reach consensus on a difficult decision. Thinking back on one of my overarching goals for my class—to help my students feel represented and included in the mission of sustainability—moving through the transparency checklist, and intentionally aligning my assignment to knowledge concepts and transferable skills helped me to step back and to welcome my students to bring in their own experiences and community identities vis a vis their choice of who stakeholders should be, and further to develop their own pathways of inquiry. It also made more explicit, for them and for me, how this unit related to their learning and exploration of systems thinking through analysis of barriers and opportunities to sustainable action, and working across scales and geographies to develop/imagine solution pathways. To be honest, I struggled with the possibility that some student teams wouldn't include a stakeholder who represented local interests, frontline communities, or residents of geographies such as Small Island Developing States—identities historically overlooked or excluded. To mitigate this risk, I made sure to scaffold this roundtable experience with readings on environmental racism, to introduce the concepts of epistemologies and multiple ways of knowing, and to hold space in the course following this module to address any potential shortcomings. These were all part of my teaching plan before, however, as part of transparent instruction I referenced these materials in the assignment brief as resources students should consider alongside their SDG research. Orienting toward this transparency, and giving room to students to develop their own stakeholder roundtables further served to reinforce their practice of the values competency (Brundier, Barth, and Cebrián et al., 2021), recognizing differential power structures and how systems of governance can reproduce inequities.

I also TILT-ed this module by spending class time making visual connections between this material and what we had already studied, and where we were going in the future. Instead of relying on my syllabus to tell the story of how I had organized my content, I shared aids in class that students could also reference later that mapped these ideas together. Further, because I would be assessing the notes students prepared to bring to their roundtable, as well as the richness of the roundtable discussions, I provided examples of various styles of note-taking, and what pieces of information I would look for when grading each type. Last, I shared my "post learning experience" reflection questions before the roundtable took place. I chose to do this to ease student anxiety regarding the use of the collective learning cycle for the first time, and to encourage them to be more confident to use their time to design imaginative solutions to wicked problems.

5. What I Learned

Some of this teaching and intervention work occurred during the 20/21 academic year, and was thus influenced by the COVID-19 pandemic and the Hy-Flex learning environment. In many ways my focus on transparency was an asset during this time, especially my emphasis on being explicit with the purpose of the learning experience, the criteria for assessment, and increased use of visual aids.

Specific to the redesign of the module, the roundtable was the most frequent (n=10) experience mentioned in the formal student evaluations administered by the University (Were there any assignments/ activities that were especially helpful? Please explain.) Student comments included:

> "The roundtable discussions were cool because everyone in the group got to take on a different perspective and that allowed me to think about issues with multiple stakeholders in mind."

> "The Roundtables allow us to look at a problem, theorize solutions, and what small actions allow us to get there rather than focusing on big goals like the SDG committee are trying to make us do."

> "I really found the roundtable discussions to be very helpful and engaging because I was able to hear different perspectives from different people."

> "I will take away that world issues have many layers, all of which are important. We must address and consider as many layers as possible while we search for solutions."

My initial concern that diverse stakeholder positions would not emerge from the roundtables proved unfounded; instead, most groups focused their analysis in a locality they were familiar with, or in a local unit of government. This gave us an opportunity to discuss the concept of transnational solidarity (Desai, 2002), and how cross-national communities may advocate together to bring greater recognition of their shared experiences and collaborate on larger scale funding projects. Moreover, in their post-roundtable reflections, as a whole students articulated robust evaluative arguments about the strengths and weaknesses of the SDGs, offering creative (and informed) ideas about what to do from their perspective, and that of their curated stakeholder role. This creativity and engagement extended to one of my final questions to them, "How do we make the SDGs more culturally relevant?" I compared these responses to previous semesters, where students had been provided with stakeholder scripts linked to a subset of the Goals. Qualitatively, student assessments demonstrated richer critical thinking and analysis.

The faculty learning community and module revision at Pacific University was my first in-depth experience with transparent teaching and instruction, though as mentioned earlier some of the practices were familiar to me through other pedagogical positions. Initially I had planned to conduct a longitudinal study, looking at shifts in student performance and tracking changes in learning outcomes through formative and summative assessments. However, taking a new teaching position interrupted some of those long-range plans. What this new change did allow for was replication of this transparent module and challenging myself to move beyond a unit approach to a whole course intervention. Fort Lewis College is a Native American, Non-Tribal Serving Institution (NANTSI) with approximately 46% of students being the first in their family to attend college, and my teaching load includes multiple first-year courses. With the demonstrated links between transparent teaching and academic success for traditionally excluded or underrepresented student communities (Winkelmes, 2015) utilizing these teaching strategies across my courses is directly linked to my goals as an educator to increase and retain diverse students in environmental science and studies (Taylor, 2018) and co-create inclusive learning environments that instill confidence and belonging. Supporting first year student learning through transparent teaching—specifically illustrating the application of skills learned/practiced— can help to bolster their competency (McGuire, 2015), their belief that they can succeed at the college level.

6. Moving Forward

Comparisons across institutions invites confounding variables; what I can confidently say after replicating this module and extending my use of transparent strategies is that TILT-ing has made me think in different ways about how I am inviting my students into the process of co-constructing learning, and the methods by which I can make cornerstone assignments in my courses more inclusive. Thinking about the field of sustainability, emphasis on transparent teaching can be one part of an equity-informed action plan to remove barriers to success and inclusion for diverse student communities in this discipline (and the adjacent fields of environmental science and studies). Moving forward, attention should be given to how we can support not just individual instructors, but departments in transparency innovations to

create positive learning environments for students across their degree program. Furthermore, efforts to create and maintain inclusive degree programs cannot be divorced from the overall need for inclusive and pluralistic sustainability solutions; creating transparent experiences for students to practice the key competencies they will need as future sustainability leaders is an investment for all of us.

Author Bio

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Innovation challenges: developing sustainability competencies through experiential learning

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Abstract

We live in a world of social, environmental and economic crises. Catastrophic bushfires, a pandemic, and tensions over racial injustice -- among other challenges -- have shaken our societies in the past few years. Sustainable development offers a vision, pathway and framework to address these problems and build a more inclusive future. However, Seatter and Ceulemans (2017) note a common problem in teaching this vast field: *"Students can be left without real insight, commitment or a sense of their position regarding meaning, beliefs and action related to sustainability"* (p. 2). This chapter describes the development and iterative improvement of one postgraduate coursework unit at Monash University, *Processes to Influence Change,* which seeks to address this challenge head-on by offering a practical, action-oriented learning experience. Our unit takes learners on a collaborative journey through an overarching real-world case study. Along the way, we aim to overturn common biases held by sustainability learners, expand their view of what is possible in creatively influencing change, and sharpen industry-relevant skills in collaboration, innovation and acting in the face of uncertainty. Learners practice applying a transferable theoretical approach and using diverse skills to address complex real-world problems. This illustrative narrative will explain our development approach and reveal practical methods to create deep, applied, in-class experiences, and share the story of our production of a suite of SDG-linked tools which support learner ideation, innovation, and creativity for sustainable development problem-solving.

Keywords: *Sustainability learners, development approach, problem solving, learner competencies, innovation challenge, simulations, creativity*

1. Introduction

Education toward sustainable development is relevant and essential, in both the Australian and global context, but poses a multi-dimensional challenge for educators due to the range of potential pedagogies and complex subject material (Lozano et al. 2017). In 2016, we embarked on a process to design and deliver Australia's first leadership-oriented postgraduate sustainability specialisation, to be part of a new cross-Faculty Masters by coursework at Monash University, Australia. The Master of Environment and Sustainability (MES) was co-designed by educators from Monash's Faculty of Science, Faculty of Arts, Faculty of Business and Economics, and the Monash Sustainable Development Institute. The interdisciplinary development process has been described in more detail by Stubbs et al. (2021) and used the Research Skills Development Framework (Willison and O'Reagan, 2011) and the Sustainable Development Goals (UN General Assembly, 2015) as unifying frameworks to inform the design of all units.

Launched in 2017, the MES attracted learners from a wide range of disciplinary, cultural and professional experience backgrounds.

The MES study structure includes four equally weighted parts: preparatory studies, core studies, specialisation studies, and advanced practice and typically takes two years to complete full-time. There are five specialisations. Each comprises three, semester-long coursework 'units.' Each unit has a learning time commitment of 144 hours. Our aim for the leadership specialisation was to develop a new, empowering education experience, for learners of any background, who will go on to diverse careers across the globe, spanning every sector and confronting the problems that define our time. It was our intention to equip learners with *"complexes of* ***knowledge, skills,*** *and* ***attitudes*** *that enable successful task performance and problem solving with respect to real-world sustainability problems, challenges, and opportunities"* (Wiek et al. 2011, p. 204). In particular, we sought an action orientation that empowered learners with the attitude to 'lead from where they are' and to influence positive change no matter their background or present position. We were guided in our development by framing leadership as a social process of influence, enacted by individuals and groups, crossing disciplinary, cultural and other boundaries (McCauley, 2011).

One unit we developed, called *Processes to Influence Change*, focused on unpacking complexity in systems and advancing innovative ideas to influence change. Since its launch, the unit has been a focus of educational experimentation and innovation, with considerable alterations made to the structure of workshops, pedagogic approaches to engage learners with key concepts, and the development of tools and methods to support learner competency development.

In this chapter, we will first explain the collaborative process we used to create *Processes to Influence Change* and describe its initial design. Then, taking this form as the 'container' in which educational experimentation could take place, we will explain the methods used to understand the learner experience of the unit and the educational impact of subsequent innovations.

Three educational innovations will be profiled based on experimentation in the unit between 2018-2021. The innovations sought to enhance the unit's efficacy in building learner capability for creatively influencing change toward sustainable development. They include the use of formative, experiential classes to build confidence in applying newly learned tools and methods; the development and use of sustainability-aligned ideation tools to enhance the creativity of change proposals; and the use of in-class simulations to integrate knowledge with practical skills and attitudes to enable learners to more effectively influence real-world change.

2. Curriculum development process and 2017 unit structure

The unit *Processes to Influence Change* is inspired by a question: "Why is transformative change so difficult?" This deceptively simple provocation invokes the frustration of many aspiring sustainability change-makers and has been noted as an emergent theme in empirical studies on student competency attainment (Levesque and Blackstone, 2020). To influence positive change in complex systems, we need to understand how change can occur, what enables or obstructs it and and apply practical tools and methods to achieve real outcomes. However, there are no widely recognised standards or professional accreditations for sustainable development practice; nor were there comparable courses in the Australian higher education landscape when we began our development. This posed our first challenge in the story of the unit's development and evolution: creating a new curriculum from scratch.

Informed by sustainability transitions theory, which highlights the need for experimentation to break system lock-in and achieve transformation (e.g. Loorbach 2010), we embarked on a collaborative and exploratory development process. This process included gaining an understanding of what sustainability leaders, scholars and practitioners saw as crucial to achieving sustainable development. Figure 1 includes a summary of the methods we used in this development process, drawing on insights including industry surveys (Bos and Hawkes, 2016), as well as review of academic literature, video interviews with sustainability leaders and collaboration with an education designer. The process was not linear, but the left-to-right progression in the figure correlates to the order of priority we gave each development activity.

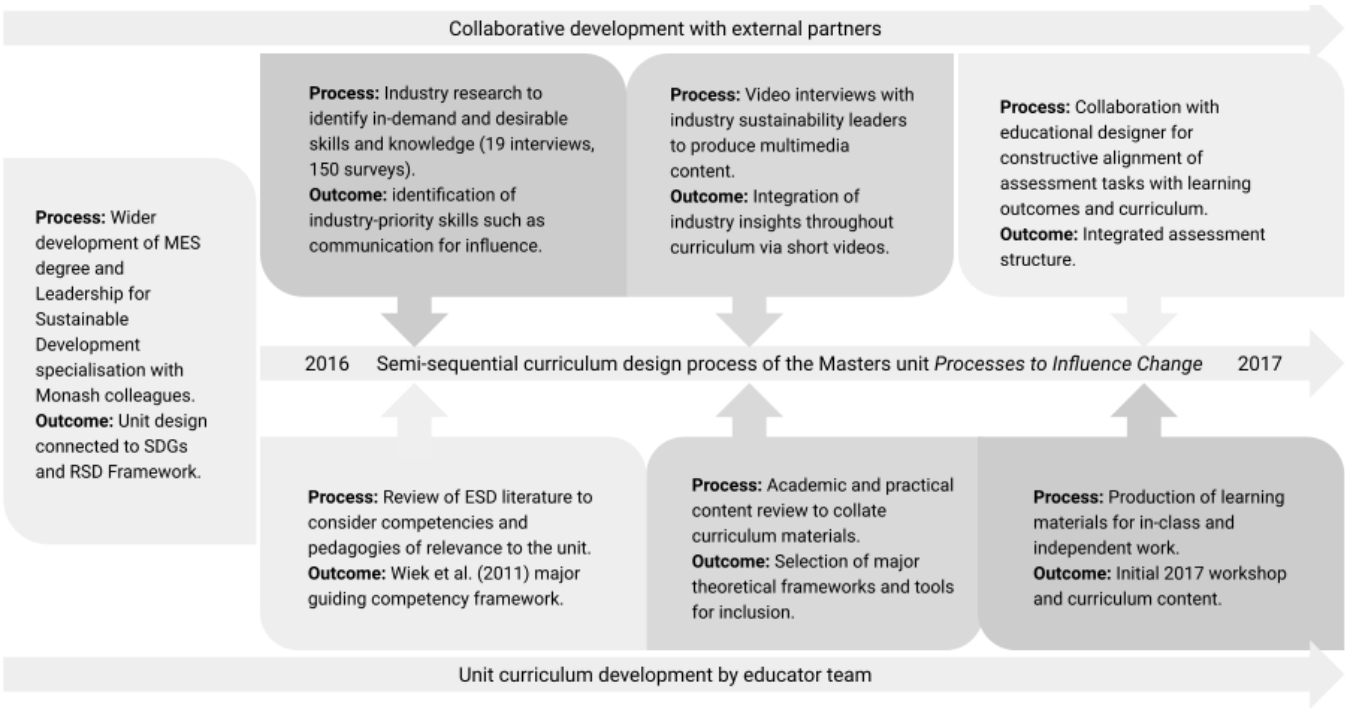

Figure 1: Summary of the development process for the Masters unit Processes to Influence Change. The majority of the development occurred in 2016, with the unit launched in February 2017.

The authors of this chapter formed the core educator team and were responsible for synthesising the insights of each part of the development process into a cohesive curriculum. This was achieved by regular meetings to consider the range of available theories, skills, frameworks, case examples, potential learning activities and more. We iterated draft structures, debated their logic, and sought advice from peers to settle on the initial curriculum. This featured content from disciplinary and interdisciplinary fields including sustainability transitions, political science, leadership theory and strategic planning, as well as insights from the author's combined backgrounds in engineering, social science, environmental science, and science communication. Relationships forged during development with industry and educational peers continued to inform later innovations and unit updates, with this initial investment of time and resources enabling smoother ongoing improvement.

The unit followed a 12-week structure, traditional to curricular teaching at Monash. Each week, learners attended a 2-hour workshop and completed pre- and post-class work (such as engaging with readings or videos). In class we discussed theories and frameworks, ran interactive activities, or featured industry guests. From 2017-2019, the unit's workshops ran exclusively on-campus; in 2020, due to the COVID-19 pandemic, it ran exclusively online, and in 2021, in concurrent hybrid form with a mix of on-campus and online participants. *Processes to Influence Change* launched with 23 participants and has grown year-on-year, with 55 enrolments in 2021.

Weekly curriculum topics were delivered alongside four 'constructively aligned' summative assessment tasks, which combined to form the entire unit grade (Figure 2) (Biggs, 2003). The tasks built on each other in sequence in what we termed an 'integrated case study'. Learners needed to research, explore and visualise the transport system of the Australian city of Melbourne; create a collaborative vision for its future; identify options for near-term action toward the vision; and propose and pitch these as tangible interventions, using real-world decision-makers as the simulated 'targets' for the proposal and pitch.

The choice of Melbourne's transport system sought to create an authentic experience of engaging with complexity, with open-ended investigation, challenges, and trade-offs to navigate. The case was selected for several reasons:

- All learners have lived experience of transport systems, with familiar technologies and general challenges across many countries.
- Transport interacts with diverse Sustainable Development Goals, across social, environmental, cultural and economic dimensions.
- Many disciplinary lenses are relevant and valuable in understanding transport; and
- Melbourne is where the unit is based and the place where most learners live, offering them the opportunity to observe and participate in the system of interest.

Weekly unit theory informed the completion of each assessment task. For example, while learners worked on the applied system analysis and diagram task, the Multi-Level Perspective (Geels, 2002) was introduced to illustrate how complex systems may be structured or change. In that week's class, learners brainstormed and organised system elements against a generic multi-level diagram, with educators clarifying nuances of the theory and helping them to see its usefulness as a way of making sense of complexity and change.

The task sequence enabled us to observe differing learner competencies in a range of ways. For example, the system analysis and visual diagram form a *concept mapping assessment* – tied to systems thinking competencies, after the typology constructed by Redman et al. (2021). The pitch is constructed as a *scenario test*, in which each learner receives a tailored email after they submit their written proposal for a change idea. The email is written in-character as if a real-world decision-maker of relevance wants to meet with them to hear more about the idea. This scenario approach demands learners apply strategic and interpersonal competence to translate their extended written proposal into a short, engaging, and persuasive verbal communication. The scenario style differentiates the task from more traditional university presentations, in which the assumed audience is a general one of classmates or the grading academic.

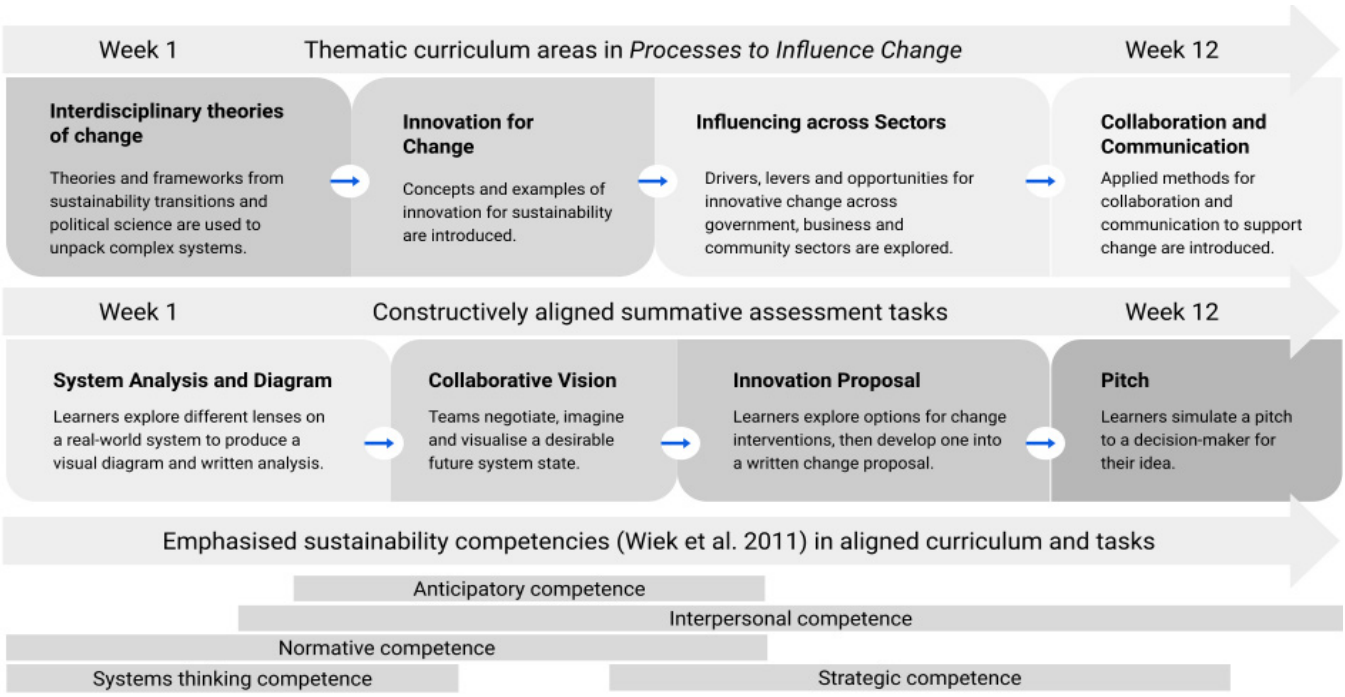

Figure 2: Thematic content areas of the 2017 ENS5510 curriculum (top) aligned with summative tasks for the real-world transport case study (middle) and emphasised sustainability competencies (Wiek et al., 2011) (bottom). Learners progressed from left to right across 12 weeks of classes.

As the unit progressed, educators placed pedagogic emphasis on specific sustainability competencies of relevance to the assessment task at hand, such as asking targeted questions for peer discussion and reflection. Emphasis shifted over the 12 weeks to cover the five competencies recognised

in Wiek et al. (2011) – systems thinking, anticipatory, normative, strategic, and interpersonal (Figure 2). We recognise that these competencies do not operate in isolation or sequence as 'neatly' as presented here, but we were nonetheless able to use this structure to guide our in-class teaching practice.

In summary, development of the unit's initial curriculum integrated a range of inputs. As educators, we were confident in the industry relevance, theoretical grounding, and alignment of the assessment tasks and learning process. However, as with any new educational offering, we knew that the actual response of learners to the curriculum and tasks could, and would, diverge from our expectations. As a result, an ongoing process of evaluation, reflection and experimentation was necessary to improve the unit and update it.

3. Ongoing evaluation methods and data used to inform this case study

Having described the initial curriculum and unit design, the focus of this chapter will move to specific educational innovations implemented in subsequent yearly deliveries of *Processes to Influence Change* (2018 onwards). Our experimentation was not structured in a single systematic evaluation or research framework. Instead, we engaged in regular expert reflection on our practice, which incorporated a range of information summarised in Table 1. This combination of approaches allowed us to change and innovate within the unit in response to three stimuli:

- **In-class insights** gained via rapid response technologies Loop and Google Forms, focusing on the in-the-moment learner experience, particularly in more complex activities;
- **Whole-of-semester** evaluation and educator reflections, including Monash's anonymous, university wide Student Evaluation of Teaching and Units (SETU) data; and
- **External insights** from active engagement by the educator team in wider sustainability practice and education innovation, including regular contact with industry and other collaborators formed in the development stages of the unit.

In 2020 and 2021, we secured ethics approval to formally gather and analyse learner assessment and reflection data as part of a wider research project. The data does not inform this case study in a structured way but is included in Table 1 as it fed into our expert reflections.

Table 1: The range of methods used to inform the educational innovations presented in this case study and the years in which the data and evaluation methods were active.

Evaluation or data gathering method	2017	2018	2019	2020	2021
Educator meetings to reflect on and discuss observations and feedback, including insights from other units taught concurrently within the MES	X	X	X	X	X
Student Evaluation of Teaching and Units (quantitative and qualitative survey, end of semester, whole-of-unit focus, anonymous)	X	X	X	X	X
In-class live evaluation using digital feedback platforms Loop or Google Forms (qualitative and quantitative feedback on in-class experience for specific sessions, anonymous)		X	X		
Formal educational research into learner creativity (including student self-assessment data, reflective materials, and assessment artefacts - human ethics obtained)				X	X
Educator discussions with industry and practice experts, including unit guest speakers, on unit content such as frameworks and tools used	X	X	X	X	X

Having clarified the combination of methods used to inform our experimentation, we now turn to elaboration of three specific innovations. Figure 3 summarises the innovations and visually situates them in relation to the overall curriculum and 12-week progression of the unit.

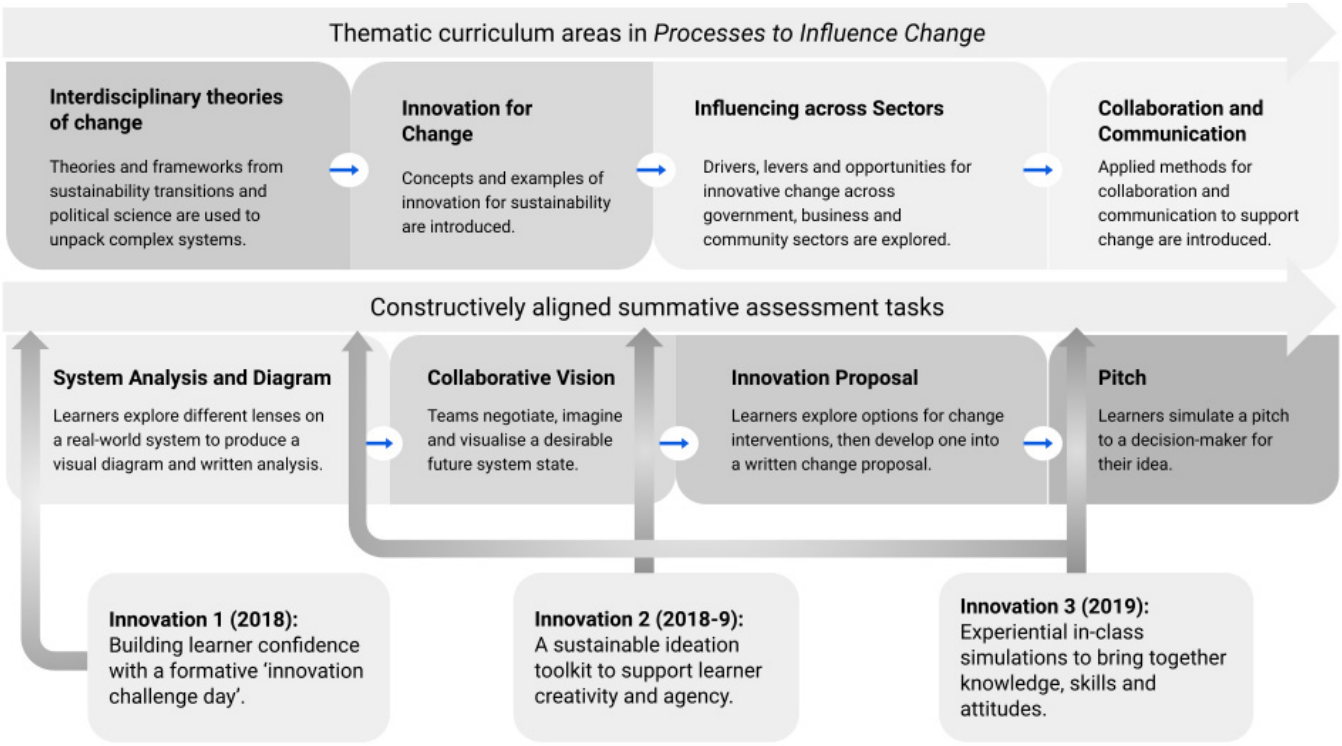

Figure 3: Case study innovations presented in this chapter in relation to the initial curriculum design of Processes to Influence Change.

4. Innovation 1: Building learner confidence with a formative 'innovation challenge day'

Learner feedback on our first delivery of *Processes to Influence Change* was generally very positive, exceeding university-wide quantitative satisfaction against other similarly sized Masters units. However, we saw room for improvements - for example, 'clarity of instructions for assessment tasks' was our lowest metric. We observed that learners without work experience found the applied tasks and real-world case study confronting and they were less clear on how to approach them, sometimes resorting to submissions styled like more traditional essays or reports. For example, learners with professional experience appeared more able to find and use documents such as government budgets to understand parts of the system and inform well-tailored system diagrams. Learners continuing directly from undergraduate studies tended to produce very generic system structures in their diagrams.

This was an example of a divergence in learner capability which we had not predicted before teaching started. As noted in the introduction, the MES cohort comprises students from almost every discipline, with a mix of international and domestic students of many cultures. Cumulatively, these many dimensions of diversity had made it hard to predict and support learners in approaching the summative applied tasks. The flip side of this barrier is that diversity offers excellent potential for peer learning. Learning in 'interlinked' or 'jigsaw' teams has been identified as a valuable pedagogy for ESD (Lozano et al. 2019), and we elected to increase the prominence of participatory and collaborative learning (UNESCO 2014) in the unit from 2018 onwards. Our efforts to do so inspired the first of three innovations within this case study.

We had observed, in 2017, excellent peer learning and cohort-building taking place in a different Masters unit which we had constructed in a blended mode (Garrison and Kanuka, 2004), which combined weekly independent online work with two major, two-day intensive workshop blocks. The observations motivated us to experiment with a similar approach in *Processes to Influence Change*. To do this, we shifted most lecture-style content online via pre-recorded short videos and replaced the weekly, 2-hour workshops with a total of five full workshop days. These were designed to facilitate teamwork, experiential learning activities, cohort building and industry engagement. The first of these days became the target of a specific pedagogical intervention - a formative (un-graded) 'Innovation Challenge Day' in week 2 which preceded work on any summative (graded) tasks. Learners worked in teams to complete

a sequence of simplified collaborative tasks – system diagramming, problem definition, ideation, idea development, and a pitch (Figure 4). This end-to-end process follows a similar pattern to the summative tasks and offers learners a preview of the type of work expected. It models how the outputs of each task become inputs to the next, embedding the overall logic of the unit's integrated case study progression in their minds before they begin summative work.

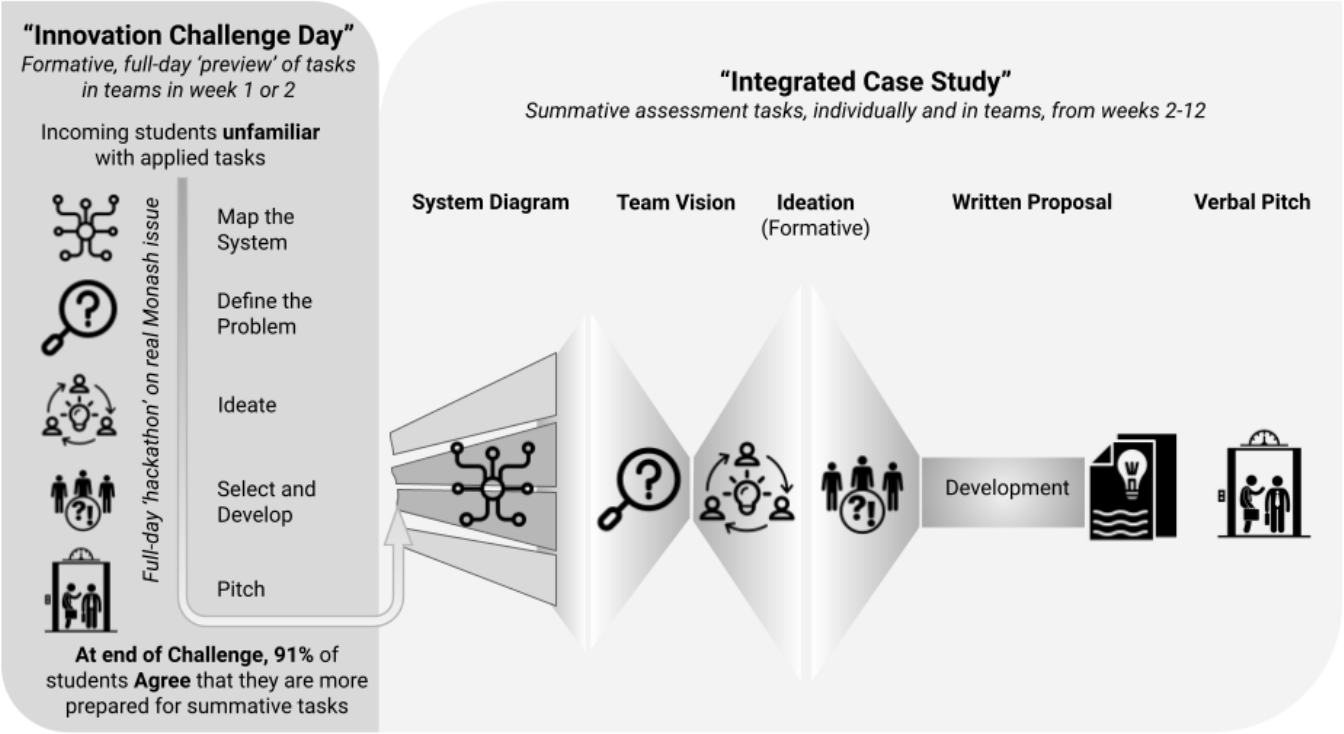

Figure 4: A visual diagram illustrating the positioning of the formative `innovation challenge day' at the beginning of the 12-week unit, before learners progressed from left to right through the summative tasks of the `integrated case study'.

In practice, this experiential introduction to the unit acted to strengthen peer bonds, introduce key methods and tools (such as system diagramming), dispel anxiety about unfamiliar tasks, and immediately expose learners to a challenge which required all 5 competencies advanced by Wiek et al. (2011). In-semester feedback on this experiment, obtained via the rapid-response technology Loop, showed that 91% of participants agreed that the formative challenge helped them with the summative tasks, and 93% rated the Innovation Challenge as a positive experience. Median quantitative evaluation scores for `clarity of instructions of assessment tasks' lifted from 3.86 out of 5 in 2017, to 4.1 in 2018 and 4.43 in 2019, demonstrating that the intervention supported more learners with the summative tasks. Learner feedback supported this, as shown by the quote from a reflection below:

> *The innovation challenge overall was extremely interesting. The whole journey from outlining a spray diagram to the causal map to the process of drawing the value-effort matrix to come up with a solution, this whole process of identifying a problem and coming up with a solution was very new to me. I think the process was very systematic, efficient and can be used in any situations.* – 2020 Learner Reflection

In 2019 and 2020, to further develop this innovation, we invited the team from Monash's Net Zero Initiative -- a whole-of-university emissions reduction program and the first of its kind to be announced in Australia -- to set the topic and judge outcomes for the Innovation Challenge. The value of partnering for hackathons (another name for rapid innovation challenges) in an education context has been noted in a case study on sustainable business education by Jonker and Faber (2019). In our experience, this change further enhanced the impact of the Innovation Challenge, with one 2019 participant subsequently

securing a job to implement their idea for a student action platform, *'Net Zero Me'*. This platform, currently in pilot form with hundreds of Monash students (as of 2021), serves as an induction to empower and educate new students to take personal emission-reducing activities, and is an example of added value of this educational intervention.

The enthusiasm of the cohort for the blended format was clear, and we ended 2018 confident that the shift to longer, experiential classes with a start-of-unit innovation challenge constituted a sound pedagogic change which supported our goal to develop an action orientation in learners.

5. Innovation 2: A sustainable ideation toolkit to support learner creativity and agency

The unit's first two iterations offered evidence that the structure of the curriculum, sequence of the assessment tasks, and in-class pedagogies were working together effectively. Our combination of interdisciplinary team teaching, problem-based learning around a real-world case study, and the use of jigsaw teams and mapping/diagramming aligned well with contemporary ESD scholarship (Lozano et al. 2017). However, when examining the real-world project concepts learners pitched at the end of the unit, we noted repetitive themes which we felt demonstrated little creativity or innovation. For example, in 2017, most learners examining the transport system of Melbourne proposed creating a `car-free city centre.' This is a reasonable idea but uses a basic lever (remove cars) to intervene in an obvious area (the city centre). Alternatively, they proposed solutions which were most likely to work if deployed toward individuals hyper-aware of, and supportive to, sustainability -- a bias we term `mini-me-ism' after Soufoulis (2011).

We knew our curriculum showcased innovative examples of ways to intervene in complex systems, but learners didn't seem to self-generate or take creative ideas forward in summative assessments. This is a recognised gap in the theoretical and practical teaching of sustainability: creativity is rarely explicitly addressed in ESD (Sandri, 2013), though Evans (2019) identifies an integrated `creative and strategic competence', which we think is a valuable framing to explore in further scholarship and practice.

To address this perceived deficit, we conducted further research into sustainability innovation, consulted colleagues with backgrounds including urban experimentation and complexity economics, and engaged in professional development with the innovation company *Inventium* around this theme (Anderson, 2017). From these we devised an original ideation toolkit based on the Sustainable Development Goals, system `leverage points' (Meadows, 1999), and diverse actors, which has now grown to include six flexible tools explained in Table 2. Following tests in 2018, we now routinely deploy the toolkits in-class between the summative team vision and written proposal tasks (Figure 3). Learners use tools to generate up to 15 diverse, discrete ideas for intervening in the system. Ideas are then shared and evaluated against multiple criteria, with the most promising taken forward to the proposal task.

Two key features of the tools are worth highlighting. One is the in-built randomness and variability of the prompts. Users will only ever be presented with a subset of the overall prompts and will attempt to connect each prompt to their problem of interest to generate a new idea. In practice, when facilitating the use of these tools, we emphasise how the randomness can liberate a user from needing to strive for `perfect' ideas every time. Simply, not all prompts will make sense when applied to a user's unique problem or situation of interest. By acknowledging the in-built possibility of failure and emphasising rapid iteration with the tools, we create a safe-to-suggest, divergent thinking environment. This counters potential biases to stick with the first, or safest, idea a learner might have had in the earlier stages of the unit. The second key feature is that the tools are normatively aligned to sustainability. They deliberately evoke principles and examples, such as the SDGs, future generations, biomimicry, system transformation theories, and more. This differs from ideation tools we learned about and tried that used similar random principles but were not normatively designed to specifically generate sustainable ideas.

Table 2: List of modified and original ideation tools piloted, then adopted in, generative phase(s) of Processes to Influence Change to support learner creativity.

Name (and source)	Summary of ideation tool
Your Big Idea (created by educator team)	Users capture and record solution ideas they've had in earlier system analysis and visioning phases. This provides an outlet for ongoing, subconscious or serendipitous ideation which may take place alongside sense-making and visioning processes.
"What Would X Do?" (adapted from innovation company *Inventium*)	Users draw a random character from a normatively created set. Each character is either inspired by an SDG or an under-represented group, such as future generations or indigenous groups. The user ideates with that character's perspective in mind. We adapted this tool from a version rooted in popular culture characters, with no normative basis, and use it to disrupt 'mini-me-ism'.
SDG Connection (adapted from *Inventium*)	Users roll two six-sided dice and consult a chart, which guides them to one of the 17 SDGs. They must try to create an idea which synergistically addresses their problem of interest and provides a benefit to the random SDG. This 'forced' connection provides a creative constraint and promotes generation of ideas with multiple sustainability benefits.
Many Pathways (created by educator team)	Users make a short series of choices which lead them to a simulated space (such as a desert), where they are given an example of an innovative sustainability 'solution' related to the space (such as a water storing Boab tree). They are prompted to use the example as inspiration to generate a new idea for their own problem of interest.
Leverage Points (adapted from Meadows (1999))	Users roll two six-sided dice and consult a chart to identify one of the 12 leverage points from the referenced text, along with an exemplar sustainability innovation which targets that leverage point. They are prompted to create a new solution inspired by that type of leverage point (such as changing a goal, altering a feedback loop, etc.). Mid-level leverage points are most commonly rolled.
Me, Me, Me (created by educator team)	Users engage in rapid structured reflection on their existing skills, academic background, and influential experiences. They are then prompted to connect the revealed parts of their own selves to the problem and generate ideas on how skills or knowledge they hold could be used to innovate.

Since the integration of these ideation tools, we have observed proposals becoming more varied and original. Examples include indigenous artist-led safety upgrades for linear parks; ecological integration of childcare with public transport; and eco-tourism driven expansion of peri-urban cycle networks. These respond more to nuanced local needs and incorporate a wider variety of levers for change and actors and validate the utility of the tools. This is reflected in end-of-semester learner reflections, including shifts in mindset (first quote, below) and the use of applied tools to support creative problem solving (second quote, below):

> *After completing this unit, I will stop settling for the first "good" solution that comes to me. I feel like in the past I would be happy to come up with a solution that seemed to fit a sustainability issue and run with it. But I believe that I now understand the process of reiteration and designing solutions/ interventions from the point of view of different stakeholders and getting feedback from different people to come up with an improved or different intervention.* - 2020 Learner Reflection.

"Thanks to all lectures and interactive activities throughout this unit, I will start using tools to strengthen my creative thinking, especially when approaching sustainability issues. Due to my engineering background, I used to have a habit formulating everything and trying to solve problems with existing step-by-step procedures. This way of problem-solving usually hinders me to approach a novel problem differently and tackle it more creatively. To deal with unprecedented sustainability challenge in the future, I will try to have more space for creativity as well as leave room for piloting ideas." - 2020 Learner Reflection.

Further work on the use of ideation tools, such as more systematically evaluating the benefits and outcomes of each of those listed in Table 2, offers an interesting direction for future research. Some tools, such as "What Would X Do?", explicitly encourage learners to exercise "empathy and change of perspective", a competency identified by Lozano et al. (2019) as under-represented in typical sustainability pedagogy. The ideation toolkit is not just useful in a single curricular context: it has since been shared across Monash and used in various industry consulting contexts. This innovation supports learners to see themselves as creative agents capable of generating diverse, sustainable ideas, thereby supporting our broader goal of enabling transformative change.

However, simply having a promising idea is not sufficient to achieve tangible sustainability outcomes. In the unit, learners must proceed to propose and pitch the idea, which requires confidence, interpersonal communication skills, and the ability to persuade other system actors. The final innovation of this chapter addresses these skills.

6. Innovation 3: Experiential in-class simulations to bring together knowledge, skills, and attitudes

In the unit's first iterations, we deployed a range of small-scale (up to 1 hour) interactive activities such as role plays, collaborative mapping, and scenario activities to bring theory and application together. The implementation of the innovation challenge in 2018 showed that longer, more complex in-class experiences effectively enabled learners to integrate knowledge with skills and, crucially, attitudes. Learner enthusiasm and commitment was extremely high in the innovation challenge. As such, we extended our experimentation with more open-ended, exploratory simulation-based workshops, noting that experiential games can offer diverse opportunities for different kinds of sustainability-relevant learning to take place (Dieleman and Huisingh, 2006).

In 2019, we collaborated with a foresight specialist with experience in facilitating complex, scenario-style experiences to run a "radically open-ended" (Finch, 2019, p.3) community role-play called 'Library Island' in which participants explore social tensions in a community and its institutions on a fictitious island. Good participant feedback led us to develop two new simulations anchored in theories from the unit. These were designed to provide a practice space for learners to enact sustainability competencies (Table 3). The two new games are run in the semester when they most clearly connect to the curriculum topics and aligned summative tasks (Figure 3).

The first, *Coalandia*, is a narrative-driven game in which the entire class must work to transition an energy system to net zero emissions. The system's governance structure reflects the Multi-Actor Perspective, a framework to consider the structure of society, sectoral boundaries, and power dynamics in transitions (Avelino and Wittmayer, 2016). The game's structural and temporal dynamics draw on the Multi-Level Perspective (Geels, 2002), with niche, regime and landscape factors built into the game. Participants are given rules only for the sub-section of the system for which they are initially 'responsible', and must sense-make, communicate, and collaborate to succeed in the transition. All actors have the same goal; tension and conflict emerge from the complexity of the system and its dynamics.

The second, *Council Chaos*, run late in the semester, sees every individual given a role as a Councillor, Advocate or Stakeholder, with realistic individual goals and point-scoring conditions. They are then given two hours to form alliances, negotiate, and formulate a council's annual transport budget, which is ultimately voted on by council members. Unlike *Coalandia*, actors have agendas which compete or conflict, and power and influence are unevenly distributed. This requires participants to act as policy entrepreneurs, after Kingdon and Stano (1984) to negotiate resolutions between conflicting values and advance their chosen ideas for implementation.

Table 3: Experiential simulations used in the unit and their connections to wider theory and ESD competencies.

Name	Type	Theoretical frameworks integrated into simulation structure	Linked ESD Competencies (Wiek et al. 2011)
Library Island	Open-ended, exploratory	Nil from unit	Anticipatory, Interpersonal, Normative
Coalandia	Team-based, collaborative	Multi-Level Perspective (Geels, 2002), Multi-Actor Perspective (Avelino and Wittmayer, 2016)	Systems Thinking, Interpersonal, Strategic
Council Chaos	Individual, competitive	Multiple Streams Theory (Kingdon and Stano, 1984), Advocacy Coalition Framework (Weible et al., 2011)	Interpersonal, Strategic, Normative, Anticipatory

Learner responses to these simulations, captured via free-write reflections and discussions, show strong emotional and intellectual responses, including specific awareness of the practical translation of the skills used:

> *The Simulation Day was a day full of fun... I found the intensive class to be incredibly valuable to my learning progress, especially because it got me to think critically about the role of politics and institutions in sustainable development. It allowed me to understand, truly, the complexities of development, and how one size truly does not fit all.* - 2020 Student Reflection.

Such reflections also highlighted the embodied nature of the experiences and emotional impact of participation – noting challenges such as uncertainty, frustration, and indecision during the tasks, as well as strongly positive senses of accomplishment, joy, and satisfaction upon completion. Having now delivered experiential simulations in three modes -- fully on-campus; fully online; and with a split 'hybrid' class (half online, half on-campus), we feel these experiments have demonstrated success in bringing together knowledge, skills, and attitudes to develop competencies in a range of classroom settings. We are looking to explore and further leverage simulations and gamification for competency development. In particular, we are investigating the ways in which these simulations expose learners to controlled situations of ambiguity and uncertainty, another less-common competency in contemporary ESD pedagogy (Lozano et al. 2017) and to test how learners can develop coping strategies as they progress within and between simulations.

7. Conclusion

Our successful development and ongoing experimentation and innovation within *Processes to Influence Change* reflects our general educational approach. We are responsive to the now; a context of multiple crises, with competing complex problems gripping our public discourse and society. We seek to shape the future; our graduates are equipped with an action orientation and toolkit to innovate and influence progress toward sustainable development. Lessons from the original collaborative development process, described in the second section of this chapter, have benefited further curriculum development projects, including interdisciplinary industry-linked projects and field-linked intensives. Tools, such as our ideation kit and how-to guide which supports the summative system diagramming task, have been shared widely, within and beyond the curricular education context. Our understanding of the interaction between independent learning and collective class experiences, and how these contribute to different facets of competency development, continues to evolve, especially in the face of the COVID-19 pandemic and its associated challenges.

We will continue to learn and grow the impact of our practice, always with a close focus on high-quality experiences for our learners, up to date curricula and powerful collective class experiences. In particular, we see significant room to further ESD scholarship and practice in connecting creativity to strategic, anticipatory and potentially interpersonal and implementation competencies, as articulated in

Brundiers et al. (2021). We believe it is essential to continue to expand and develop offerings like this across higher education contexts to support transformative learning experiences for learners of all backgrounds. We would like to close with the words of a learner which we believe show the transformative potential of the unit, and the sense of agency it cultivates:

> *I think a brilliant lesson from this unit was that solving real-world problems takes a multidisciplinary approach and requires flexibility and creativity. Having recently finished a science degree, I had definitely fallen into a pattern of approaching everything from a very analytical, practical and scientific perspective. While that way of thinking can be beneficial and certainly has its place in change making, I think using a range of lenses and approaches is the most effective way... (t)his unit has honestly reinvigorated my zest generating ideas and my creative side. Thank you, it was honestly fantastic.* - 2020 Student Reflection

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Teaching Systems Thinking

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Abstract

Principles of Sustainability is the second course in the three-course core sequence in Environmental Studies at University of Montevallo. It serves as the transitional course between theory and action. My narrative focuses on a series of activities I have developed to teach systems thinking in this course, which is a key competency for the course as well as for the Environmental Studies program more broadly. I first introduce systems thinking and theory with readings, reflections, and discussion. Second, students work in groups to make sense of various visual representations of social-ecological systems, presenting their systems to the class in a peer-teaching activity. Finally, the students apply their new system thinking knowledge to one of the best systems examples available: Biosphere 2. We apply systems thinking to Biosphere 2 to understand its outcomes and future. I have experimented with different systems thinking texts and activities over the seven years I have taught this course, and I will always consider it a work in progress; in many ways, teaching systems thinking mirrors the complexity of the subject at hand. However, the sequence of activities I use implement best practices and foundational theories to balance complexity with accessibility in systems thinking for sustainability. Most importantly, as systems thinking can be exceptionally challenging for students, the engaged components of these activities help me assess student skill-building and comprehension in real time and correct any issues as they arise.

Keywords: *Systems thinking, peer teaching, systems dynamics, sequential activities, systems diagramming, wicked problems*

1. Introduction

Sustainability education is a growing and critical component of higher education, and a key mechanism to address our collective global environmental crisis (Ruiz-Mallén & Heras, 2020; Weiss & Barth, 2019; Sibbel, 2009). Universities are addressing this need for sustainability leaders in a variety of ways, including the addition of majors, minors, concentrations, general education requirements, and standalone courses that prepare students across campuses to engage with sustainability concepts on campus and beyond (Evans, 2019; Johnston, 2013; NAS 2020; Barlett and Rappaport, 2009). As the field of Sustainability has matured and gained legitimacy, researchers and educators in the field have identified several key competencies in Sustainability education; most notably, Wiek and colleagues (2011) have identified five key competencies: systems thinking, interpersonal, strategic, normative, and anticipatory competence. Brundiers and colleagues (2021) added implementation competency and intrapersonal competency to the list, and National Academies of Sciences report on sustainability education (2020) emphasized the importance of implementation for producing agents of change.

Systems thinking is considered to be foundational to sustainability management and decision-making (Porter and Cordoba, 2008; Vincent and Focht, 2009; Rieckmann, 2012). Complex systems thinking is integral to problem-solving in the real world beyond just sustainability challenges (Meadows, 2008; Rittel & Webber, 1973). This type of thinking is central to sustainability because sustainability problem-solving requires an understanding of how different elements of social-ecological systems interact to produce feedback loops, dynamic behavior, tipping points, and emergent behavior (Habron et al, 2012; Bosch et al., 2007). Systems thinking also requires consideration of diverse types of data and stakeholders (Wiek et al., 2011). Systems thinking is also connected to the concept of wicked problems, which are problems that resist reductionist and linear thinking (Seager et al., 2012). Sustainability problems tend to be wicked because they do not have a single correct response, they are all symptoms of other problems, the problems and any potential responses are all unique, and the require consideration of multiple stakeholders (Mulligan, 2018). Thus, in order to become an effective sustainability leader, one needs to understand system dynamics and how to leverage points in those systems to effect change (Brundiers et al., 2021).

As a competency in sustainability education, students ideally will demonstrate the ability to interpret and create visualizations of social-ecological systems (Wiek et al., 2011). However, sustainability textbooks for the most part tend to describe systems thinking as a separate concept, presenting very few meaningful opportunities to practice building diagrams or interpreting them (see Robertson, 2017; Brinkmann, 2016; Mulligan, 2018 for examples). This leaves instructors to produce their own meaningful activities that build systems thinking into the key topical areas of sustainability. In this chapter, I present my own efforts to operationalize the abstract ideas of complex thinking into real-world examples drawn from the literature and history, so that students can practice interpreting both the visualizations of systems and the dynamics embedded therein.

2. General Class Structure

Principles of Sustainability is a sophomore-level class within the Environmental Studies major at University of Montevallo. It is the first "majors only" course, and it is the middle course in a scaffolded, 3-course core sequence. The introductory course, Environment and Society, presents interdisciplinary theory and practice. Environmental Studies in Action is the capstone course in which students spend the entire semester on a client-driven, real-world sustainability project. As a sophomore level course, Principles of Sustainability bridges those two areas by teaching key sustainability theories and applying them to a campus sustainability project using AASHE STARS as the guiding framework.[1]

Principles of Sustainability introduces key theoretical frameworks in the field, including thermodynamic considerations, and conceptual models like 3E, TBL, 4 pillars, and the 5 axioms[2] (Mulligan, 2018; Niesenbaum, 2019; Heinberg, 2010). We then study important topical areas in Sustainability, including waste, water, energy, agriculture, green building, and others. Specific topics depend on which textbook I use. Finally, students complete group projects that aim to improve our AASHE STARS score, working with key campus partners to advance a particular sustainability goal (AASHE 2021).

I have struggled to find an appropriate textbook for this course. Since 2014, I have used books by Taylor (2014), Brown (2008), Robertson (2017), Niesenbaum (2019), and Mulligan (2018), and I have reviewed many more. All of these books have valuable information and a helpful perspective on many issues, but none of them have provided the exact perspective I'm looking for in this course. Specifically, none of these books consistently apply systems thinking to understanding sustainability issues; instead, they

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1 AASHE STARS is the Association for the Advancement of Sustainability in Higher Education's Sustainability Tracking, Assessment, and Rating System. Universities earn points within the system in order to achieve a bronze, silver, gold, or platinum rating. See stars.aashe.org for more information.

2 3Es are Environment, Equity, and Economy. TBL stands for Triple Bottom Line which is usually understood as People, Planet, and Profit. The 4 pillars include economic, social, environmental, and cultural considerations. Heinberg's 5 axioms are: "1) Any society that continues to use critical resources unsustainably will collapse; 2) Population growth and/or growth in the rates of consumption of resources cannot be sustained; 3) To be sustainable, the use of renewable resources must proceed at a rate that is less than or equal to the rate of natural replenishment; 4) To be sustainable, the use of non-renewable resources must proceed at a rate that is declining, and the rate of decline must be greater than or equal to the rate of depletion; 5) Sustainability requires that substances introduced into the environment from human activities be minimized and rendered harmless to biosphere functions (Heinberg, 2010)".

typically introduce systems thinking conceptually at the beginning but rarely use it throughout the rest of the text. I have supplemented the textbooks with diverse readings to include additional perspectives (the Post Carbon Reader, edited by Heinberg and Lerch (2010) has been a favorite supplemental text for years), but even those readings rarely center systems thinking. Thus, my supplemental materials aim to provide practice with understanding, interpreting, and building conceptual diagrams for social-ecological systems for sustainability.

3. Teaching Systems Thinking

While systems thinking is embedded throughout the class, I devote three 75-minute class periods to explicit training in systems thinking. This unit typically occurs after a general introduction to sustainability thinking and sustainability models, and before we dive into topical themes (water, waste, energy, etc.).

On the first day, I introduce key theories that underpin systems thinking. This includes a more purist account of systems by Donella Meadows from her book, Systems Thinking: A Primer (2008). While the whole book could provide a lot of useful information for the class, I only use the introduction and first chapter, as I think that gives us sufficient introduction to the key ideas of feedback loops, emergent behavior, stocks and flows, etc.

I supplement this reading with a paper from the Stockholm Resilience Centre focused on resilience thinking. This reading connects general systems thinking with specific sustainability-related goals, highlighting the importance of connectivity, redundancy, diversity, feedback management, learning, and participation/polycentric governance for sustainable systems (Simonson 2015). To prepare for discussion, students write reading reflections in advance of class, and then we use the class period to explore ideas further, and make sure all key terms and concepts are clear before moving onto application. We also walk through a couple of basic system diagrams together to being practicing how to interpret positive and negative feedback within a system, which is one of the most challenging elements of systems thinking. Two of my favorite graphics come from Elmansy (2016; Figure 1) and Gore's Inconvenient Truth (2006).

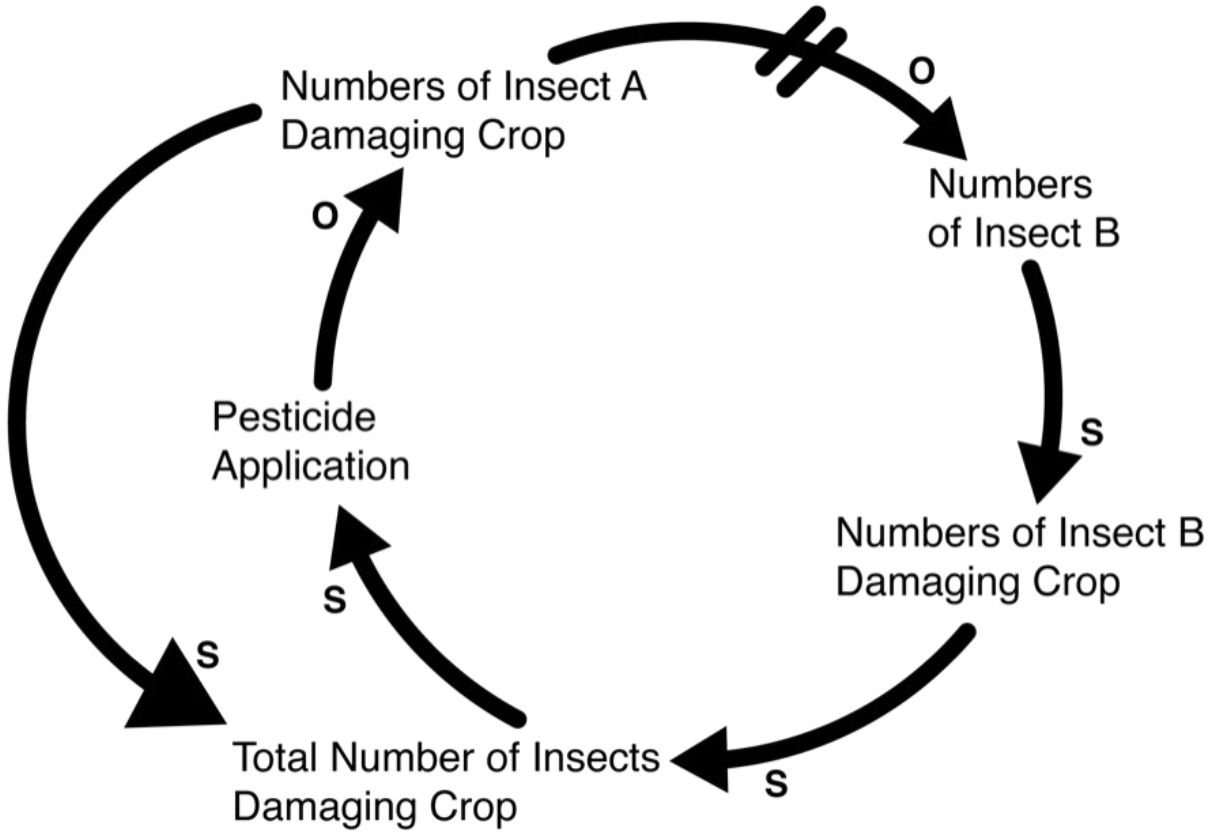

Figure 1: Very basic system (Goodman and Karash, as cited in Elmansy 2016).

On the second day, we interpret and make sense of visualizations of social-ecological systems diagrams at different scales. I first demonstrate the task by projecting a simple social-ecological systems graphic displayed on a PowerPoint projection and then verbally and visually walking through the graphic (Figure 2). As I walk through the system from variable to variable, I first define each variable, then explain how the variables are connected to each other, and then envision a perturbation to the system, following it through the system itself. So, for example, a decrease in ecosystem regulating services would lead to a decrease in provisioning services, which would decrease human well-being. Humans could then respond by restricting use of/access to ecosystem services OR ecologically engineer ecosystems to help their services recover, and both of those activities would complete a balancing feedback loop.

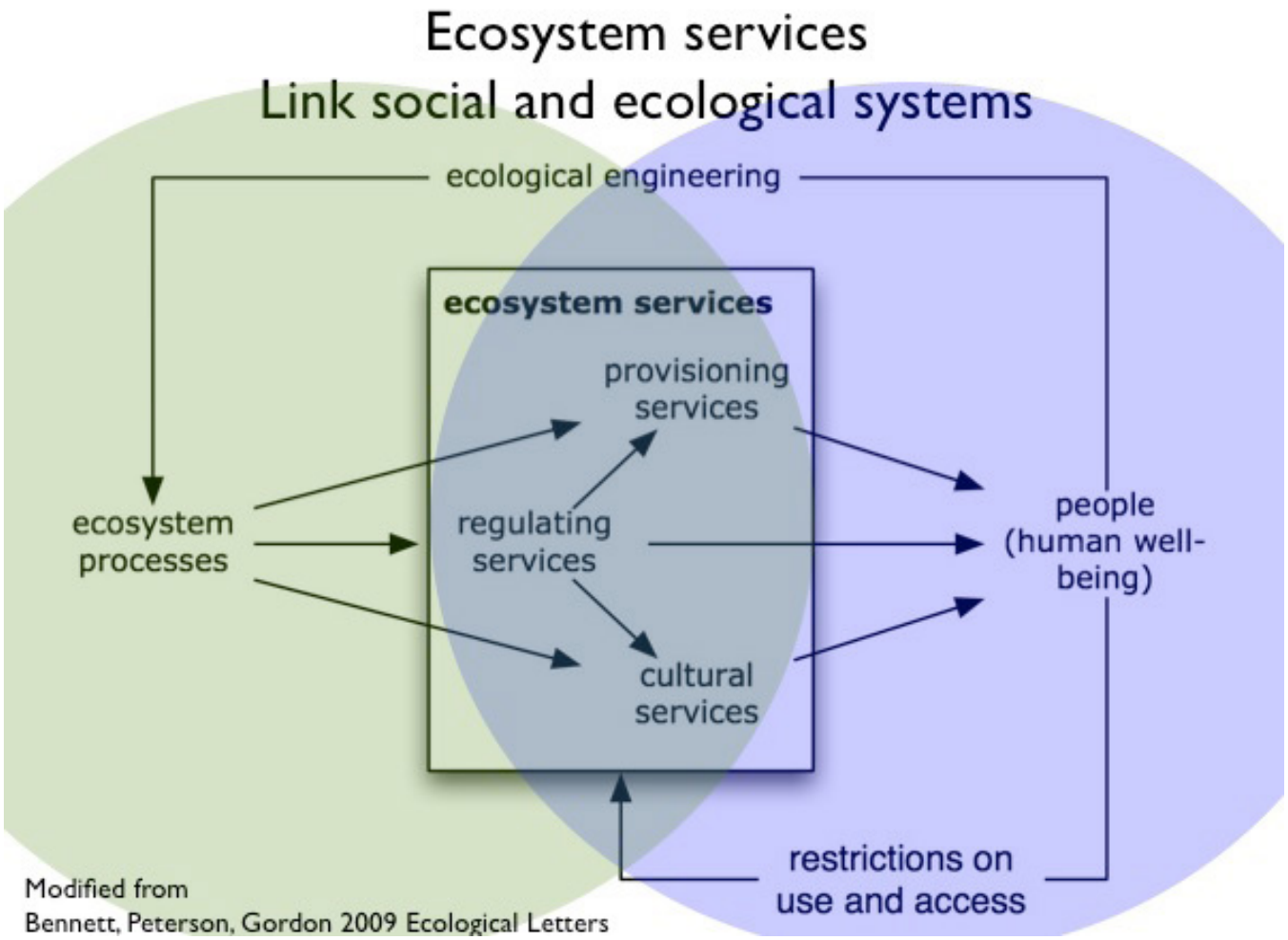

Figure 2: A basic social-ecological system, modified by Peterson (2013) from Bennett, Peterson and Gordon (2009).

I then give groups of 2-3 students their own diagram, each drawn from peer-reviewed literature, to interpret for the class in a peer-teaching activity. The diagrams I provide do not follow the same conventions for labeling and mapping, so part of the activity is understanding diverse visualizations of systems and considering why visual diversity is endemic to systems diversity.

They then present their diagram to the class in the same way that I did – defining variables, explaining their relationships, and then following a theoretical perturbation through the system to explore balancing and reinforcing feedback loops. While I have used dozens of diagrams over the years, some of my favorite diagrams come from articles about soil health (Chapin et al., 2006; Figure 3), ecotourism (Potschin-Young et al., 2011), lobster fisheries (Partelow & Boda, 2015) and pike management (Martin & Schlüter, 2015).

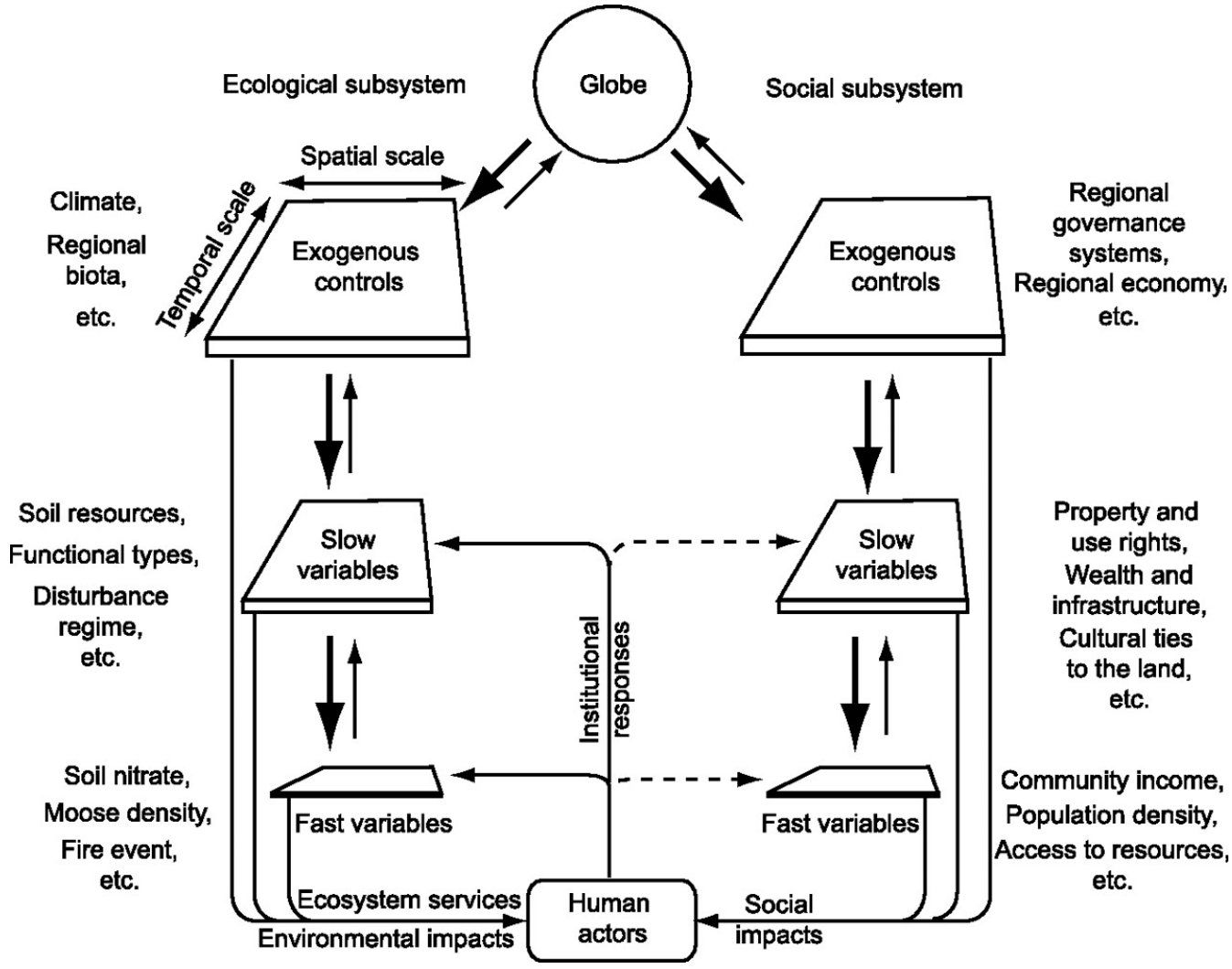

Figure 3: Another example of a social-ecological system diagram (Chapin et al., 2006).

After they have shared their diagrams with the class, I have them consider more questions related to sustainability management: In the systems they have been assigned, what would a sustainability policy aim to do? How might its success be measured? What data would you need to collected to measure that success? These questions touch on other key competencies, including strategic, anticipatory, and implementation competency, as students are asked to consider both ideas for solutions and the potential consequences of those actions. I find that students often have interesting, creative ideas for data collection and indicators of success, but that many of the variables are difficult (if not impossible) to measure – we then discuss feasibility in data collection, which foreshadows our unit on data/measurement that follows the systems thinking component. Finally, I ask: are there any important elements missing from the diagram? This last question helps empower the students to remember that these are creative approximations of infinitely complex and messy real-world systems; as such, they are not the only way, or perhaps even the best way, to organize the elements of a social-ecological system. This question also facilitates discussion on the importance of drawing boundaries on systems, while celebrating student curiosities and allowing space for their frustrations about the perceived lack of information or detail in some diagrams. However, I find it's important to not venture too far into the constructivist viewpoint of systems diagrams at this point, as students can also get frustrated at the lack of absolute "truth" embedded in these diagrams. We study social constructivism in the first course in the core series, so I sometimes also review those concepts as a reminder that these diagrams bridge complex reality and our limited comprehension of said reality.

On the last day, we apply systems thinking to the case of Biosphere 2. Most students are unaware of the Biosphere 2 experiment, in which eight people lived inside a bubble for two years in the early 1990s (Smith, 2010), and so this is a unique opportunity to consider both complexity and the risk of oversimplification using one of the more bizarre happenings of the 20th century.

We first watch a New York Times retrospective report video about the project (New York Times, 2013), which gives basic details of the project and interviews several original Biospherians. I then I show them a diagram of Biosphere 2's water system (Figure 4; Nelson et al. 1999) that they walk through using similar systems skills from the previous class period. They consider the differences between an engineering diagram (like a water management system) and a complex socio-environmental system. Finally, they engage in another peer-learning activity, in which they are tasked with putting together a systems narrative for Biosphere 2 using small snippets of information from Wikipedia (2021), Walker and Carroll (2021), and the Yale -New Haven Teachers' Institute (Kinder, 1992). Each student is given 1-2 paragraphs from one of these sources about one element of the Biosphere 2 system; example system foci include the atmosphere, climate, agriculture, water, social dynamics, waste, political climate, pests, nutrition, etc., As they each have different information, they listen to their colleagues and add their information whenever they think it might link to the previous student's information. Thus, they collaboratively build the narrative with specific attention to how the pieces are interdependent within a complex social-ecological system. This activity ensures that every student participates, as each one has a different piece to contribute; there is also no correct order in which to volunteer, which also reflects the web-like structure of systems themselves.

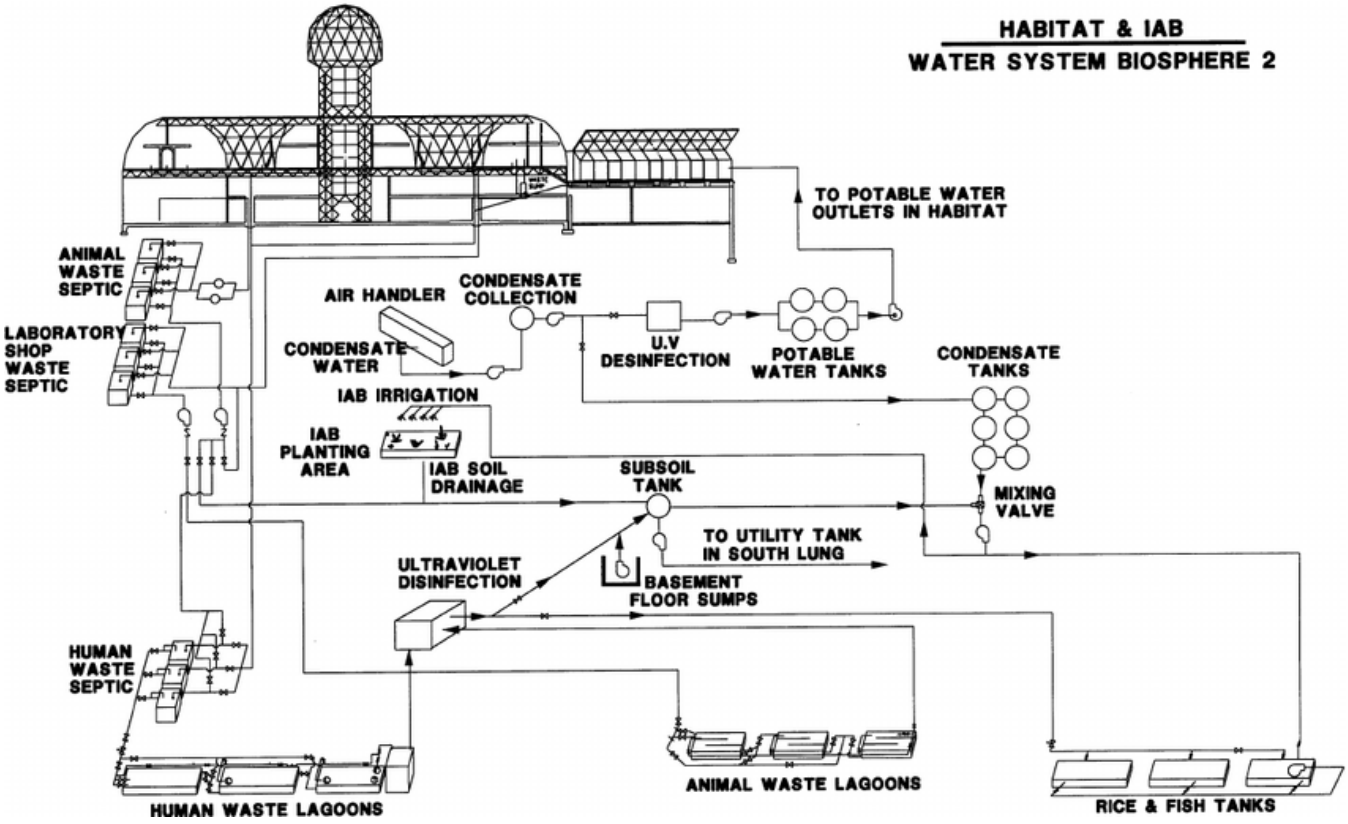

Figure 4: Biosphere 2's Water System (Nelson et al. 1999, Institute of Ecotechnics).

Finally, after piecing together the story, they think more broadly about the value of the Biosphere 2 experiment from a systems thinking perspective. and how the course material helps us make sense of Biosphere 2. Students often note that the failure of the experiment is part of the value of it. This argument has several components: first, system perturbations often (if not always) have unpredictable

consequences, and Biosphere 2 demonstrates that quite clearly. Second, the impossibility of reproducing the ecosystem services of Biosphere 1 (planet earth) at a smaller scale strengthens the case for global ecosystem protection. Finally, the sheer ambition of the project serves as an inspiration for those who might worry that big changes are out of reach, and that big failure might be too scary of a prospect. In the end, the Biosphere 2 facility became a valuable and productive scientific lab from which important scientific discoveries emerged, including several predicting the impacts of climate change on natural systems (Cornelius, 2021). This "happy ending" proves to be somewhat of a relief to the students, as descriptions of the original experiment often focus on its folly and wastefulness. To further emphasize ending on a fun note, I end with showing them photos from my personal visit to Biosphere 2 (Figure 5), and encourage them to visit the facility if they ever have the opportunity to do so.

Figure 5: Caplow contemplating the Biosphere 2 experience.

Overall, I find that these activities combine both the important content in systems thinking with some best practices in higher education, including peer teaching, flipped classrooms, small-group learning, and real world problem-solving (Fink, 2016; Bishop & Verleger, 2013). They participate in a flipped classroom by engaging with content in advance of class so that we can use class time for application. Students work in small groups to interpret systems diagrams. The whole unit is heavily dependent on peer teaching, as they are given ample instructional time to explain diagrams to each other and to present content from the Biosphere 2 example. Finally, while in this unit they don't directly engage in real-world problem solving, this content prepares them to navigate the complexities of doing so, which they do later in the semester in their AASHE STARS projects on campus.

Other than the written reading responses, all of the assessment data I collect during these activities are verbal. I do this for two reasons. First, communicating key concepts in sustainability is one of the key student learning outcomes in my program. Second, requiring students to explain content in the classroom as a peer teaching activity ensure that students who are speaking understand the concepts well enough to articulate them, and the listening students might better understand ideas when communicated in the words of their peers (Rees et al., 2016; Wagner and Gansemer-Topf, 2006). Finally, verbal engagement allows me to probe into areas of misunderstanding more quickly and fully than I would be able to if I were grading written assignments. So while I do not have any written data to report, I can say that during these classroom activities, students successfully interpret complex system diagrams, discuss real-world examples, and imagine ways to assess and adapt policies to best achieve sustainability goals.

4. Future Directions

We use systems language and thinking throughout the rest of the semester in Principles of Sustainability. Then, the final exam asks students to apply systems thinking in a variety of ways, from diagramming systems to explicitly identifying connections between different types of systems. The students generally succeed in mastering these concepts, although I have not experimented with the absence of these activities to determine whether they are superior to other options. In future years I plan to eliminate the use of a textbook so that I can have space to develop more materials to undergird this class that explicitly use systems thinking in sustainability in all key content areas. I am also considering including an oral component of the final exam to further emphasize peer teaching and to require more involved descriptions of systems (as walking through a system is a wordy enterprise, I can't ask for too much detail in a written exam).

I also found that in the production of this narrative, I was struck by the idea that the implementation of systems thinking in the classroom mirrors the complexity of systems themselves. No two semesters produce the same conversations, the same observations, the same recommendations, nor the same levels of satisfaction among students, and I never seem to arrive at one convergent solution that represents the ultimate in best practice. The students themselves represent diverse stakeholders, and while I think we have a desire or tendency to distill education practice into something highly repeatable and standardized for the integrity of the discipline, I advocate for celebrating the unpredictability of the outcomes we might experience – for this unpredictability is what allows students to have a genuine stake in their own education and in the future of sustainability itself. I certainly would not argue that efforts to standardize sustainability education are bad for the discipline, I only suggest that viewing sustainability education itself as a complex system also gives us the forgiveness to experiment, fail, and adapt to somewhat wicked and ever-changing circumstances.

Author Bio

Dr. Susan Caplow is an associate professor of Environmental Studies at University of Montevallo. She coordinates the Environmental Studies program and sustainability initiatives at UM. She received her Ph.D. in Environment and Ecology from UNC-Chapel Hill, her M.Sc. in Environmental Sciences and Policy from Central European University, and her B.A. in Public Policy Analysis/Biology from Pomona College. Dr. Caplow teaches courses that explore the interface between humans and the environment, and she incorporates field-based activities, community engagement, and service learning into her courses as much as possible. Dr. Caplow is the recipient of the Association for Environmental Studies and Sciences' 2020 Early Career Award.

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Spirituality: Competence & pedagogy for sustainability education

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Abstract

While the imperative for higher consciousness is a common theme in sustainability education, spirituality and spiritual practice are virtually absent as outcome or method in the literature. To be sure, future professionals must understand and effectively respond to the realities of today's wicked problems, which are more frequently laden in difference, conflict, and violence. Transcending such challenges is more a question of spiritual aptitude than any other competence. This chapter illustrates how the topic of spirituality and spiritual practice have been integrated in an interdisciplinary sustainable design curriculum to foster awareness and agency while mitigating depression and paralysis commonly associated with sustainability learning. This chapter provides a description of how mindfulness meditation, contemplative writing, and other explorations of spirituality have been introduced in the curriculum. Students have positively received this integration, reporting benefits such as the capacity to examine personal biases and enact one's spiritual knowing in their personal and professional decision-making.

Keywords: *Spirituality, mindfulness, contemplative, eco-spirituality, creation care*

1. Introduction

Supporting human well-being in an era of climate change is the most critical adaptive challenge of our time; replete with wicked problems that are more frequently rooted in difference, conflict, and violence (Orr, 2002; Eaton, Davies, Williams, & MacGregor, 2017). Cognitive and emotional intelligence are at a premium for college graduates who must understand and respond effectively to the environmental, social, and economic realities that are reshaping every industry. The complexity of these problems is incomprehensible and often depressing, and logic alone will be insufficient to transcend them (Orr, 2002). John Carroll (2004), author of *Sustainability and Spirituality,* argues that ecological health is now more a question of religion, moral choices, and spiritual values than a scientific, economic, or political question. While many scholars have developed frameworks of sustainability competence and suggest pedagogical approaches to engage capacities like empathy, ethics, or cooperation (Evans, 2019; Sipos, Battisti, & Grimm, 2008; Wiek, Withycombe, & Redman, 2011), most fall short of treating learners as spiritual beings.

Orr (2005) argues that a spiritual awareness of our relationship with Earth allows us to transform our beliefs and thinking to align with Nature's knowledge and limits. A spiritual aptitude is required to intuit this wisdom. Carroll (2004) argues that this aptitude is inherent in all human beings, as we all engage in the act of belief, faith, and religion in some form, and we are invariably shaped by these beliefs and values. To not pointedly access and explore this at institutions of higher learning is to suppress ways of knowing beyond the mind that are critical to understanding and responding to wicked problems with humility and compassion (Eaton, Davies, Williams, & MacGregor, 2017). Evidence suggests that exploring one's own

spirituality while learning about these daunting challenges is an effective pedagogy (Eaton, Hughes, & MacGregor, 2017; Podger, 2009; Podger, Mustakova-Possardt, & Reid, 2010).

This chapter illustrates how spirituality has been integrated into an interdisciplinary sustainable design curriculum as a method to foster awareness and agency among young learners. Specifically, we illustrate how spiritual practice, such as mindfulness and contemplation, have been used to examine personal biases, reflect on one's well-being, and stimulate creativity.

2. Situating Spirituality in Sustainability Education

While religion involves subscription to a doctrine and/or membership in a social institution, spirituality is far more concerned with "one's striving for and experience of connection with oneself, with others and nature, and with the transcendent"; connectedness or relatedness being an essential element of spirituality (Meezenbroek, et al., 2012, p. 338). This relatedness underpins the search for meaning in life and finds expression in personal authenticity, inner harmony or peace, self-knowledge, compassion, caring, gratitude, wonder, and other insightful aspects of human experience (Meezenbroek, et al., 2012). Spirituality is both instrumental as well as existential, contributing to the matters of everyday life and one's sense of self (Gross, 2009). Though there is a tendency in modern society to assign higher value to matter or the material in life rather than to the spirit, these are, indeed, two sides of the same coin that constitute "being" (Suzuki, 2007). The spirit breathes life into us, energizing the part of us that seeks to understand the great mystery and our part in it, often providing a foundation for hope and agency (Carroll, 2004).

Spirituality is not distinct from what sustainability education scholars have described as an imperative for higher consciousness and its virtues therein: to stretch the bounds of selfish concern to a compassionate involvement with the world that requires both self-critique and morality (Orr, 2005; Sterling, 2007). Sipos, et al. (2008) organized key learning objectives for sustainability education in terms of Head (cognitive), Hands (psychomotor), and Heart (affective).These authors argue that the inclusion of affective learning objectives aid learners in the translation of passion and values to behavior in the context of transdisciplinary problem-solving. Similarly, Podger, et al. (2010) reinforced the notion of engaging multiple pathways to learning and suggest a whole person approach to sustainability education that focuses on building "higher order dispositions" among learners (p. 340). These authors more intentionally address the subject of human will, suggesting the use of Mustakova-Possardt's four dimensions of moral motivation (sense of identity, sense of authority, sense of relatedness, meaning of life) to frame the integrative development and orientation of the learner's mind, heart, and will to work toward a common good. These spiritual approaches not only improve human well-being but also aid young learners in the development of their individuality and shaping a lens on the world that is understanding and inclusive of others (de Souza, 2009). This approach has many implications, chief among them, a spiritual orientation to teaching and learning (Podger, et al., 2010).

In the book *Contemplative Approaches to Sustainability in Higher Education* (Eaton, Hughes, & MacGregor, 2017), various authors suggest contemplative pedagogies to target multiple ways of knowing, including somatic, cognitive, affective, and ethical. The body, as the seat of perception and emotion, permits tremendous capacity for learning through the senses during experiential activity. Affect is likewise central to intuiting the beauty and wonder about the world, and these emotional experiences can provide important motivation to face the realities of sustainability challenges. When cognitive and ethical levers are integrated with these types of knowing, more robust perception and understanding emerges. Specifically, contemplative methods originating from religious and spiritual practice, including writing, listening, meditation, and other processes of discernment, can be used to open the learner to listen to these various sources of knowing without judgement (Daloz Parks, 2017; Eaton, Davies, Williams & MacGregor, 2017). Integrating spirituality and spiritual practice invites a psychological maturity that is an uncommon goal or programmatic choice in higher education curricula (Eaton, Hughes, & MacGregor, 2017).

Among some of the most well-known sustainability competence frameworks, Wiek, et al.'s (2011) competence model (e.g., systems thinking, anticipatory, normative, interpersonal, strategic) includes some consideration of ethics (normative competence) and the need to foster capacity for relationships with others (interpersonal competence), emphasizing empathy, cooperation, and leadership. However, the thrust of pedagogical suggestions emphasize cognitive analyses and teamwork rather than the cultivation of inner capacities. Evans (2019) developed a framework (systems, interpersonal and

communication, critical and normative, transdisciplinary) extending Wiek, et al.'s (2011) model with more nuance informed by time and practice. Evans (2019) adds a transdisciplinary competence that aptly includes multiple ways of knowing and finds pedagogical approaches such as reflexivity and creative expression as relevant to advancing higher order capacities. Spirituality and spiritual practice may most suitably reside within this transdisciplinary umbrella, as both a competence and pedagogy, prompting the learner to draw upon many capacities in their discernment and identity development.

3. Background

Spiritual approaches and content have been integrated into an interdisciplinary sustainable design curriculum at Oklahoma State University. The program is a collection of short courses covering topics relevant to industry practice, including research, design, and marketing processes informed by the philosophy of sustainable design. Students majoring in interior design, fashion design, and fashion merchandising are required to complete courses in this program, including a first-year course called *Wicked Problems of Industrial Practice* and two other short courses of their choosing. Students in other majors also opt into these courses to complete a minor in sustainable design. Mindfulness meditation has been integrated into the first-year course that all students experience, while the topic of spirituality is more formally explored in an optional short course. Following is a description of these approaches and student insight from our experience.

4. Introducing Mindfulness Meditation Practice

Meditation and other mindfulness practice have received little attention in the context of sustainability teaching until more recently when its benefits of memory, learning, and emotional regulation piqued the interest of practitioners seeking a more contemplative pedagogy for tackling complex sustainability problems in the classroom (Lau, 2009; Wamsler et al., 2018). Ericson, Kjønstad, and Barstad (2014) argue that health and well-being are compulsory to addressing larger societal change, as it is difficult to foster broader care for the world if one is preoccupied with personal stress or pain. Therefore, mindfulness, with its well-established benefits to human well-being, may provide an important pathway to sustainability learning. In 2016, mindfulness meditation was integrated into the aforementioned first-year wicked problems course in the sustainable design curriculum. This strategy was employed to mitigate the observations of stress, depression, and paralysis that are common responses to sustainability-related learning. Mindfulness was also introduced as a potential intervention.

Description of Method

The first-year course provides an introduction to environmental, social, and economic challenges propelled by industrial practice, meeting once per week over an 8-week period. The course includes a broad overview of problems with a viewing of the movie *The 11th Hour*, a discussion of the collapse of Easter Island, and the framing of these problems with the characteristics of wicked problems (Remington-Doucette, 2016). During the third week of the course, a mindfulness workshop introduces meditation as a mindfulness practice and includes some basic instruction and practice exercises around posture, breathing, and how to encounter and observe thoughts with acceptance and non-judgment. Then, students participate in a jigsaw discussion that focuses on the connection of mindfulness to sustainability, primarily its role in subjective well-being. The students explore the article by Ericson, et al. (2014) called *Mindfulness and Sustainability.* This article highlights the potential role of mindfulness in sustainability by increasing happiness through present-moment awareness, an increased capacity for empathy and compassion that enhances relational capacity, clarification of one's personal values, and slowing the "hedonic treadmill" that is associated with consumerism. Students discuss the role mindfulness in implementing sustainable practice in their personal lives and then the potential for revised industry practice.

At the end of the workshop, students are invited to establish a daily mindfulness practice of their own and report their experience in a course blog assignment that is completed four times during the class. They are asked to begin with a 5-minute daily practice the first week and then increase that practice to 10 minutes. Each of the five remaining class meetings begin with a 10-minute guided meditation, each employing a different approach to meditation, such as loving kindness, walking meditation,

guided imagery, and Visio Divina. The week following the mindfulness workshop, students examine the compatibility of Western paradigms with sustainability, using a reading from the book *Taking Sides: Clashing Views in Sustainability* (Taylor, 2013). This reading explores two perspectives, one that is rooted in scientific advancement and global economic growth, and the other oriented to equity, well-being, and shared prosperity. During this lesson, students make connections between spiritual practice and the development of beliefs and values. Paradigms are virtually unchangeable unless a consciousness is fostered intentionally; thus, the relevance of spiritual practices such as mindfulness in raising consciousness and improving well-being and its potential for shifting paradigms are both punctuated in this lesson.

The remainder of the course explores problems more specifically associated with the students' fields of study; for instance, the concept of fashion's role in fueling over consumption, the role that material extraction plays in world poverty, and the government's role in regulating industry practice. The presence of a regular mindfulness practice in the classroom, as well as the student's periodic sharing about their own practice, fosters a sense of community around facing difficult realities and developing humble and compassionate responses. The class culminates in a final project that requires students to conduct research about a specific wicked problem associated with their particular field, which includes a description of the problem using the characteristics of wicked problems.

The Student Perspective

At the end of this course students have a greater awareness of the environmental, social, and economic challenges within their chosen industries. Prior to this course, students' knowledge of these wicked problems are often perceived as marketing ploys through the lens of social media. Through the mindfulness activities during the course, the students begin to understand the correlation between the environment and themselves, noting that if the environment is not well, a person cannot be well, either. The mindfulness practices learned through this course allow students to see and examine their biases, and to be receptive to new topics. Students continue these mindfulness practices outside of the course. They use this tool to take a perspective-changing element into their other courses as a creative tool and use techniques such as deep breathing to calm their bodies down when their course load began to weigh them down.

5. Spirituality and Sustainability Course Framework

In 2020, a new short course was added to the sustainable design curriculum, titled *Spirituality and Sustainability*. A primary aim of the course was to expose students to the primary spiritual orientations to sustainability and prompt students to examine their own orientation and its implications for their personal and professional practice. The course culminated in the development of an ethic of care: a short statement that provides a spiritual grounding in one's call to care.

Description of Method

This course was taught in four three-hour workshops over a 15-week semester, meeting monthly at a local ecumenical spiritual retreat center, which provided a spiritual setting in which to learn. The delivery of this course was impacted by the Covid-19 pandemic. Initially conceptualized as an interactive experience including group activities, discussion, and interaction with guest speakers, its delivery was forced into a guest lecture format that did not include as much interaction as desired. Nevertheless, a framework was developed for this course to help students understand the perspectives of guest speakers along a continuum of different spiritual orientations to sustainability, from Christian evangelical perspectives ("creation care") to eco-spiritual orientations, some of which are heavily rooted in science. The framework provided scaffolding to invite guests according to their orientation to share their personal experience, which included the historical development of their beliefs and examples of their enactment of belief in practice. Students were assigned pre- and post-writing contemplative prompts to prepare them to interact with speakers and then critically reflect on the ideas presented by each course guest, using the framework to position various perspectives.

The course framework (see Table 1) is an adaptation of Kearns' (1996) categorization of models for Christian related eco-theological ethics that excluded non-Christian experience. This framework was expanded using ethnographic research conducted by this chapter's first author to include non-Christian orientations to sustainability found within a rural, chemical-free farming community. Findings from this work resulted in several additions to Kearns' (1996) framework, including "eco-spirituality" as a category of experience, the inclusion of humanistic experience within creation spirituality, and a new characteristic, termed "value of life," which includes how human beings relate to other forms of life in Nature. Some categories of experience in the framework were also simplified to be more understandable to young learners. Generally, the framework describes the way in which most people spirituality orient themselves to environmental and social problems, including how the roots of these problems are defined, the level of perceived "dominion" over Nature and its degradation, the narratives that underpin the human-nature relationship and responsibilities therein, and how different orientations tend to influence certain types of activism. Notably, two perspectives of sustainability issues, creationism and eco-fundamentalism, are not reflected here, as the former is far more religious than spiritual and downplays individual agency in regard to sustainability challenges, and the latter is more political than spiritual.

The Student Perspective

The lessons taught throughout this course allowed students to see environmental issues through the lens of other religions and spiritualities to which they were previously unfamiliar. Students began to understand that feelings of being connected to the environment can be a spiritual topic, allowing them to feel more deeply about sustainability issues. For example, students learned how a spiritual connection can guide a farmer's journey in planting and harvesting crops in a way that benefits the Earth while also providing a living. In some instances, the land is praised and looked after in a way that is not typical to a capitalistic society that is focused on profit. This connection that farmers have with the soil allows them to till the land in a way that cultivates care for the growth of the crops, which is then received through consumption of the harvest. In this way individuals take care of the Earth through their consumption instead of ruining the Earth with consumption. Many students had never considered the production of food in a religious and/or spiritual context.

In addition to the experiences shared throughout this course, students are equipped with tools to open their mind to possibilities beyond capitalistic views of industry. The different orientations to spirituality, seen in Table 1, provide a visual representation to explore where their own spirituality aligns. Students then feel that they can begin to examine and enact sustainable choices, personally and professionally, that align with their spirituality rather than an economic motive. This helps students transcend experiences of eco-guilt by empowering them to make decisions based on inward rather than outward incentives.

6. Conclusion

These pedagogical approaches and student responses make a case for spirituality's place alongside other key competences in sustainability education. We hope that our experience is an invitation to those tasked with teaching sustainability to more deliberately make spirituality a part of their pedagogy and curricula with some assurance that young learners will embrace it. It is our contention that spirituality and spiritual practice, and the use of these terms, have a place in sustainability education because it is an aspect of human experience and well-being that is expressed via one's deepest aspirations, temperament, and actions. To deny this fundamental aspect of being is to further compound our separateness from Nature and each other, which dwells at the heart of all wicked problems.

Table 1. Spiritual Orientations to Sustainability

Characteristic	Creation Care (earth care, stewardship tradition)	Eco-justice	Eco-spirituality	Creation Spirituality
Basis	Biblical mandate	Social justice	Rooted in Nature experiences	Nature-science oriented; cosmological; rooted in myth; science as most real form of truth
Relationship w/science & religion	Emphasis given to religion (the Word)	Emphasis given to religion	Emphasis on need for convergence of science & religion	Emphasis on science
Creation origins	God conceived creation; includes young creationism, old creationism, evolutionary creationism	God conceived creation; includes young creationism, old creationism, evolutionary creationism	Evolutionary creation story	Evolutionary creation story; "New Story," "New Genesis," "Universe Story", or "New cosmology"; creation narrative must include the creation of all things & the cosmos
Theology	Christian, especially evangelical	Mainline Christian social justice	Broad; interspiritual	Ecumenical to humanistic
Images of Divine	Transcendent (God as external source of authority)	Transcendent (God as external source of liberation)	Transcendence (God as external manifestation) & Immanence (God in all)	Immanence (seeing God in all)
Value of life	Hierarchical (humans, then animals, then plants); dominion/ responsibility given to humans	Dominion/ responsibility given to humans	Equity in value (Nature, humans)	Equity in value (Nature, humans)
Human-nature relationship	Gardener/caretaker	Sustainable management of natural resources for human betterment	Participatory	Situates humans place in bio-system
View on roots of ecological crisis	Human sinfulness, disobedience to God	Injustice/ inequality; economic systems	Dualism (e.g., separateness from Nature)	Dualism, anthropocentrism; human alienation from Nature
Prescribed response	Correct doctrine; restore Christianity as guide; balance Bible & biology	Correct praxis; government regulation; grass-roots organizing	Correct being/ spirituality; new worldview	Connection with Nature inspires values development = changed behavior
Issues of focus	Resource depletion; degradation of land & culture; agriculture	Toxic/hazardous waste; health pollution; agriculture	Wilderness preservation; species extinction	Wilderness preservation; species extinction

Author Bios

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Innovating and Integrating Sustainability Literacy and Competencies Across the Curricula–Lessons Learned from The College of Charleston

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Abstract

This chapter briefly shares lessons learned by faculty who participated in an internally funded reaccreditation project centered upon working with faculty to collectively embed sustainability literacy into existing courses across the undergraduate curricula at The College of Charleston (CofC), a public liberal arts college in Charleston, South Carolina, USA. The chapter provides an overview of the project; shares faculty case studies written by respective faculty from various disciplines who taught sustainability courses under the auspices of the project; and concludes by briefly exploring and analyzing best practices for teaching sustainability competencies across the undergraduate curricula. It does so by focusing on the six key sustainability competencies identified by Wiek, Withycombe, and Redman (2011) and Evans (2019), and how these may help address interdisciplinary 21st century "wicked" problems in the classroom setting.

Keywords: *Climate change, sustainability literacy, sustainability education, systems thinking, 21st century, sustainability competency*

1. Overview of CofC's Sustainability Project

In academic year 2016-2017 CofC created its five-year Quality Enhancement Plan (QEP) reaccreditation project, "Sustainability Literacy as a Bridge to Addressing 21st Century Problems." A QEP is a timed project that meets requirements[1] for two of the approximately 90 standards that are required to be met by SACSCOC. The College created a new Sustainability Literacy Institute (SLI), housed in CofC's Division of Academic Affairs, to direct the administration of the project. In my dual-director role of both the SLI and QEP I track the QEP's implementation and assessment and oversee its budget and support staff, which I have been doing since the project officially began programming in 2017-2018, with the project wrapping up in academic year 2021-2022.

In 2016-2017 a QEP implementation committee accepted a working definition of sustainability literacy that guided the project, and which defined such literacy as "having the knowledge and skills to advocate for resilient social, economic and environmental systems." Thus, the QEP adopted a weak sustainability

1 Required by The Southern Association of Colleges and Schools Commission on Colleges (SACSCOC), the regional accrediting body for colleges and universities in Texas, Virginia, Kentucky, North Carolina, Tennessee, Georgia, South Carolina, Alabama, Louisiana, Florida, Mississippi, and Latin America/international campuses. For more see https://sacscoc.org/ (accessed 14 June 2021).

perspective of the triple bottom line and tethered receiving such literacy (knowledge and skills) to advocating for resiliency in solving 21st century sustainability problems. A variety of curricular and co-curricular programming around an annual "CofC Sustains/Solves" theme was implemented by the SLI to expose CofC undergraduates to triple-bottom line thinking with this programming organized around the five goals and seven student learning objectives of the QEP (see table 1).

Table 1: The goals and learning outcomes of the QEP

QEP Goal:	QEP Student Learning Outcome/s (SLO/s) for each goal:
Goal 1: Build Awareness	SLO 1: Students can identify various elements of sustainability and the relationships between them (social, economic, and environmental).
	SLO 2: Students can identify key ways to be more sustainable in personal life and on campus.
Goal 2: Synthesize and Integrate Knowledge	SLO 3: Students can identify policies and practices that have led to unsustainability.
	SLO 4: Students can synthesize knowledge from two or more systems to address a sustainability problem.
Goal 3: Skill Building and Competency Learning	SLO 5: Students can demonstrate the impact of production/consumption practices on social, economic, and/or ecological systems.
Goal 4: Experiential and Learning Practice	SLO 6: Students can design a solution to a given sustainability problem.
Goal 5: Change Agents for Resiliency	SLO 7: Students can advocate for resiliency at the individual, institutional, community, national, or international level.

The central mechanism for meeting the above goals and SLOs was investing in CofC's faculty: (1) investing in their knowledge of sustainability; and (2) investing in their ability to impart sustainability literacy across the undergraduate curricula. To assist in this the SLI provided ongoing sustainability trainings to faculty; organized and hosted sustainability teaching workshops; organized sustainability reading groups; and, beginning in academic year 2020-2021, convened the first of two annual year-long interdisciplinary faculty cohorts who worked together on sharing best teaching practices for teaching sustainability literacy in a fall course, and then again in a spring course.[2] Faculty in this cohort adopted two of the QEP's SLOs in a fall and again in a spring course (they could pick any grouping of SLOs they wanted) and assessed these SLOs using a course-embedded assignment and a rubric provided by the SLI. This cohort was directed by myself and the SLI Faculty Development Fellow, Dr. Jen Wright, a full Professor in the Psychology Department. The 24 cohort members met for a day-long training on sustainability literacy in May of 2020, and then for one hour each month over eight months during the 2020-2021 academic year via Zoom. These meetings were structured around discussing shared readings on sustainability pedagogy, lessons learned in the classroom while teaching to the 2020-2021 CofC Sustains/Solves theme of global warming and climate change and watching videos on sustainability issues.

The next section of the chapter shares "lessons learned" by some of the faculty involved in the 2020-2021 cohort with each respective author reflecting on their experience engaging in sustained dialogue with others across the curricula over an entire academic year; transforming their courses to be sustainability focused and address climate change; developing best practices and lessons learned to

2 Prior to this the SLI hosted a 1-day training with faculty, who then embedded a QEP SLO in a course and turned in assessment results. There was no sustained, focused contact between the SLI/QEP director and any faculty, let alone a core group engaging in pedagogical trainings around sustainability over an academic year.

teach key sustainability competencies, including systems thinking competencies; and for some faculty, structuring sequential learning of sustainability to educate students to be change agents. Given the institutional investment in faculty development around sustainability literacy and the truly interdisciplinary nature of the 24-member cohort who engaged in sustained dialogue around sustainability literacy best practices, the below discussion offers important insights to anyone interested in teaching sustainability in higher education today.

2. Faculty Perspectives on Teaching Sustainability Competencies

In the spring of 2021, I approached faculty from the 2020-2021 QEP cohort, asking for them to join me as co-authors of this chapter. They were specifically asked to write about their experience with the cohort and teaching to the competencies outlined by Wiek and colleagues (2011) and Evans (2019), with a specific focus on systems thinking. I asked them to try to highlight their experience teaching the systems thinking competency because many faculty in higher education are not trained in systems thinking; and because it was shared amongst the cohort that this was the hardest competency to address, especially in an entry-level course. The faculty I approached were particularly engaged with the SLI and learning opportunities the project created, and they consistently spoke up and engaged with other faculty during the year-long meetings. In short, they became committed to teaching sustainability in their respective courses and in rethinking their approach to education in the context of 21st century sustainability problems. The first faculty is Dr. Allison Welch, Associate Professor of Biology, who also serves on the QEP Assessment Team; followed by Dr. Christy Kollath-Cattano (Associate Professor) and Dr. Katie Trejo Tello (Assistant Professor) from CofC's Public Health Program; followed by full professor Dr. Meta Van Sickle of CofC's Teacher Education Program (who also became the SLI Faculty Development Fellow in 2021-2022 and who oversaw that year's 14 member cohort); and Marianne Verlinden**,** a Senior Instructor in the Department of Hispanic Studies. These perspectives also cover four of the six Schools at CofC: the School of Humanities and Social Sciences (LeVasseur); the School of Sciences and Mathematics (Welch); the School of Education, Health, and Human Performance (Van Sickle, Kollath-Cattano, Trejo Tello); and the School of Languages, Cultures, and World Affairs (Verlinden).

SLI Faculty Cohort Member Reflection #1, Dr. Allison Welch (Note Dr. Welch is also director of CofC's undergraduate Environmental and Sustainability Studies minor):

Dr. Welch has been involved with the SLI since 2016, and her experience over this time reflects an evolution in her thinking, particularly about the value of sustainability content in a disciplinary course. Biodiversity, Ecology, and Conservation Biology is a sophomore level course required for Biology majors, which includes a 20-student discussion section that meets weekly for three hours. Over several years of gradually infusing more sustainability content into this course, she found that developing transdisciplinary competence within a disciplinary course is a valuable way to situate disciplinary content while introducing systems thinking and developing communication and interpersonal skills.

Before joining the SLI, her treatment of sustainability in this course was myopically focused on her own discipline's role. She first used sustainability-related examples primarily to engage students in learning disciplinary content with real-world relevance, for example, by relating climate change to the carbon cycle. Encouraged by student interest, she next sought to activate students to apply disciplinary knowledge to sustainability issues in their everyday lives, for example, by empowering them to make evidence-based choices to decrease their carbon footprint. Although this step in her evolution of teaching sustainability encouraged real-world action, it was still fundamentally a disciplinary perspective.

Progressing to a truly transdisciplinary perspective required a much larger shift in her thinking. Transdisciplinary competence is defined by Evans (2019) as the "ability to draw, in critical and integrative ways, upon multiple disciplinary frameworks to inform sustainability-oriented thinking and action," a way of thinking that "implies a critique of standard disciplinary divisions as it both confronts and transcends the limits of addressing real world problems from within the confines of traditional disciplinary methodologies" (10). Although the SLI actively encourages faculty to address the interplay of social, economic, and environmental systems, Welch was initially wary of overstepping her disciplinary bounds, particularly in a disciplinary class. However, as she encouraged students to envision solutions to sustainability problems, and as she interacted with faculty from other disciplines around sustainability, she became acutely

aware that focusing only on the natural sciences was trapping her students in simplistic and ineffective thinking. This thinking failed to grasp the complexity of sustainability problems and the importance of other disciplines' contributions. This experience deepened her appreciation for the need to engage across disciplines and fundamentally shifted her views about how and why to include sustainability content in her course. Dr. Welch came to believe that helping her students develop the motivation and skills to interact with other disciplines would enable them, as biologists, to navigate complex real-world problems more effectively. For example, she now aims for students to recognize that understanding climate change as an ecological problem – while important – is not enough to achieve solutions, without also considering the social and economic elements of the issue.

Two transdisciplinary activities that she has implemented in her biology course are a position paper and a sustainability panel. For the first activity, students are provided with several popular press readings exploring potential solutions to climate change from a variety of technological, political, economic, and social perspectives. Each student selects a few of these articles and writes a position paper, and there is a class discussion conducted on climate solutions. In addition to engaging with complexity, exploring various perspectives, and considering social, economic, and/or ethical dimensions, students gain experience conversing with peers who have different perspectives and, she hopes, find resonance for themselves in how to view climate change from a sustainability lens. The second activity was inspired by her SLI cohort experience. Colleagues from three other disciplines are invited to class to participate in a sustainability panel, with the discussion led by students, using questions they collaboratively generate for each guest's area of expertise. In addition to allowing students to interact directly with experts from other disciplines, this activity models transdisciplinary values of respect for other areas of expertise, dialogue among disciplines, and embracing complexity. In addition to helping students develop transdisciplinary competence, these activities also promote systems thinking and interpersonal skills, two other key competencies for sustainability education (Evans, 2019).

Dr. Welch's experience suggests that bringing together faculty across disciplines for sustained interactions around teaching sustainability can be an effective way to promote transdisciplinary competence among faculty and students. She feels that at CofC the SLI provided opportunities to build relationships with and learn from colleagues across a variety of disciplines, through training and workshops, reading groups, and the year-long cohort. However, this type of cross-disciplinary community building around sustainability could happen in other ways, for example via grass-roots interest groups or in coordination with existing campus-wide efforts that transcend disciplines (e.g., first-year experience and honors program, centers for teaching and learning). A transdisciplinary perspective can help faculty transcend narrow disciplinary expertise and can benefit students as emerging practitioners within their own discipline precisely because, for meaningful real-world impact, they will need to understand how to communicate across disciplines and approach problems from a transdisciplinary, systems perspective.

SLI Faculty Cohort Reflection #2, co-authored by Drs. Christy Kollath-Cattano and Dr. Katie Trejo Tello:

These faculty are in the Public Health Program housed in the Department of Health and Human Performance. They respectively taught 6 sections (3 each) of a sustainability-focused Global Health course during the 2020-2021 academic year, reaching a total of 154 students. This introductory course is a requirement for Public Health majors and an elective option for several additional majors/minors and is open to all students on campus. They felt that being part of a cohort of teacher-scholars committed to sustainability was beneficial to them as participants in terms of personal and professional growth and to the students enrolled in sustainability designated classes as their students also became embedded in this wider community. During cohort discussions they explored the concept of sustainability, both theoretically and methodologically, through the lens of different disciplines, which provided them the tools to illustrate these cross-disciplinary connections for their students. The monthly cohort meetings afforded the opportunity to share pedagogical resources and techniques, which often sparked innovative ideas on how to more effectively engage students in sustainability related issues and assess their knowledge of these competencies.

Overall, they found that the cohort facilitated engagement with sustainability inside and outside of the classroom through the creation of community. This is because they had the possibility to incorporate

additional voices into their courses through guest speakers, panel discussions, and video clips featuring other cohort members. Through these exchanges and through the 2020-2021 Climate Friday Talks[3] hosted by the SLI, students were able to see their professors and fellow students working to address sustainability in general and climate change in particular and learn how they could also become involved in advocating for solutions to climate change.

In terms of course transformation, as indicated by the United Nations Sustainable Development Goals, sustainability has already been a core concept within global health as almost all of the goals either directly or indirectly relate to health outcomes.[4] Furthermore, teaching global health also necessitates addressing climate change since it negatively impacts human health in a myriad of ways.[5] Therefore, while they did not have to adjust the content of their global health course considerably, they did refine their approach by deliberately and consistently emphasizing the triple bottom line and sustainability. To better integrate the impact of climate change throughout the course, they added focused readings (Hanefeld, et al, 2018) and video clips.[6] For assessment purposes they added one substantial climate change focused assignment which required students to watch and respond to the documentary *Before the Flood* (Stevens, 2016). Students had to analyze the film's key messages related to causal factors and potential solutions to climate change, discuss how they relate to global health concepts, and identify strategies for living more sustainably. Additionally, they modified an existing essay assignment and required students to identify a global health disparity and describe its causes in relation to the triple bottom line of sustainability.

Several practices allowed them to be effective in enhancing student engagement with sustainability competencies. First, they taught the same course, which represented a unique opportunity within the QEP/SLI year-long cohort and allowed them to "partner up." This let them collaborate on course planning, designing assignments and assessments, gathering curricular resources, and evaluating their teaching practices. While interdisciplinary faculty dialogue was a central and beneficial component of the experience, this partnership resulted in a richer experience for both faculty and the students, and they would recommend this strategy for others looking to incorporate sustainability competencies into their courses.

They also found it necessary to assume that students had not been exposed to sustainability competencies before. Relevant vocabulary and concepts, such as the triple bottom line, were introduced early and even appeared on the course syllabus. Finally, they found that modeling was critical to comprehension. Modeling, via focused discussion prompts based on short readings or videos that included relevant practice-based examples such as medical mission trips, guided textbook reading questions, and review of example assignments, enabled students to develop skills related to sustainability competencies.

SLI Faculty Cohort Reflection #3, Dr. Meta Van Sickle:

Dr. Van Sickle is a full professor in the Department of Teacher Education who for the last two academic years has included sustainability work in the Early Childhood Science Methods course that she teaches to future elementary school teachers. Teacher education programs have many accreditation requirements attached to coursework that must be measured/evaluated on a regular basis. In this course, the results are tallied each semester, aggregated by year and then the averages are summed with a resultant mean

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3 Every other Friday one to three CofC faculty members from across disciplines addressed climate change from their perspectives by giving a campus-wide talk for 40 minutes, followed by Q and A with students, staff, and faculty audience members.

4 United Nations. Sustainable Development: The 17 Goals. https://sdgs.un.org/goals. Accessed July 19, 2021.

5 World Health Organization. Climate Change and Health. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health.

6 Holder C. Cheryl Holder: The link between climate change, health, and poverty. Presented at TEDMED 2020. March 2-4, 2020: Boston, MA. https://www.ted.com/talks/cheryl_holder_the_link_between_climate_change_health_and_poverty?language=en Accessed September 1, 2020.

for the accreditation period which is typically five to seven years. Because of the numerous accreditation requirements adding one more to the set is always a challenge. Metaphorically, it is a practice that requires yoking disparate entities such as a fish with an orange and an elephant as finding the practice and content to match across the accrediting requirements is always a challenge. Of course, remember, this is a professional course and the ultimate purpose is to prepare the teacher education candidate for the classroom.

Teacher education accreditation standards typically do not address sustainability, so overlaps with sustainability education must be sought out and creatively addressed to center teaching about sustainability issues within the science methods courses. With a brief review of Evans's work (2019), it is clear that core competencies in sustainability can be matched or cross walked with core teaching practices. For example, sustainability is transdisciplinary in that it addresses complex issues and requires many inputs across content areas. The science education standards Dr. Van Sickle's students must address include the use of science, mathematics and English language arts, thus requiring the use of multiple content areas to address the transdisciplinary model of teaching. Because of the English language arts components of the science standards and the practices of science, interpersonal and communication competencies are addressed. Other core competencies of sustainability education such as systems thinking, critical and normative competency, and creative and strategic competency (Evans, 2019) would be left to the teacher to include in the lesson plan.

In her class, Dr. Van Sickle started with the practice of teaching in order to help her students better understand the relevance of sustainability to teacher education. One practice required is the development of a thorough, thoughtful and effective learning cycle plan that focuses on implementation of higher order thinking questions. First, a learning cycle lesson plan is designed to entice the students to want to learn or engage in the content followed by deep exploration (exploration and explanation) and then extended to illustrate application (extension) and completed with an evaluation. In the early childhood years the physical manipulation of materials is essential, as young children have not yet had the life experiences to "see" things in their minds or more technically, think abstractly. It is equally important to enhance the child's opportunity to speak and use their words. This means the teacher must also use the appropriate words in order to model them for their young students. In an extension activity the child uses prior knowledge to apply what they know and/or extend the ideas to the next level. Finally, the child completes an assessment that is a new problem using the same materials, actions and words. The lesson is successful if the child can complete the novel work.

A second aspect of this lesson plan that is equally important is the ability to ask the child higher order thinking questions that guide what they do and how they answer. As Dr. Van Sickle has written elsewhere,

> Conceptual thinking is required to do the sciences. The child must form big ideas about concepts and then link the concepts together to solve problems. This means the child must develop understanding beyond the remember and understand levels on the Revised Bloom's taxonomy. Concepts take time and experience to understand and sadly children are frequently denied these opportunities. When a teacher tells the child facts, she rarely understands the concept. The child may speak a dictionary perfect definition and not comprehend the meaning. The child must experience the concept and develop his/her own words and drawings of explanation. Once the words and drawings match the text definition then the science vocabulary development begins in earnest (Van Sickle, 2021, p. 134).

The use of the Revised Bloom's Taxonomy for questioning is a helpful guide to the novice teacher. The guide helps them identify and then write questions across the spectrum of forms of higher order thinking questions from remembering to evaluating. Since writing and asking these questions is not a natural process, she works to get students to first ask what and how questions at the various levels. Such questions help the child focus on the materials they are manipulating as they gain understanding. Such questioning assists the young child in thinking about the physical world and not a mythological world, so the focus then remains on the content to be learned.

The following are some examples one might ask a young child about change to help them focus on the tangible world, especially for example, when thinking about change over time: "How did you look when you were a baby?;" "How do you look now?;" "What changed?;" "How many years did the change take?" Then questions are asked about something from plant life, such as, "What did the trees or flowers look like in the spring?" "What did they look like in the fall?;" "What did they look like in the

winter?;" "How did they change?;" "Did the change happen all at one time or during a span of time?" Next Dr. Van Sickle works on the idea that change happens everywhere, with questions like, "What things do you see that change?" and "What places do you see change?" Then she changes to the idea that change can be random or predictable, asking, "In what ways does a tree change?;" "Which of the ways a tree changes are predictable?;" "Which are not predictable?;" and "How do you know?" Finally, Dr. Van Sickle moves to questions that will help young students understand that change can be man-made or natural. For this series of questions, she is likely to ask, "What are the ways I can get a room to change from dark to light?'" "What happens when I dig in the ground and plant flowers?" and "What happens in the garden if I don't dig out the weeds?" (Van Sickle, 2021, p. 135-136).

With practice, the future teacher can use these practices to develop a lesson plan with the following requirements that adds sustainability content. This allows undergraduates who are being taught how to pass teacher education accreditation tests, that often do not include sustainability, to still be exposed to sustainability literacy and competencies, which they can then bring into the elementary school classroom. For example, the following lesson plan from Dr. Van Sickle was created and assigned in her QEP classes to precisely require her students to foreground sustainability competencies (bold and italics and capitalization are all from the assignment):

3. Developing an Early Childhood Lesson Plan

The **CofC Sustainability Literacy Institute (SLI) wants every student to know that every activity that humans undertake, whether that's generating electrical power, growing food, or taking a trip, has three categories of costs associated with them: 1) SOCIAL costs, 2) ECONOMIC costs, and 3) ENVIRONMENTAL costs.** Once all the costs are subtracted from the accounting, what's left is the "bottom line". A *SUSTAINABLE* practice needs to consider the **"TRIPLE BOTTOM LINE**" of all three kinds of costs before a decision to move forward is made. For example, if a country or state decides to build a dam, there will be financial (economic) costs, but there will also be costs to anyone who is displaced by the dam and its future reservoir (a social cost) as well as costs to the ecosystems affected by that reservoir (an environmental cost).

You will use a lesson plan from *Weather Reporter*. You can choose any lesson plan starting on page 77 and continuing to the end of the unit. You will need to reformat the plan into a learning cycle or 5e's plan. You may use the questions that are already used in the booklet. Be sure to add questions to your plan so that you cover the categories of the costs, social, economic and environmental. I want you to earn all the points for the lesson plan!

Truly *sustainable* development projects begin by asking, "Are we going to do any harm to anyone or anything with this proposed project (in this case to our students)?"

Lesson Plan 3 for this course—incorporates CofC Sustainability Literacy Institute Student Learning Outcome # 4: *Students will synthesize knowledge from two or more systems—environmental, economic, and/or social to address a sustainability problem.*

Please note that in early childhood we work to differentiate weather and climate. The wording is highly intentional. (Note to reader: this ends the lesson plan assignment.)

The cohort experience introduced Dr. Van Sickle to many colleagues and their ideas. Because of the multiple disciplines represented among the cohort members, she was able to directly talk with "experts" in the fields of weather, climate, agriculture, botany, biology, and many others. This group of faculty members helped her do several things related to the above assignment as it was developed. First, it helped sharpen the way in which she communicated the content and at the same time developed ideas to illustrate the content. For example, one of the reasons for sea level rise is the temperature rise of the water. To help the non-science future teacher understand this, she and her students in the course designed a very small-scale model where her students had to get a large cooking pot and fill it about two-thirds full of water. They then had to mark the level of the water in the pot, heat the water, and watch what happened to the level of the water over time: with the heating of the water, they were able see it rise. They now had an exercise on sustainability they could do with elementary school students, focused on the science of climate change. A second feature that was helpful was the ability to invite cohort members to give lectures. This included two female colleagues in the natural sciences who visited the class and talked with her students. Because future teachers are predominantly female, they all reported

greater comfort talking with scientists who were women. Both features of the cohort model thus helped create better outcomes and practices for the class, and the key competencies of sustainability allowed Dr. Van Sickle to foreground systems thinking as a skill to bring into elementary education teaching to make such teaching relevant to sustainability literacy.

SLI Faculty Cohort Reflection #4, Marianne Verlinden:

Marianne Verlinden is a Senior Instructor in the Department of Hispanic Studies. This section shares her experience bringing sustainability literacy into her fall 2020 three-credit sustainability-focused course entitled *El cambio climático y su impacto en la salud humana en el mundo hispanohablante* (Climate Change and Its Impact on Human Health in the Spanish-Speaking World). This is a 6th semester Spanish course that was open to students who had declared a minor or major in Spanish in the Department of Hispanic Studies.

Key for her success in teaching sustainability competencies within the context of this course was the regular monthly meetings with faculty from the QEP Tier 2 Cohort. These meetings not only deepened her understanding of many topics related to climate change, they also opened her eyes to new perspectives on this complex (wicked) problem, and led her to explore academic and educational resources she would not have been aware of, some of which she even adapted for class use.

Instructor Verlinden felt that the way monthly discussions were conducted by the SLI Faculty Fellow, Jen Wright, and myself, modeled the interdisciplinary collaboration essential to address the challenges presented by the climate crisis. The interdisciplinary monthly meetings, trainings, and discussions encouraged her not only to reconsider some of her teaching practices, but also reflect on larger questions such as the urgent need for higher education to place among its top priorities equipping students with the knowledge, skills, and abilities to address global issues, and do so in a tangible and sustained manner.

The cohort experience helped transform her class from the more "traditional" *Spanish for the Healthcare Professions* that she teaches every year. This course typically focused on exploring the main medical conditions and mental health disorders affecting Hispanics in the U.S. In this class students would learn the basics about the functioning of the various systems of the human body and examine in depth one or two diseases for each, such as asthma (respiratory system) and obesity and diabetes (digestive system) so those can be explained to patients who are Spanish-language dominant. Students also explore some common cultural beliefs related to health held among various subgroups in the Spanish-speaking world. Although valuable in promoting the acquisition of medical terminology in Spanish and cultural competencies, this approach views the causes of many diseases and disorders and possible therapeutic interventions primarily in terms of personal choices, placing the responsibility on the individual patient to change behaviors to address the ailment.

Instead, the sustainability-focused version of the course looks at social, economic, and environmental conditions leading to health disparities in Latin American and Caribbean areas. This triple bottom line sustainability literacy focus enabled Instructor Verlinden to entirely redesign her course in a way that she felt was more relevant to students, and that allowed for them to critically examine sustainability issues they would not be exposed to in an upper-level course in her department. For example, her students examined how higher concentrations of carbon dioxide in the atmosphere not only contribute to climate change but also exacerbate asthma. Even obesity, seen through the lens of climate change, leads to an exploration of how changes in rainfall and severe weather events threaten food production and quality, risking worsening what is already an epidemic in Latin America and the Caribbean by pushing the poor to cope by consuming cheaper nutrient-poor but calorie-rich food. These are discussions that her time in the cohort equipped her to successfully lead, and she felt her course now prepares students to critically understand sustainability issues.

Systems competence and interpersonal and communication competence are two of the five sustainability field core competencies identified by Evans (2019) addressed primarily in the course. In terms of systems competence, students are repeatedly asked to articulate the interconnections and interdependencies between some unsustainable practices, climate change, and health adverse effects using the framework of the triple bottom line. They are prompted to consider how their individual actions, the practices in which some businesses such as the extractive industries and the energy sector engage, and some governmental policies exacerbate climate change and impact the health of people not only in the U.S., but also far beyond the borders of the U.S.

Interpersonal and communication competence as it relates to sustainability overlaps to a large extent with the goals of the course in terms of language and culture. Students are presented with assignments that help them communicate notions of sustainability to diverse audiences. For example, they are asked to report and reflect in writing on personal sustainability challenges related to reducing their carbon and water footprints, and the generation of waste, and to share orally with classmates three actions/ practices new to them that they are willing to adopt permanently. After identifying ways to be more sustainable on campus, guided step by step, through a pre-writing, first version and rewrite, they also each produce an individual letter to petition the Director of the Center for Sustainability to consider the recommendations they believe to be most likely to be embraced by the administration and peer students. Yet, because these tasks are accomplished in Spanish, it is crucial to be very intentional about scaffolding the activities to achieve language proficiency goals, which leads to a discussion of best practices.

Instructor Verlinden suggests that for those embedding sustainability literacy in language courses they should consider sequencing their material so students move from reading and/or listening or viewing a video about the topic to writing and speaking about it in conversations and a more formal presentational mode, thereby recycling language and content to approach greater mastery. To facilitate comprehension, she suggests supplying the cultural context they may be missing. She also suggests that those who want to infuse sustainability into language courses start their exploration of specific issues with the personal, then expand, and have students reflect on and share with each other what they have observed in the local community, the state, what they may have read at the national level, then present related issues in Spanish-speaking countries. For example, one can ask students to describe their water usage, explain how clean water contributes to maintaining health, research the source of the water they consume, and brainstorm ways to conserve water. Then, have students list issues related to water that they have observed in the community, and explain how climate change exacerbates some of these issues. Finally introduce the concept of virtual water and show learners how these issues are affecting select Spanish-speaking countries or regions and what, if anything, is done to tackle them. Lastly, and key for Instructor Verlinden, each time a new topic is introduced, instruct students to identify who are the most vulnerable populations to the often-devastating health consequences of climate change and who are contributing most to the problem, which leads naturally to a discussion of social-ecological equity and justice.

4. Analysis and Conclusion

One of the challenges of sustainability is that it can possibly have many definitions. CofC's efforts to embed sustainability literacy have been aided by the operational definition of sustainability and also sustainability literacy afforded by the QEP. The function of the QEP--to enhance student learning around an identified need, with SLOs catered to those needs--allowed for the operational definition of sustainability (based on the triple bottom line) and sustainability literacy (the knowledge and skills to advocate for resiliency in solving 21st century sustainability problems) to be utilized by all faculty involved with the QEP, regardless of discipline. This shared understanding of sustainability, coupled with shared SLOs, allowed for structured and focused professional development opportunities through the creation and funding of the SLI and its interactions with faculty. The SLI benefitted from early adopters who were passionate about developing new pedagogical skills and approaches to course content, and who were motivated to support the goals of the QEP. These early adopters trained with the QEP in years one to three, with many then joining the first year-long cohort. Those in this 2020-2021 cohort were eager to engage in sustained, critical discussions about how to better teach students to solve climate change and 21st century sustainability problems. This year-long cohort that utilized an internally created schema of shared SLOs and assessment rubric is a unique project in higher education.

CofC's QEP, housed within the SLI, presents a vibrant and visionary way to approach sustainability education in higher education. The project recognizes that faculty deserve compensation for their time to learn new content; benefitted from adequate resources (staffing, financial, visibility, support from chairs and deans, marketing); and fit into an accreditation project that carried with it institutional backing, heft, and immediacy. The challenges of sustainability education as articulated by those in the cohort are many of the same that have been present for years: sustainability requires faculty to branch out beyond their discipline; sustainability requires the mastering and teaching of new competencies; many faculty were

not trained in sustainability, or sustainability competencies (especially systems thinking), so must deal with imposter syndrome, thinking beyond their disciplinary silo, and trying to "justify" their efforts to colleagues who do not get the importance of sustainability; and to adequately teach sustainability requires a huge investment of time by a faculty member.

CofC's experience of a sustained cohort over one year, with that cohort exposed early to the triple bottom line concept of sustainability and the key competencies of sustainability, with subsequent trainings and discussions consistently circling back to those competencies, seems to be an effective way to support the teaching of sustainability in higher education across disciplines and to all levels of students. The ability to dialogue with faculty from other disciplines, learn about sustainability competencies together, share resources, and provide critical feedback on planned assignments and lectures in a nurturing space built over twelve months of engaged interactions, all while earning added pay compensation for the extra work, is a model that can be replicated by other institutions across higher education to help embed key sustainability competences across the curricula.

Author Bio

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Integrating Systems-thinking Concepts of Sustainability into Academic Courses through Information Literacy Training

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Abstract

The emergence of COVID-19 has brought the need for information literacy training into the spotlight. Problematic information regarding the pandemic has become a disease itself: an infodemic. By integrating concepts of sustainability into information literacy training, we can better understand how information is actively used in daily community lives. An Information Literacy course taught by librarians is a natural venue for tackling an infodemic, allowing students to investigate the pandemic's connection to concepts of sustainability through proactive and critical engagement with information. This chapter outlines the process followed at New Mexico State University in addressing the infodemic with the fall 2020 Information Literacy course. Using scaffolded assignments, course readings, and a focus on local to international information resources allows students to create a sustainability-minded understanding of and relationship to information and how it connects us with our environments.

Keywords: *information literacy, local to global, infodemic, fake news, misinformation, disinformation, libraries, information, systems-thinking*

1. Introduction

In mid-March of 2020, responding to the rapidly changing landscape of a new global pandemic, and in moments of great uncertainty, New Mexico State University (NMSU) issued a series of orders resulting in a scaffolded closure of campuses statewide and a flip to online learning. The library on the main campus in Las Cruces, New Mexico subsequently enacted closing procedures to protect the health and safety of the campus community and shifted to serving in a virtual format. This is not an unfamiliar story. Libraries around the world made similar swift changes for the protection and benefit of their employees and user groups during COVID-19.

The New Mexico State University Library offers a credit course taught by librarians on staff. Interested in seeing how COVID-19 could be addressed through course content, I volunteered to teach the fall semester Information Literacy course. I wanted to lead the students to directly tackle data and information emerging from various areas relating to the pandemic crisis, helping them to create a research strategy and way of interacting with information that was sustainable beyond their academic life, into their personal lives and careers after graduation.

The library's for-credit course on information literacy provides the perfect environment for interacting with and interrogating data related to COVID-19 from the perspective of a systems-thinking competence. According to Wiek, Withycombe, and Redman: "systems-thinking competence is the ability to collectively

analyze complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global)" (2011, p. 207). By crafting assignments focusing on local sources of COVID-19 data and information, students were able to see the direct connections between the skills they were learning in the class, and the local sources of data and information that surrounded them. Students also learned how to engage with those sources in a meaningful way that encourages long-term engagement in local public information, implementation in their own lives, creation of sustainable evaluation habits and a focus on active change.

2. Background

The New Mexico State University Library's Information Literacy course promises: "to give students the technological skills and critical thinking abilities needed to use the printed and electronic information resources found on the Information Highway. Includes how to locate, critically evaluate, and apply information for academic, professional, and personal purposes." (New Mexico State University, 2021). This focus on evaluating information across students' lives is critical to the systems-thinking competency and allows library faculty to infuse students with an understanding of information that is grounded in considering sustainability. Taught since 2006, this course serves as a fulfillment of NMSU's Viewing the Wider World program in which students scrutinize: "the importance of a carefully considered values system (…) to have a familiarity with the various branches of human understanding" (New Mexico State University, 2021). Information literacy is universally applicable, an excellent interdisciplinary course selection, and the course is championed by several departments across the NMSU campus as a highly useful and desirable accompaniment to their major courses.

The Information Literacy class focuses on the teaching of information literacy. According to the Association of College & Research Libraries (ACRL): "Information literacy is the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning" (2016). The ACRL Framework for Information Literacy in Higher Education, a core document in information literacy education in libraries, outlines six important concepts:

- Authority is Constructed and Contextual
- Information Creation as a Process
- Information Has Value
- Research as Inquiry
- Scholarship as Conversation
- Searching as Strategic Exploration (Association of College & Research Libraries, 2016)

Mastering these concepts of information literacy is an integral step towards helping students understand and develop a sustainable research life both in school and outside of it in their personal lives and as citizens of the world. These concepts fit well into the systems-thinking competence, requiring students to consider information wholly and within a larger context and scope.

As the six concepts show, tackling misinformation, disinformation, and fake news are an important part of information literacy and subsequently the Information Literacy course taught at NMSU. However, after seeing months of misinformation, disinformation, and fake news related to the COVID-19 pandemic, and problematic interactions with that information on various social media and in student academic work on the rise, it was important to address the pandemic specifically during the course.

Misinformation, disinformation, and fake news are often used in conversation without a clear idea of how each is defined. They do each have a separate definition. In Lazer, et al.'s 2018 article on the science of fake news, they explain the connection between these three terms, saying: "We define "fake news" as fabricated information that mimics news media content in form but not in organizational process or intent. (...) (which) overlaps with other information disorders, such as misinformation (false or misleading information) and disinformation (false information that is purposely spread to deceive people)" (p. 1094).

The plethora of published news and other circulating information on COVID-19 created a glut of readily available information of varying levels of reliability and currency. This excess of information has led to an infodemic surrounding COVID-19. According to Naeem and Bhatti, an infodemic is "an excessive amount of information concerning a problem such that the solution is made more difficult. The end result is that an anxious public finds it difficult to distinguish between evidence-based information and a broad

range of unreliable misinformation" (2020). Dashboards had popped up to track COVID cases; all looking quite different. News coverage was nearly constant, and experts of all sorts were chiming in with their opinions. My students were overwhelmed: how to make sense of the information our experts and leaders are giving us? Several assignments had students looking specifically for news articles relating to COVID-19 for in-class analysis. However, the majority of the assignments focused on two main areas for evaluation: COVID-19 data dashboards, and university communication relating to the pandemic on campus, including a study initiated by some of the faculty at the university. These were the practice arenas of the class's evaluation exercises, but subsequent class discussions and lectures took these evaluations a step further to connect directly to the way the students and their immediate friends and family were reacting to news of the virus, and how to make the best choices for ourselves and our families.

3. Implemented Activities

To connect students to the importance of the evaluation work they were doing and understand how the skills from the course could be applied in their own lives, I decided to start local and move to the global. This allowed them to engage with smaller bits of data and information first, before taking on something global and more intimidating and overwhelming. We had lengthy in-class discussions throughout these various activities where I asked students to reflect on the connections they were seeing between the local information and international information.

Throughout the semester, I implemented several different strategies and assignments to engage my students with information relating to COVID-19. We investigated the pandemic on national and international levels, as well as looked at the science and the side effects of our new pandemic life. It was also covered on a local basis, bringing students face-to-face with how the bigger picture was affecting their actual lives.

4. Lectures and Readings

COVID-19 was a main example in my classes and lectures over the course of the term. The course text for the semester, Daniel Levitin's *Weaponized Lies* (also published in previous and a new version under the title *A Field Guide to Lies*), is about being critical users of information, and the focus of each class session followed the chapters of the book, with the exception of days we diverted to other readings for other topics such as open access information and the Sci-Hub debate. Exercises in the class were paired with chapters from the Levitin text and other course readings. Some of these related readings included Tom Nichols' article "The Death of Expertise", a precursor to his 2017 book of the same title, and The Oatmeal's popular web comic on the backfire effect "You're not going to believe what I'm about to tell you".

5. Discussions

Discussions were held both in online discussion boards through our learning management system or via "in-person" Zoom class discussions. The discussion boards were graded using a rubric that prioritized depth of response and meaningful interaction with their peers, while the "in-person" discussions were counted towards their overall class participation grade. The first complex assignment relating to evaluating COVID-19 data that the students were given was a discussion board (Appendix A). This was assigned during a synchronous, off-Zoom class period in which the students did not have to be in our normal synchronous Zoom session but did have to complete the work within the time frame of the class. Students were asked to apply the most recent chapter they had read in Levitin's book ("Hijinks with Numbers") to various local COVID-19 dashboards in New Mexico and our neighbor down the highway, El Paso, Texas. Students then responded to classmates' posts by comparing their analysis to a national or international COVID-19 dashboard. This was perhaps the hardest assignment, as they were tasked with doing this analysis and replying in a very limited time.

In a debriefing class discussion at our next synchronous session on Zoom, students expressed how they did not feel as if their evaluations were good enough because they were so pressed for time. We then got to have a discussion about the nature of social media and online information and whether or not they normally took enough time to properly evaluate everything they were seeing. Students brainstormed ways they could hold themselves accountable for evaluating information they came across online in the future, and how to avoid sharing something they were uncertain about.

6. Group Work and Journals

Throughout the semester, students frequently worked in groups to develop the community that this particular class thrives on and tackle hard questions together. Throughout the term the students had journal assignments that they completed individually or in groups, asking them to think critically about or apply class readings in different contexts. These journals were graded on how in-depth the students went into the purpose of the particular journal, the more the students showed their skills the higher the score. There was a particular university town hall that was full of data, visualizations, and information relating to COVID-19, and outlined a study some faculty on campus were going to begin. Assigning the class to random groups, I asked them to create a single journal entry for each group answering questions about the NMSU COVID-19 dashboard that they had looked at previously, and about a specific section of the most recent town hall where the faculty members outlined the COVID study they would be initiating (Appendix B). The purpose of this journal was ultimately for them to create a set of questions they would need to pose to university administration in order to feel confident that the data and information they were seeing and hearing in the aforementioned university communications was accurate and reliable.

7. The Letter

To show how engaging with local information could have an impact, I wanted the students to engage with the NMSU administration's public communications regarding the pandemic and the university community. Specifically, their questions were so excellent that I wanted to submit them on behalf of the class. In one of our synchronous Zoom sessions, I allowed them to vote. If the majority agreed, I would send a letter to university administration leading the Town Halls on behalf of the class asking the questions they had created for their Town Hall journal assignment. In order to offer them some semblance of privacy, no identifying information would be attached to the questions; it is hard and scary to ask questions and be critical of people in power. I was hoping they would agree, but I wanted to make sure they felt safe. I was ecstatic when almost all of my students agreed to send some of their questions to university administration. I drafted a letter to university administration explaining where the questions were coming from and included at least one question from each group, sometimes several. I also shared this letter with the class. I heard back quickly from university administration that they would be answering some of the questions in the next town hall, and tuned in on that day to watch, student questions in hand, while university administration answered all but one of the questions my students had submitted.

8. Results

The results of the semester were positive overall. Students were genuinely pleased and proud that University Administration had responded to the letter and answered their questions. A handful of folks on campus who knew it was my class who had submitted questions emailed me to say that they thought it was the best, most detailed information they had gotten from university administration since the start of the pandemic. I passed that along to my students as well, which increased their feeling of accomplishment and connection with their university community. In addition, as students gained more practice completing assignments throughout the term, their analyses became more detailed and confident and higher quality. This was apparent as most students' discussion board posts and journals became more detailed and critical as the semester wore on and they honed their expertise in evaluating information. They also felt more comfortable having conversations with classmates on the discussion boards about whether or not information was reliable, and willingly offered judgements of what information was needed to fill the gaps they were encountering. Not long after that Town Hall meeting, the NMSU COVID-19 dashboard was updated, and the data was represented and communicated more effectively. Though there is no evidence that these changes had been made in relation to the students' questions alone, the students noticed, and it made them feel like their work in class had been impactful and beneficial for the New Mexico State University community. Students expressed excitement, pride, and showed an increased interest in how evaluating information could be useful in their lives.

The seriousness of the COVID-19 pandemic will not last forever. Already, we have learned more about how to fight it effectively, developing vaccines and strategies to combat the virus daily. However, the opportunity for information literacy education that current events like the COVID-19 pandemic provides is just one example of how teaching information literacy skills can launch students into a more meaningful

relationship with information and with research in their daily lives and in their communities. The strength of tackling information literacy through current events, particularly on a local to global scale, not only shows students the importance of the skill, but also shows them that quality evaluation and their ability to be voices of reason and change is within their abilities. Providing opportunities for students to engage with local and regional information allows students to see where their own power lies and how they can positively affect their own lives and communities.

9. Appendix A

Two-Part Discussion Post: Hijinks with Numbers

This assignment has 2 steps. The first involves the creation of your original post, the second is in responding to classmates. This discussion board closes at the end of class time, and you have until then to make your posts and replies. You must first post before you can see others' evaluations. This is going to be difficult, but *fun* and *important* because this is how our government and schools are presenting important data to their citizens. We're looking to them to understand how to manage our lives in the midst of this. Be brutal in your evaluations. Access to good information is your right.

It's very hard sometimes to look at data and visualizations and not get scared when it's something serious like this. Those fears are real and they are valid. Remember that we're looking at this as objectively as possible and with strict attention to the presentation of the data. If you feel yourself getting too emotional or anxious, feel free to pop over to the Zoom chat and talk to me. This is hard to talk and think about.

PART 1:

Using what you've learned in "Hijinks with Numbers" (feel free to bring in other Levitin chapters too, if you feel it's appropriate) take a look at the following data, briefly (2-4 sentences each) evaluate whether or not the data on each website is credible, then compare and contrast the websites that are grouped together (4-6 sentences for each pair):

Group 1:

NMSU's COVID-19 Dashboard (Links to an external site.)

University of Texas El Paso's COVID-19 Dashboard (Links to an external site.)

Group 2:

NM Department of Health COVID-19 Dashboard (Links to an external site.)

Texas Department of Health COVID-19 Dashboard (Links to an external site.)

Group 3:

El Paso COVID-19 Dashboard (Links to an external site.)

Las Cruces COVID-19 Dashboard (Links to an external site.)

PART 2:

Respond to at least 2 classmates. Answer the following questions in relation to their post:

1. Is there anything missing from their analyses?
2. Choose *one* of their Group analyses to focus on. Using their evaluation, look at one of the following websites, and compare the data (yes this will be hard, give it your best shot!):
    a. Center for Disease Control COVID-19 Dashboard (Links to an external site.)
    b. World Health Organization COVID-19 Dashboard (Links to an external site.)
    c. COVID-19 Dashboard by the Center for Systems Science and Engineering at Johns Hopkins University (Links to an external site.)

10. Appendix B

Journal 7 (in-class)

In class today we viewed the most recent NMSU Town Hall, specifically the portion outlining the study on COVID-19 that will be happening on campus. We also briefly looked at NMSU's new COVID-19 dashboard.

If your group needs to refer back to this: NMSU Town Hall (Links to an external site.). The discussion we watched in class takes place at timestamp: 1:08:10

Here is the link to: the new COVID-19 dashboard (Links to an external site.).

In your group, please take a look at these two sources and answer the following questions:

1. Is there anything here that confuses you? Why?
2. Relate back to Levitin. Do you see anything in the study or on the dashboard that raises an alarm bell in your head? What specifically from Levitin are you concerned you are seeing?
3. Relating to question #2, what exactly would you need to see to alleviate these concerns?
4. Take question #2 and #3 and rephrase them as a question. What questions do you need to ask to get these answers?

This chapter is dedicated to my Fall 2020 Information Literacy class, whose brilliance and perseverance through a global pandemic and its fallout led to the success of the course and the work detailed here.

Author Bio

Erin Renee Wahl is a white, straight, cisgender, able-bodied woman born and raised in a small farming community in the Midwest. At the me of wri ng, she has a as a mid-career librarian employed in a tenure-track posi on at an R2 research university in New Mexico, and a PhD student in Educa onal Leadership and Adminis that same university. As such, my perspec ve of my research is colored through the experiences and perspec ves my background brings to the table. Her research the intersec on of sustainability and libraries, library work environments, and interdisciplinary use of archives.

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Stop Telling People What to Do: Teaching Sustainability Through Cultural Learning

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Abstract

Students often come to sustainability courses with preconceived notions about what is or could be the ideal solution to the multiple sustainability challenges we face. Because most of our students are from the US, their proposed solutions are often rooted in Western science, positivism, Christian worldviews, and white cultural perspectives. Many students draw on these perspectives and uncritically apply them to other places and peoples (e.g., telling Indigenous peoples to go vegan to save the planet). Without cultural humility and competency, students are not prepared to effectively learn from, listen to, and collaborate with people with backgrounds different from their own in their future careers. Here we discuss two courses --"Judaism, Justice, and Food" and "Culture, Power, Environment" -- and how we use people's lived experiences and first-person accounts to help students understand other perspectives. In addition, we include in our course learning outcomes that students will learn how to apply a cultural lens, whether Jewish texts and traditions or traditional or local environmental knowledge, to a contemporary problem and use that lens to propose culturally appropriate solutions. The result is students who are culturally competent and ready to engage in collaborative sustainability work in summer internships, senior theses, and after graduation.

Keywords: *American Judaism; collaborative learning; diversity; food studies; local knowledge; historically underserved communuties; pedagogy; storytelling; sustainability education*

1. Introduction

The past two decades have seen a rapid increase in the number of sustainability degree programs and courses. These academic programs typically bridge the natural and social sciences, and aim to foster an understanding of interlocking environmental, economic, and social systems (O'Byrne et al., 2015). Such programs should integrate "wider questions of social needs and welfare, and economic opportunity" because these are inherently connected with the environment (Agyeman et al., 2002, pg. 3). However, a review of their curricula found that natural science courses are overrepresented, and humanities courses severely underrepresented in the core curriculum of sustainability bachelor's programs (O'Byrne et al., 2015). This overrepresentation leads to the portrayal of sustainability as an objective concept, one which exists outside of the perspectives, values, and biases of individual scientists and practitioners, rather than as the normative concept that it is. Sustainability is value-laden, particularly when it comes to decisions made in response to a wicked problem or efforts to build a more sustainable society. Courses drawing on the social sciences and humanities allow students to gain an understanding of moral and ethical debates, other cultures and societies, and alternative ways of viewing the world.

Students taking sustainability courses and interested in sustainability careers are motivated by their passion for the environment, and their desire to help solve the social, cultural, political, and ecological challenges to a more sustainable world. Early classes take advantage of this, utilizing problem-based learning and collaborative assignments and projects to help engage in environmental problem-solving. While students come to realize there are no simple or easy solutions to these "wicked" problems, the solutions they develop or support derive primarily from their own context and experiences (in the United States, mostly white, Christian, Western experiences). This is further compounded by the faculty, who themselves overwhelmingly are and teach from white, Christian, Western and/or Eurocentric perspectives. When combined with the typical approach to teaching sustainability, there is a severe risk of perpetuating the notion that there is only one right way to solve a sustainability problem (e.g., the technoscientific one).

Two of the Education for Sustainable Development Competencies developed by Lozano et al. (2017) illustrate the necessity of incorporating diverse perspectives into sustainability education: "justice, responsibility, and ethics" and "interpersonal relations and collaboration." The "justice, responsibility and ethics" competency requires the "application of concepts of ethics, justice, and social and ecological integrity, and equity" (Lozano et al., 2017). When combined with another competency, "systems thinking," students are able to assess large-scale problems as systemic failures, and consider solutions based in justice and equity. In order to determine which solutions are just and equitable, attention to the "interpersonal relations and collaboration" competency is essential. Students cannot propose just and equitable solutions if they have not been introduced to diverse perspectives that enable them to learn, empathize, and collaborate with people who have different backgrounds than them (Lozano et al., 2017). More recent work by Brundiers et al. (2021) extends this by combining what experts say to update the values-thinking, interpersonal, futures-thinking, and strategic-thinking competencies which had previously been developed.

The just sustainabilities framework developed by Agyeman et al. (2002) similarly points to the importance of considering multiple perspectives and ways of life. They define a 'just' sustainability as "the need to ensure a better quality of life for all, now, and into the future, in a just and equitable manner, while living within the limits of supporting ecosystems" (pg. 2). In using the plural 'sustainabilities' rather than the singular 'sustainability,' they acknowledge that, prescriptions for sustainability cannot and should not be universalized because they are bound to culture and place (Agyeman, 2013).

There are clear limits to Western, Christian, and white perspectives because they fail to take into consideration the ways in which diverse people (Black, Brown, Indigenous, and Melanated Peoples) from myriad religious traditions (Buddhism, Judaism, Islam, Sikhism, etc.) view and live in the world, the environmental challenges they face, and the solutions to these challenges which can be developed in alignment with their worldviews. Without cultural humility and competency, students are ill-prepared for the real world of sustainability work where they will need to work with diverse groups and in a multitude of locations to solve complex sustainability challenges. Elsewhere, Byrnes and Davis (2021) argue that a critical understanding of race and its effects on the environmental sciences must be taught beginning at the introductory level. Here we provide practical strategies for using cultural learning in the upper-division undergraduate sustainability classroom.

2. Our Context

We (Adrienne and Brittany) describe our experiences teaching two different upper-division undergraduate sustainability courses at Allegheny College, a predominantly white liberal arts college of approximately 1600 students in rural northwestern Pennsylvania. According to Allegheny College Data, in 2020 the student population was 68.8% white, 8.9% Black or African American, 8.9% Hispanic/Latino, 3.8% Asian, and 4.1% two or more races (Allegheny College, 2020). We describe our own pedagogical approaches to demonstrate the applicability of the "justice, responsibility, and ethics" and "interpersonal relations and collaboration" competencies in predominantly white classrooms (Lozano et al., 2017). We also acknowledge our own positionality. Adrienne is a cis, able-bodied white Jewish woman from the Northeast. Brittany is a cis, able-bodied Black woman from the US South. Our identities and experiences inform our worldviews and our teaching, calling us to bring oft-neglected voices and perspectives into our sustainability classrooms in different ways, as the examples below illustrate.

As Smith and Tuck (2016) explain in their article "Decentering Whiteness," class texts and media are some of the more sustained encounters with the perspectives of peoples of color for white students (p. 23). Smith and Tuck (2016) argue that including diverse voices in a syllabus "help(s) to disabuse students of the idea that social justice and equity pedagogy are issues that are relevant only for people of color." We both include diverse voices in our syllabi to increase encounters with diverse perspectives for all of our students and to cultivate competency in "interpersonal relations and collaboration" (Lozano et al., 2017). We also incorporate other pedagogical approaches that center "alternative interpretive frameworks" as valuable resources for solving complex environmental problems (Smith & Tuck, 2016, p. 26). In doing so, we emphasize that "stories and how they are told matter" (Sze, 2020, pg. 68) as they help bring marginalized voices to the center. The following two sections describe how we do this in detail, to illustrate for the reader the possibilities for competency in areas including ethics, cultural and social responsibility, and justice (similar to Lozano et al., 2017), as well as competency in values-thinking, strategic-thinking, and futures-thinking (Brundiers et al., 2021), which unfold when Western, Christian, and white perspectives are at the margins, rather than the center, of the course.

3. Part 1: Food Justice through a Jewish Lens

3.1 Introduction

"Judaism, Justice, and Food" is an upper-level course that is cross-listed as an Environmental Science and Sustainability and Religious Studies course at Allegheny College. The course is offered annually, and the class enrollment is twenty to twenty-five students. Most of the students each semester are juniors and seniors and usually around 20% of the class is made up of Jewish students, though the Jewish backgrounds of those students vary widely. For the Jewish and non-Jewish students, this class is an opportunity for them to build competency in "interpersonal relations and collaboration" as they engage a cultural tradition, Judaism, that offers a different perspective than the majority Christian culture that informs much of the way we as Americans think about contemporary problems like food justice (Lozano et al., 2017). I (Adrienne) use a combination of three pedagogical tools to help students think about food justice from a Jewish perspective: they read Jewish texts, learn using Jewish educational methods, and work within Jewish systems to solve complex problems and develop competency in "justice, responsibility, and ethics" (Lozano et al., 2017).

3.2 Jewish Texts

In the "Judaism, Justice, and Food" course, students read about food justice in thematic modules like food and animals, food and labor, or food and gender. Their assigned readings represent a wide variety of perspectives including academics, journalists, activists, writers, and farmers. More than half of the assigned authors and creators are writing as Jews, and they engage Jewish texts, traditions, and ideas in their work. Jewish texts are paired with non-Jewish texts throughout the semester to provide students with background information on food justice issues and help them think through the issue from a Jewish perspective.

In the module on food waste, students read the Natural Resources Defense Council (NRDC) report "Wasted: How America is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill" by Dana Gunders (2017) alongside the conclusion of Tanhum Yoreh's (2019) book, *Waste Not: A Jewish Environmental Ethic*. The NRDC report offers clear data on food waste in all areas of the United States food system and the Yoreh chapter considers the historical interpretation and contemporary relevance of the Jewish concept of *Bal Tashhit*, which is the Biblical prohibition against wastefulness and destruction. Using these texts together, students consider how Jewish communities might think about and prevent food waste based on their own texts and traditions. These paired readings help students think about problems through different perspectives and encourage them to think more broadly about where they might find answers to similar problems in the future.

3.2 Jewish Learning

Students in "Judaism, Justice, and Food" work through these texts in collaboration. This is a variation of "inter-disciplinary team teaching," a pedagogical approach discussed by Lozano et al. (2017). The difference is that instead of professors team teaching the course, students take on some of the teaching

themselves and bring their own interdisciplinary and diverse perspectives to the course materials. This is a valued approach in Education for Sustainable Development (Lozano et al., 2017), but it is also an approach that has been central to Jewish education for almost two thousand years. In Jewish communities *chavruta*, which is translated as friend or fellowship, is the traditional rabbinic method for studying Torah and Talmud. The *chavruta* model centers discussion and debate, which are understood to be fundamental aspects of Jewish learning.

During each course module, a group of two or three students are assigned as discussion leaders. This group of students work together in *chavruta* to prepare to team-teach a class session wherein they introduce the authors and their positionality, highlight key points from the readings, and ask questions meant to spark discussion and debate in the class. Students often put the two readings in conversation with each other, but they also bring in their own perspectives based on their own backgrounds and other courses they have taken. In past iterations of this course, students have shared descriptions of Hungarian food traditions, insight from raising pigs in 4H, and lessons learned from working in restaurants. As students work in *chavruta* to team-teach a session of our course, they learn to consider the diverse perspectives of experts on food justice issues alongside the experiences of their peers. A student noted the value of this method in their evaluation of the course in Spring 2021: "The discussions helped me learn the most, especially on days when students led the group because it brought in new perspectives and helped me understand the readings in a better way."

3.4 Jewish Systems

In the early weeks of the semester, students become familiar with the intricacies of the kosher system. We also spend a class session talking about *hechshers*, certifications that are granted to kosher foods by trained kosher supervisors or *mashgichim*. This prepares students for the final project, which asks students to create a *hechsher* of their own to address one injustice in the food system. This assignment, called the Just Kosher Project, asks individual students to create justice-focused certifications, which requires an understanding of the detail oriented kosher certification process, a contemporary food justice issue, and the Jewish perspective on that issue in enough depth to suggest a change to the system.

The Just Kosher assignment has four parts. First, they write a persuasive essay using class materials and outside sources to describe their *hechsher* and the injustice(s) it will address to an audience of rabbis. The second part of the assignment is to write a set of guidelines for their certification process that details what producers would have to do to earn a certification. The third part of the assignment requires students to write two short press releases for their *hechsher* - one for producers to convince them to pursue this certification and one for consumers to persuade them to seek out products with this certification. The final part of the assignment is to design the *hechsher* itself as it would appear on certified products. Through these four parts of the assignment, students work within the Jewish system of food certification and prepare arguments about the urgency of a food justice issue for varied audiences. As they work within the food system of a marginalized community, they learn that there are myriad ways to solve contemporary problems and that working with communities to develop solutions that work for them is a viable and justice-centered approach, which moves them towards competency in "justice, responsibility, and ethics" (Lozano et al., 2017).

4. Part 2: Valuing All Knowledges

In reviewing the overall departmental curriculum in Environmental Science and Sustainability, a gap in coverage of non-Western knowledge became apparent. To partially ameliorate this, Brittany developed a new upper-level course: "Culture, Power, and Environment," listed in the Department of Environmental Science and Sustainability and counted as an elective by the Black Studies and Women, Gender, and Sexuality Studies Programs at Allegheny College. The course explores the ways in which people across the Americas understand, use, control, and manage natural resources. Fundamental to this is helping students develop their ability to see human environments in terms of the biophysical processes which shape and sustain them, and physical environments in terms of the social, political, economic, and legal practices that determine their material form. These perspectives help students understand how unjust environments are developed and maintained, as well as how to disrupt the current status quo. One of the challenges in teaching this course is that often students enter the course with preconceived notions about objectivity

and scientific expertise, which cause them to devalue knowledges, methodologies, and practices which do not align with the (Western) science they have been taught throughout high school and college.

4.1. Community Voices & Expertise

Early in the semester, students are introduced to the concepts of local environmental knowledge (LEK) and traditional ecological knowledge (TEK) through the work of Indigenous scholars and scholars from the Global South. They frequently ask, "How can we know that TEK holders are right if scientists don't go in and verify what they say?" This question, one which many scientists also ask, raises questions about knowledge production and scientific expertise which in turn lead to robust class discussions about whose knowledge we value and why. As instructor and facilitator, this provides an opportunity to pose epistemological questions about objectivity in science, methodological questions about how we conduct research and who we listen to, and sociological questions about who students view as a scientist/expert and why. These course dialogues are crucial for the development of the "values-thinking competency" (Brundiers et al., 2021) because they learn to think critically about what scientists value and how this affects research and praxis.

The early course readings encourage students to explore these dynamics. For example, reading Calheiros et al. (2000) shows students how local knowledge can be used to conduct ecological research and the ways in which it can exceed scientific understanding, particularly when the scientists are outsiders to the area they are studying. This reading can be unsettling for students, as they do not expect the scientists to conclude that the local knowledge in the region is greater than that of the scientific community. This then leads to discussions about the costs of doing research, particularly in distant or remote communities, and about engaging the local community in environmental decision-making and management. Through this, students develop a deeper understanding of how scientific knowledge and expertise are constructed and begin to question the value of Western researchers traveling around the globe to conduct research into what local communities already know, practices which negatively impact both global climate change and the value of local communities and their knowledge. Engaging with this invites students to consider the ethics and social responsibility of widely accepted research practices, raising their competency in these domains as Lozano et al. (2017) calls for.

4.2 Learning from Others

Students work together in pairs and groups of varying sizes to discuss and thus more deeply understand the material. They also complete two projects. The first course project focuses on deeper engagement with either TEK or LEK with students having two options. Option 1 is to examine diverse strategies for developing and utilizing social and political power rooted in TEK or LEK and how these types of power influence environmental governance of primary natural resources. Students wrote papers where they engaged with questions about the cultural, ecological, and political factors affecting natural resources and how people's experiences, identities, and knowledge shape their use of and decisions about these resources in locations around the world. The second option is to develop a proposal for an ethnographic research project which incorporates TEK or LEK to address an environmental problem. As part of their project design, students must identify who the knowledge-experts around their chosen environmental problem are, and how they could collaborate with them if they were asked to carry out this research project.

To help prepare students for these discussions and projects, we start each class with the same assignment: EK (Environmental Knowledge) in the News. Each student selects a day on which they will share a recent news piece (e.g., article, video, social media post) related to diverse forms of environmental knowledge. They summarize their news piece and provide their own interpretation of it, including connections to the course content and discussions. These brief presentations raise collective awareness of current environmental issues affecting local and Indigenous communities around the globe and community responses. They also introduce students to potential topics for future class projects. Moreover, the EK in the News assignment helps students more deeply understand what we mean when we say that the stories and challenges facing some communities go untold. Thinking more deeply about these stories and how they might collaborate with those communities helps students develop what Lozano et al. (2017) describes as the "interpersonal relations and collaboration" competency and the interpersonal and values-thinking competencies as refined by Brundiers et al. (2021).

4.3 Telling Their Story

The course draws heavily on readings, podcasts, and documentaries, using these to highlight Black, Indigenous, and Latine scholars, activists, and communities. The aim is to help students develop their ability to listen, understand, and learn from those whose perspectives differ from their own. These also help foreground the importance of storytelling. Students learn to think about how stories are told, whose stories are heard or receive attention, and how we share knowledge through stories, helping them come to see storytelling as "a deeply political act" which "involves both the telling and the act of listening" (Sze, 2020, pg. 68). Showing students what happens when we bring marginalized voices to the center, rather than leaving them on the outside of our scientific practices helps them develop the interpersonal competency which, as described by Brundiers et al. (2021), requires being able "to empathically work with collaborators' and citizens' different ways of knowing and communication" (22). The final assignment gives students the opportunity to tell their story in their own way.

For their final course project, students write an environmental autobiography of about 2000 words and share an excerpt of their work with the class orally. Drawing on an assignment originally developed by Dr. Laurel Kearns at Drew University (see Alexander et al., 2021 for a more detailed description of the assignment), the final paper shifts the focus of the course from examples and case studies to the students themselves. The assignment prompt asks students to explore how a variety of influences have shaped their attitudes toward the environment, to better understand their ecological self, to recognize specific messages about values and behavior which they carry in their orientation toward nature and the environment, and to recognize the connections (and disconnections) between their attitudes, beliefs and values and their actions and behavior toward the "more-than human world." Ending the course with this assignment allows students to more deeply understand themselves and what they are bringing to their sustainability work by telling their story. This helps them understand their responsibility and role more thoroughly. As they reflect and refine their own thinking and the role they might play, they develop two of the five key competencies in sustainability higher education according to Brundiers et al (2021): 1) the strategic-thinking competency (through recognition of the roots of the environments they have experienced), and 2) the futures-thinking competency (by gaining practice iterating and refining their own views and reflecting on the role they might play).

For their final assignment, students complete a course reflection where they discuss what they have learned in the course, what has changed for them, and how they'll carry forward what they have learned into their future courses and work. Reading these reflections makes apparent the impact of the course. Students write about questioning scientific practices and expertise, how they will take other perspectives into consideration, and of the mistakes in their own past views. The reflections allow students to explain how they internalized what they have learned throughout the semester while also showing them how their perspective and views will continue to evolve throughout their lives, a crucial component of the "futures-thinking competency" (Brundiers et al., 2021).

5. Conclusion

In approaching our courses in these ways, we aim to have our students leave with deeper understanding (and hopefully appreciation) of other cultures, perspectives, and values. In "Judaism, Justice, and Food," students engage Jewish and non-Jewish texts, collaborate to team teach and foster discussion and debate to further public education on Judaism, and to think within a Jewish system to address a contemporary food justice issue. In "Culture, Power, and Environment," students learn about how local and traditional environmental knowledge systems affect resource management practices, think through alternative ways to conduct research, and develop their ability to listen, understand, and value other perspectives on the environment. Students in both courses learn to seek out diverse perspectives, work with others and learn alongside them, and consider solutions that work within, rather than against, cultural systems. All of this prepares students to do the same in future sustainability work because they have developed the necessary competencies, particularly ethics, justice, and social and cultural responsibility (Lozano et al, 2017) and the ability to apply these through strategic, futures-oriented, and integrated problem-solving approaches (Brundiers et al., 2021).

The pedagogical approaches used in our classrooms at Allegheny College are also broadly applicable at other institutions (Brittany has since used them while teaching undergraduates at two other institutions), but in the model of our argument here, we believe instructors should utilize their own perspectives and experiences to build their syllabi. In other words, we are not here to tell people what to do. That said, we hope the assignments and frameworks we discussed here will inspire others to revise their syllabi and assignments to better engage with diverse perspectives. One starting point can be King and Casanova's (2021) recent chapter which offers a detailed overview of pedagogical principles that can be used to transform education on sustainability, racial equity, and social justice by raising critical consciousness. After taking these courses and others like them, students are also better prepared to engage with the diverse, multicultural world in which sustainability challenges occur. Through these courses, Environmental Science and Sustainability graduates are no longer entering the workforce believing that their ideas/values should be centered in their work, and they are better able to listen to and learn from the communities they work with and in. In other words, they are well prepared to stop telling people what to do and instead collaborate with others to foster just, sustainable solutions that engage and work for the diverse communities that need them.

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Seven Ways to Make Change – Framing the Work of Systemic Change Beyond Personal Choices

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Abstract

Co-curricular project-based learning is a valuable and effective pedagogical strategy for sustainability education. Students are drawn to sustainability work because of a desire to create positive change in their communities. A framework for understanding basic strategies for change-making is helpful to guide students to be more effective in their work. Students need to be aware of the full landscape of possible change-making efforts, their purpose, and how they related to one another. Without at least a foundational understanding of what can be done to create change, students can be left feeling directionless and even hopeless in the face of the immense environmental and social challenges facing our world.

Keywords: *Environmental, personal ethical action, position of power, change, systemic change, students*

1. Introduction

Throughout sustainability education, project-based learning has been accepted as a common and highly effective pedagogical approach. This approach can be refined further by distinguishing between in-class or organization/community-based learning (Evans, 2019; Lozano et al., 2017; Weik et al., 2014). At Fort Lewis College, a public liberal arts institution in Durango, Colorado, the Environmental Center (the EC) fulfils the role of an extra- and co-curricular project-based sustainability learning center within the Division of Student Engagement. Approximately 3,500 students attend Fort Lewis College: 97% are undergraduates, about 30% are first generation college students, 57% are students of color, and 42% of all students are Native American or Alaska Native[1]. The mission of the EC is to strengthen students' commitment to creating a more environmentally and socially responsible world by providing them meaningful opportunities to foster change on campus and in our community. Students gain practical experience as change-agents through their work by brainstorming, planning, implementing, maintaining, evaluating, and improving dozens of projects, programs, and campaigns.

During my time overseeing the EC, I developed a framework to help students better contextualize their work within the broader sustainability movement. Early on, I began categorizing the types of projects and efforts I was seeing students pursue in their work at the EC. I continued to refine this framework based on my ongoing professional experience and observations of other institutions' efforts, primarily

1 https://www.fortlewis.edu/about-flc/fast-facts

via conferences, webinars, and online forums hosted by the Association for the Advancement of Sustainability in Higher Education (AASHE). My approach to creating this framework is representative of my role as a sustainability staff member and not academic faculty – I developed this teaching tool primarily through my experience working with students rather than through literature review.

A framework for categorizing the common roles of change agents is helpful because sustainability work is, by its very nature, interdisciplinary, systems-oriented, and complex (Lozano et al. 2017, Rieckmann, 2012). Students who are engaged in efforts to create change need to be aware of the full landscape of possible change-making efforts, their purpose, and how they related to one another. Without at least a foundational understanding of what can be done to create positive change, students can be left feeling directionless and even hopeless in the face of the immense environmental and social challenges facing our world. I vividly recall a moment at a large climate change symposium on campus when a student asked a prominent climate scientist, "What can we do to fight climate change?" The speaker's answer: a list of ways to reduce one's own personal energy use, culminating in the advice to dry clothes on a clothesline instead of in a dryer. This answer wasn't wrong per se, but it was pretty clear that the student was hoping for something more substantial. After an entire event showcasing what a big deal global warming is, this response just felt so insignificant by comparison.

Big, complex problems must be met with a host of big, complex solutions. We know that there is no sliver-bullet solution to any of the major environmental and social issues we face. So, our students must be motivated to be a part of a multi-leveled, multi-pronged movements for change.

2. Distinguishing Personal Ethical Actions

The lifestyle choices we make as we navigate our daily routine are what I refer to as personal ethical actions: our purchasing decisions, how we commute, the food we choose to eat, managing our waste with a "refuse-reduce-reuse-recycle" mindset, reducing energy and water consumption in our homes, family planning, etc. Blogs and social media posts for "how to be sustainable" consistently cover these actions. Indeed, the aforementioned advice to dry clothes on a clothesline is a personal ethical action. These are important starting places for conceptualizing the fact that our personal choices and actions have environmental and social consequences. However, I intentionally present personal ethical actions to students as being separate from the main framework of change-making work. The seven categories within the framework are all focused on work that changes some aspect of a larger system, while personal ethical actions are focused on making the "best" choice with the current options provided by the system. Indeed, this distinction between personal choices and systemic change is the central focus of the popular environmental short documentary, *Forget Shorter Showers*, (Brown, dir., 2015), adapted from Derrick Jenson's essay by the same title[2]. Still, before proceeding to the main framework, a quick review of personal ethical actions is warranted.

The primary paradox with personal ethical actions lies in their scope of impact. In almost any case, if one person were to engage in a certain behavior (or not), the effect on the system at large is negligible. At the same time, the collective impact of combined individual actions can be enormous. If one person decides to bike to work instead of drive, there would be essentially no observable difference in automobile congestion or pollution. But if nearly everyone in a community were to bike, the place would be radically transformed in numerous ways. These kinds of actions seem to not matter when considered individually, but matter quite a bit when considered as part of a collective. Furthermore, the complexity of personal ethical actions can make it difficult to compare all the potential trade-offs of one choice over another, especially for someone who has only a basic knowledge of a certain environmental or social topic. Even a well-known topic like using a certain type of grocery bag does not have an immediately obvious answer for which choice is the most environmentally friendly (Cho, 2020).

The reasoning gets a bit circular. When it comes to social or environmental change, the goal is to re-shape how our societies function. However, a functioning society is not a single thing, but rather comprised of countless actions performed by individuals. So, systemic change occurs when everyone

2 Jenson, D. (2009, July 7) Forget Shorter Showers: Why personal change does not equal political change. Orion. https://orionmagazine.org/article/forget-shorter-showers/

performs certain actions instead of others. Yet, simply changing one's own individual behavior will not lead to systemic change.

Conversations with students around this topic are an excellent introduction into the concept of collective action problems (Dowding, 2013), and I typically try to steer the conversation back to two key points: First, the choices we make reflect our personal ethics, and we must practice what we preach in order to avoid hypocrisy. Second, we can take part in these individual actions while also engaging in work that can lead to systemic change. Understanding ways that an individual can contribute to larger systemic change is the purpose of the following framework as a teaching tool.

3. A Framework for Affecting Change

The framework is presented to students as an ordered list of seven categories. The order is not meant to be sequential nor meant to emphasize one category of work over another; each category of work fills a necessary role in the overall landscape of change-making. However, the order does represent the categories' relationship to affecting systemic power structures, with the latter categories arguably having more deep-rooted effects. In many ways, though, the latter categories of work would not be possible without progress made in the earlier categories. Change-making is an iterative process, with efforts in one category constantly informing and affecting efforts in another.

The framework is also designed so that it can be applied to any topic area (food systems, waste management, climate change, social justice, etc.) and at any scale (campus-specific projects to national programs). The three-word titles for each category are purposefully crafted to make the list more relatable and memorable for students. The overall purpose is to provide a set of simple, easily understood, foundational categories which encompass the most common types of change-making work. With this guidance, students can orient their current and future efforts as change agents.

1 – Gain Deeper Insights. This category of work involves performing research, investigation, and monitoring that provides data and insight to inform other work and decision making – work such as performing audits on campus building systems (waste, energy, water, etc.); surveying peoples' behavior or preferences; investigating previous case studies or seeking direct advice on a potential new project; or evaluating the impact of a certain effort.

Research is, of course, a cornerstone of academia. As such, this category of work is something that students are likely to be exposed to while in school, developing the skills and experience needed to perform quality research. When it comes to the impact that research can have on systemic change, all types of research have purpose and value, and the findings have the potential to change the world in a myriad of ways. That said, in my experience students who are interested in creating social and environmental change are most interested in applied research which addresses a specific, tangible problem and helps inform effective action.

For the purposes of sustainability education, the opportunity to utilize campus or community as a living lab is evident – any campus or surrounding community has abundant opportunity for research. The challenges lie in curating the list of potential research questions, ensuring quality research, and effectively sharing and archiving the results. The strategies for addressing these issues will depend on the size, resources, and expertise of the entity overseeing the research. Additionally, the scope and complexity of such research must be matched to the students' ability level. One of the more practical approaches is to align student research opportunities with a campus or community sustainability management plan and/or a sustainability assessment framework.

It is important to acknowledge that research on its own does not lead to change. Its purpose is to help every category of work (including additional research) to be more informed and effective. In that regard, it is crucial that researchers understand how to effectively communicate their findings to a variety of audiences. At the same time, change-agents must take time to investigate any research that has already done in their field to avoid unnecessary duplication, or to properly work to replicate (or contradict) prior results.

2 – Actualize the Service. This category of work involves managing an operational effort that provides a service that is more sustainable than the conventional alternative (or more sustainable than doing nothing) – work such as running campus move-out donations and collection; running a garden or farm that utilizes sustainable growing practices; or providing ecosystem restoration service work.

Consider one of the traditional Brundtland definitions of sustainability, "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Meeting peoples' needs involves a vast, interconnected system of people providing various services to other people. Sustainability education provides the opportunity to analyze aspects of social systems to see how they align with accepted definitions of sustainability, even as those definitions are continually scrutinized and refined (Vos, 2007, p. 335). These criteria can be used to determine if there is a more sustainable way of doing things compared to the current, conventional approach (a perfect example of the importance of "gaining deeper insights"). Even with a strong understanding of what a more sustainable approach may look like, that new approach still must be put into practice.

Progress in this category assumes a person or entity has the resources and autonomy to carry out this work. If not, then some of the later categories on this list – those which push on power structures – may be necessary. The work of "actualizing the service" can draw upon existing information in areas such as entrepreneurism, management, or even simple how-to guides. The typical thought process for implementation follows three simple questions:

1) What fundamental social service is being provided?
2) Is there a more sustainable way to provide this service, based on accepted tenants of sustainability?
3) What would it take (resources and management) to provide this service as envisioned?

This category of work may seem broad and perhaps uninspiring. However, it is critical for students to explore what it takes to actualize various sustainable services and operations. They must also be inspired to recognize this work is indeed contributing to systemic change. It is one thing for students to say "we need more composting," or "we need more renewable energy," or "we need more local organic food," but only a student who has actually experienced what it takes to run a compost system, or install solar panels, or grow organic food and bring it to market will understand the challenges and complexities of that work.

3 – Design through Innovation. This category of work involves the design, development, and/or deployment of a new or improved technology that is more sustainable than the conventional alternative – work such as deploying an e-bike share; contributing to the development of bio-based materials; or hosting a student-led hackathon to create a new breakthrough product.

Of all the categories, this is perhaps the hardest to guide students through. First off, even the concepts of "technology" and "innovation" are difficult to encapsulate. It can range from work on biological processes to renewable energy to computer programming and everything in between. Similarly, the processes of innovative technological development are immensely variable depending on the field. Additionally, these processes of development are often (though certainly not always) methodical and incremental, which can be dissatisfying for some students. Lastly, technological development can (not always) be quite resource intensive in terms of funding and equipment. All that said, this category of work can be engrossing for certain students, particularly those at institutions with departments who are specializing in various kinds of sustainable technology development.

It is important to reinforce the idea that any technology will have costs and benefits, positive and negative effects on natural and social systems. It is equally important that students understand both the concepts of life-cycle analysis and unintended consequences. Plastic shopping bags were originally invented with the intent to reduce the environmental impacts of producing paper bags, but now they are a global environmental pollutant (Weston, 2019). It can be admittedly challenging to compare the relative value of different variables in when making these analyses. This exercise is often dictated by personal values and limited by the lack of common quantifiable metrics for comparison. It is precisely because this ambiguity exists, however, that the role of sustainability in technology (and vice versa) must be continuously explored.

4 – Motivate Behavior Change. This category of work involves affecting peoples' values, beliefs, attitudes, and behavior through education, awareness & engagement – work such as hosting a speaker or expert panel on a given topic; designing captivating informational signage; running a campus clean-commute week competition; or creating a film or art project showcasing a certain social or environmental issue.

There is a mantra familiar to anyone who wishes to see a change in the world: "If only everyone would just (fill in the blank) then the world would be such a better place!" With some sustainability issues, the challenge lies in understanding what exactly the most sustainable option may be, given all the systemic costs and benefits – the air dryer vs. paper towel debate comes to mind (Subramanian, 2019). With other issues, however, the scientific evidence points strongly in favor of certain actions over others, but frustratingly, it can be difficult to get unanimous support and adoption of those actions. Waste reduction and recycling, or vaccination adoption are examples here.

Getting people to care, to act, and/or change their minds on a given issue can be extremely challenging, but that certainly doesn't mean that this type of work is futile. The end goal of this kind of work is to motivate others to take any of the actions on this list, as well as any relevant personal ethical actions that are in support of a given sustainability issue. A basic understanding of key behavioral science is crucial for success, and students must understand how to identify incentives and disincentives within a system. Community Based Social Marketing (CBSM), as pioneered by Dr. Doug McKenzie-Mohr is a commonly used starting place for exploring this topic. Furthermore, students should learn how to connect with their audience's existing values and identity (rather than the student's own), and how to effectively communicate through active listening and effective storytelling (Hayhoe, 2018). Coaching students often involves questions such as:

1) Who is your intended audience?
2) What action do you want them to take?
3) What are their values and motivations for action, and how are you going to utilize those?
4) What can improve the chances that the changed attitude or behavior will stick?

5 – Push on Leaders. This category of work involves influencing decision makers through community organizing, advocacy & activism – work such as giving public comment to a decision-making body; gathering signatures to show support of fossil fuel divestment; or organizing a demonstration to draw attention to injustice.

In some ways, this type of work can be thought of as a focused version of the category above. In this case the efforts are specifically targeting decision makers in positions of power. The strategies for this work are different than those above and must be tailored to fit each specific leader and scenario. Students must consider broader strategies in this area of work, because actions can be ineffective or even backfire if not deployed correctly. For instance, perhaps a sign-on letter and public comments at a council meeting will effectively sway leaders, where a march or sit-in would unnecessarily escalate the issue (and require significantly more work to organize). Alternatively, perhaps leaders are unresponsive or constantly downplaying the seriousness of an issue. In this case, stronger direct action is needed to gain media attention, build public support, and motivate leaders to act. Students should be guided to consider:

1) What specific outcome (i.e., decision or policy) are you trying to achieve?
2) What person, office, or agency actually has the power to carry it out?
3) How do those leaders currently stand – in favor, against, or neutral, and how strongly?
4) What kind of messaging will these leaders respond to most effectively?

It is common to have strong debate, even argument, among even the most experienced community organizers and activists about which actions should be taken as part of an overall strategy. If multiple stakeholders are involved, they may have different goals and different previous experiences guiding their perspectives and desired approach. As much as possible, though, coalitions of stakeholders must work through these challenges proactively to formulate cohesive plans and strategies that are mutually beneficial. This step of coalition building can be as challenging as implementing the ultimate agreed-upon plan of action itself, particularly in the face of a pressing desire for change. However, the time spent on gathering multiple perspectives and voices to a cause can avoid future setbacks and missteps.

At an introductory level, students should explore and discuss the benefits and drawbacks of different approaches to pushing on leaders. Additionally, they should certainly practice the skill of gathering multiple stakeholders together to discuss desired outcomes and work through the pros and cons of various strategies. Ultimately, students interested in this realm of work should seek out ways to be involved with different kinds of work, ideally with established organizations that have experience working with students, one example being The Public Interest Network. Then, they should spend time reflecting on which kinds of action resonate most strongly with them.

6 - Leadership and Power. This category of work involves gaining a position of power or authority – work such as running for an elected position; working on an election campaign to support a candidate friendly to the cause; or climbing the ranks within an organization.

If the previous category was focused on getting decision makers to act in a certain way, then this category is an alternate approach to achieving similar ends. In this case, the work is done not in the convincing, but in the attainment of the leadership position. To borrow a line from the musical Hamilton, this is about being "in the room where it happens" (Miranda, 2015, 2.5). It is important for students to understand what kind of authority certain positions hold (whether in government, on campus, in companies, or in popular culture) and the pathways to securing those positions. For elected positions, students should seek experience with election campaigns – or run for a position themselves – in order to understand the processes and strategies these efforts entail. As mentioned previously, students can often benefit from joining on with existing organizations, rather than try to build an effort from scratch.

Sometimes students will be forced to seek opportunities beyond what can be offered through an official college program due to rules around political activity. However, not all work in this category is strictly political in nature. For example, the electric co-op that provides electricity to Fort Lewis College is overseen by board that is elected – students are allowed to support climate action oriented candidates because the co-op is a non-governmental entity.

It is important for students to also recognize that positions of power are not always obvious, and these positions can be attained through paths that students may not often consider. For instance, a facilities director has an immense amount of sway over operational sustainability decisions at an institution. These types of positions are nearly always held by individuals who have spent years in their careers climbing the ranks in that particular line of work. It may be hard for this example to resonate with students seeking immediate results, but there is value highlighting the less illustrious paths to authority.

7 - Change the Rules. This category of work involves how to succeed in getting new laws or policies enacted, or protecting existing ones from being weakened by policies that run counter to the cause – work such as getting a municipal organic waste ban passed; influencing natural resource management plans; or having a state adopt or maintain a renewable energy standard.

The previous two categories address actions taken and decisions made by people in positions of power. It is crucial for students to understand how actions and decisions that ultimately change the rules hold special significance. In her essential primer, *Thinking in Systems,* Donella Meadows puts it simply: "Power over rules is real power . . . If you want to understand the deepest malfunctions of systems, pay attention to the rules and who has power over them." (Meadows, 2008, p. 158). A change to the rules is a change to how a social system operates, and in democratic systems, these rules outlast any individual leader. This is the difference between a food service manager deciding to purchase food from a local farm versus a policy that mandates food being purchased from local sources.

Rules can be considered as both informal social norms as well as codified policies and laws, both categories affecting and reinforcing one another. A policy or law is only going to be palatable to leaders and/or voters if it aligns with social norms to a certain degree. Once in place, policies and laws can further shape social norms, setting the stage for yet another shift. Strategies for changing social norms relate primarily to the fourth category of work: "motivate behavior change." Strategies for changing formal rules typically involve navigating established processes of the rulemaking institution, often by employing work from the categories of "gain deeper insights" (category one), "motivate behavior change" (category four), "push on leaders" (category five), and "leadership and power" (category six).

Changing both formal and informal rules can be considered the culmination of the push to create a positive change in the world. But of course, there is no ultimate set of perfect rules for any social system. New discoveries and technologies must be continually addressed, while shifting social demographics and paradigms will change what rules are deemed appropriate. The purpose is not to change the rules for the sake of change, but to adjust the rules to our changing circumstances – our ever-changing "new normal" – in order to align with sustainability goals and systems thinking concepts.

4. In Summary

For each category described above, there is extensive additional substantive information and theory to investigate. By introducing this framework, I hope to provide a jumping-off point for faculty, staff, and students to explore their own strengths and learn more about a given category of work. Through the lens of this framework, we can see how various endeavors might fit as pieces of a larger overall movement for change. Of course, a given activity or effort may include multiple categories of work, thus encouraging critical thinking about goals. Is a student trying to accomplish too many things at once? Or perhaps they are missing out on an opportunity to include another category of work in their project?

At Fort Lewis College, one student-led project we ran through the EC was to give kits to student renters containing basic energy and water saving fixtures which "actualized the service" (category three) of promoting resource conservation. The simplest way to run this project would be to just hand out bags of free stuff. However, using this framework, I encouraged the students to think about other goals they could accomplish and how this effort relates to other pieces of the change-making framework. For instance, we discussed the importance of LEDs as a breakthrough energy-saving technology, and how the development of LEDs falls under "design through innovation" (category two). They also decided to create pamphlets with catchy information and links explaining how each product helps the environment in order to "motivate behavior change" (category four), and they administered a survey to better understand how students pay for and manage their utilities use at home in order to "gain deeper insights" (category one). At least one student was inspired to explore the ways to address the split incentive issue of utility conservation for renters (Bird and Hernández, 2012, p. 506). This effort would involve researching what policies have been effective in other communities ("gain deeper insights"), working with community groups developing a campaign to bring this issue to their attention ("push on leaders"), with the eventual goal of getting a new city ordinance passed ("change the rules").

By categorizing these multiple, interconnected approaches, these students gained a more comprehensive understanding of how they can work to achieve the goal of energy and water conservation. As this example shows, applied sustainability education programs can utilize this framework to help students identify potential projects and draw connections throughout the vast landscape of potential change-making work.

Author Bio

Marty was first introduced to sustainability through the topic of green building, performing assessments of energy, water, and material consumption for building operators and businesses. He applied this experience in overseeing student-led sustainability efforts at the Fort Lewis College Environmental Center. Marty now works as the Sustainability Manager for the City of Durango where he provides technical assistance across city departments and serves as the point person for the broader community on sustainability initiatives. Marty holds a B.S. Architectural Engineering from the University of Colorado, Boulder, and an M.S. in Environmental Policy and Management from the University of Denver.

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Teaching Behavior Change Skills for Climate Careers

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Abstract

Universities are not adequately preparing students to meet the climate crisis through climate action. To meet this need, the Center for Behavior and Climate has developed a Behavior Change for Climate Action course for students along a climate change career path and for climate change professionals. This course teaches behavior change principles for mitigating climate change through individual and collective action. The course is **interdisciplinary** and **transdisciplinary**, encompassing psychology, social psychology, behavior analysis, sociology, political science, decision science, cognitive science, communications, and marketing. Learning outcomes include: discriminating the influencing factors hindering pro-climate behavior; selecting proper application of behavioral tools for countering these factors; identifying effective strategies for outreach and communication; and identifying the proper behavioral tool for specific audiences and situations. Case studies are provided throughout. Available as an online synchronous version or live workshop, the course builds upon 20 years of experience in effective online instruction to behavior analysts-in-training by Behavior Development Solutions. Incorporating the scientific principles and methods of applied behavior analysis to **instructional design** (Tiemann & Markle, 1990), the course is comprised of lectures and learning modules requiring **active student responding**. Exercises enable students to apply behavioral tools to specific audiences and real world situations.

Keywords: *Behavior change, climate change, climate action, active student responding, competency, online asynchronous, fluency, instructional design*

Climate change is an epic global challenge facing humanity. Our fight against it requires behavioural change and social change. - Kim-Pong Tam et al. (2021)

1. Introduction: The Need

To address climate change in the short timeframe we have left requires nothing more than transformational systems change. Accordingly, students planning careers that address climate change need multiple skills under their belts to be effective change agents. They need to master the refined key competencies for sustainability as identified by Brundiers (2021)— systems-thinking, anticipatory/futures-thinking, normative/values-thinking, strategic-thinking, interpersonal/collaborative, and integrated problem-solving. Subsumed under these competencies are skill sets such as understanding climate science through a systems lens, determining which climate solutions are most effective, and how to build

resilience into ecological and social systems. The students need to understand politics, economics, and how policies, institutions, and societies change. We contend that they also need behavior change skills to facilitate support and implementation of climate actions by the general public, private sector, or public sectors (c.f., Vaughter, 2016), because behavior change is one of the essential ingredients of systems change (Fig. 1). Behavior change skills comprise both the understanding and the ability to apply behavior change techniques appropriately.

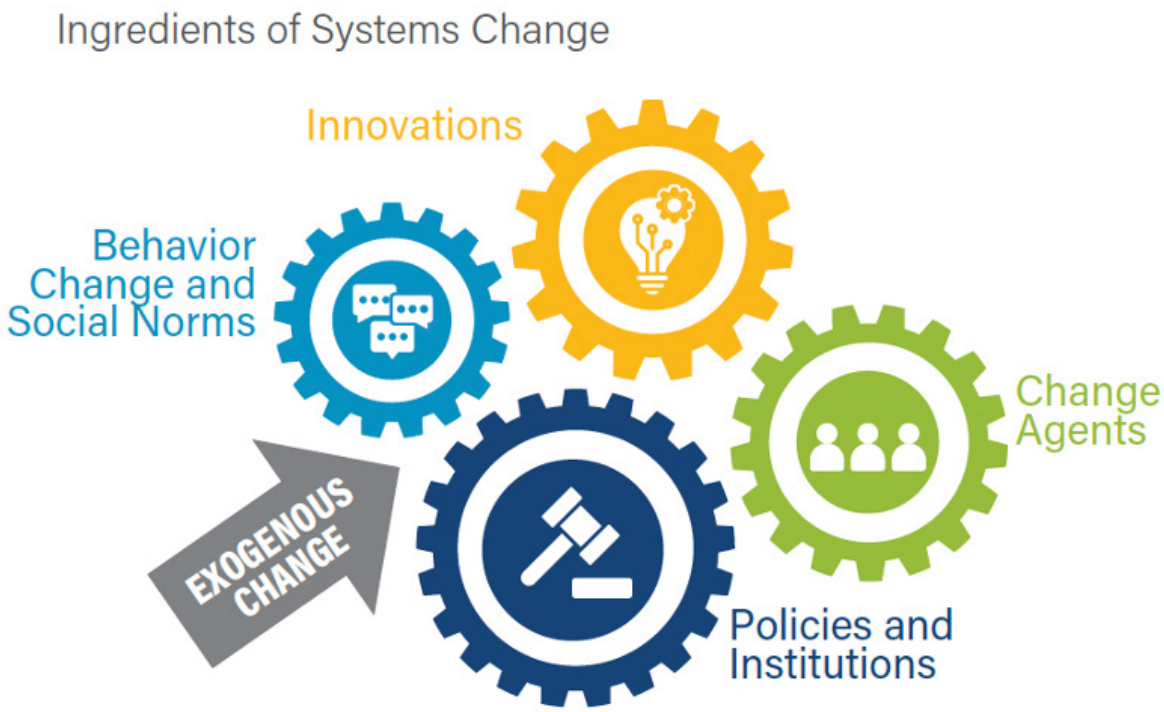

Figure 1. Ingredients of systems change. Global Commons Alliance, 2020.

Why is understanding behavior change so critical? Consider three barriers to climate action where the application of behavioral understanding matters. First is partisan resistance to a proposed climate change bill, which can hinge upon how the issue is **framed.** Framing a climate bill as a carbon tax or carbon offset affects its popularity across ideological groups, with the former framing only being supported by Democrats, while the latter framing garners support across all ideological groups (Hardisty et al., 2009). Second is a town's resistance to proven climate adaptation options that are better both economically and environmentally over the long run. The better options may be blocked due to **cognitive biases** leading to faulty judgements. For example, **present bias** (the tendency to prioritize immediate risks over future ones) and fears about sea level rise lead to pressures for seawalls today even though seawalls often lead to more erosion and costly damage to coastal homes in the future. Third is institutional resistance to climate action. Overcoming such resistance may depend upon **behavioral barriers** being overcome, as determined by the staff who work there. Two of the top four categories of barriers to climate action at a municipal level were behavioral: 1) attitudes, values, and motivation, and 2) politics (Ekstrom and Moser, 2014).

While energy utilities, cities, and national governments worldwide are increasing their behavior change focus, few universities teach behavior change in their environmental or sustainability courses or address environmental issues in their psychology, decision science, or behavioral economics courses. We randomly sampled 100 universities from a population of 2,822 four-year colleges and universities, ranging from small liberal arts colleges to large universities, provided by the Integrated Postsecondary Education System (IPEDS) for the National Center of Education Statistics (NCES) (Fig. 2). Only 6% taught behavior change skills linked to the environment. We then randomly sampled 100 universities from a population of 347 universities with interdisciplinary environmental, sustainability, and energy baccalaureate and

graduate education (IESE) programs in the US as provided by the National Council for Science and the Environment through the Carnegie Classification of Institutions of Higher Education (Vincent et al., 2017). Even within these interdisciplinary sustainability programs, just 20% taught behavior change linked to the environment. Course titles included, among others, *Environmental Communication, Psychology for Sustainability, Environmental Psychology, Psychological Insights for Science Communication, and Global Behavioral Science.* Within these two samples, however, we did not find any courses specifically targeting teaching behavior change skills for climate action.

Currently, neither of the two credentialing organizations in our field, the International Society of Sustainability Professionals (ISSP), nor the Association of Climate Change Officers (ACCO), teach behavior change skills associated with climate change.[1]

Type	Source	n	Percentage Of Programs Addressing Behavior Change & Environment
Universities, four-year, general (N = 2882)	IPEDS/NCES	100	6
Sustainability programs, four-year (N = 347)	Carnegie	100	20
ISSP (Intl Society of Sustainability Professionals)	Organization'sWebsite	1	0
ACCO (Assoc. of Climate Change Officers)	Organization'sWebsite	1	0

Figure 2. Analysis of environmental or sustainability university and professional courses addressing behavior change and the environment.

2. The Course Content

In response to this need, we've created a Behavior Change for Climate Action 101 course that teaches students how to increase climate action at the individual and collective level with behavior change. The course was reviewed by our Advisory Council, comprised of behavioral scientists and climate practitioners.

We address both individual and collective action in this first course because research shows that those who believe they can make a difference with personal actions are more willing to support climate change policies (Lorenzoni et al., 2007), and to believe that stakeholders at all levels bear a responsibility to act (Associated Press-NORC Center for Public Affairs Research, 2019). Further, groups ranging from the International Energy Agency (IEA) to Project Drawdown note the critical role that individuals play in driving social change in the energy transformations needed to address the climate crisis (International Energy Agency, 2021; Frischmann & Chissell, 2021). For example, the IEA estimates that roughly 63% of the energy reduction needed to reach net-zero carbon emissions will require people to change their behaviors through personal energy choices and societal demand.

The course is **interdisciplinary and transdisciplinary,** covering the fields of psychology, social psychology, behavior analysis, decision science, cognitive science, sociology, political science, communications, and marketing. From these disciplines, we've identified behavioral barriers to climate action, as well as **evidence-based behavior change tools** to address them.

Our course describes twelve behavioral barriers[2] that we consider to be important for impeding climate action (Fig. 2, left). Ten of these barriers are among those identified by Gifford (2011: we add motivation and moral foundations to the list (Deci and Ryan, 2000; Haidt and Graham, 2007). A regression model by Bamberg and Möser (2007) identifies the barriers with strong predictive value for influencing

1 ACCO's courses include stakeholder engagement and organizational change management. ISSP's credentialing course includes stakeholder engagement. Neither organization provides understanding of the theories behind behavior changes, the behavioral barriers underlying stakeholder responses, or the suite of behavioral tools available.

2 The course uses the terms "behavioral barriers" and "influencing factors" interchangeably.

behavior: attitudes, moral norms, influenced by social norms, and perceived behavioral control[3]. For each barrier, we describe the behavior change tool with the most empirical support for countering that particular barrier and increasing pro-environmental behavior (Fig. 3, right). Ten of these tools are derived from a 2012 meta-analysis (Osbaldiston and Schott, 2012). The remaining three tools: games, block leaders, and community interventions, are derived from review papers documenting effectiveness of behavior change techniques in energy conservation and social intervention approach, respectively (Iweka et al., 2009; Abrahamse and Steg, 2013). Additional behavioral techniques are provided for countering specific cognitive biases.[4] The course also includes an overview of several outreach and communication tools--framing and storytelling. In these polarized times, framing messages selectively enables one to increase pro-environmental behavior in both liberals and conservatives (Kidwell et al., 2013; Wolsko et al., 2013). Storytelling (even very brief radio ads) can increase conservatives' perceptions that Republicans care about climate change (Commercon et al., 2021). Personal stories help to increase the publics' recognition that climate change is here and now, and so climate action needs to be here and now.

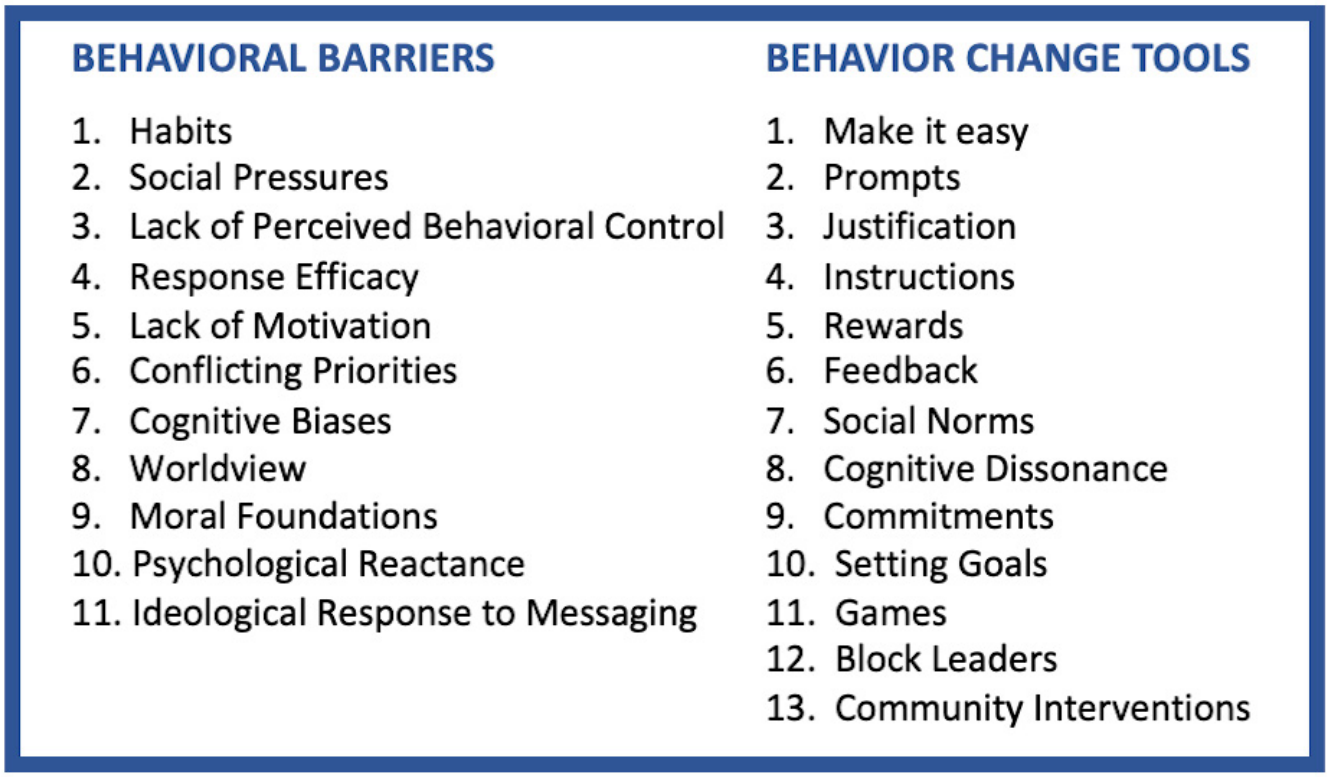

Figure 3. Behavioral barriers and behavior change tools used in the course.

2.1. Matching the Behavior Change Tool to the Audience and Situation

The first step in applying behavior change for climate action is to identify the audience group and the desired target behavior. Then, like a carpenter, one needs to know how to choose the right tool for a given task (such as a flat-head or Phillips screwdriver depending on the type of screw). Accordingly, the course provides the student with the skills to apply behavior change tools appropriately. The course includes a useful table (modified from Schultz, 2013) that enables one to match the appropriate behavior change tool to the barriers and benefits for a given audience (Fig. 4). **Barriers,** on the Y axis, refer to anything that reduces the probability of the given audience engaging in that target behavior: such as

3 Perceived behavioral control means the extent to which we believe we can control our own behavior. A lack of perceived behavioral control is reflective of climate despair, or feeling that we can't make a difference on climate.

4 The cognitive biases discussed include: present bias/future discounting, cognitive dissonance, confirmation bias, commitment bias, motivated reasoning, single action bias, loss aversion, and dual-process reasoning.

cost, time, difficulty making the behavior change, or lack of access. **Benefits,** on the X axis, refer to a person's or groups' beliefs about the positive outcomes associated with the behavior--saving money, protecting the environment, receiving social approval, etc. The appropriate tools to use for that barrier/benefit combination are in the respective quadrant. An inset at the right notes the most effective tools to use for energy conservation (as indicated by the double asterisks) and social interventions (as indicated by the stars). Examples of specific climate actions are provided for each quadrant.

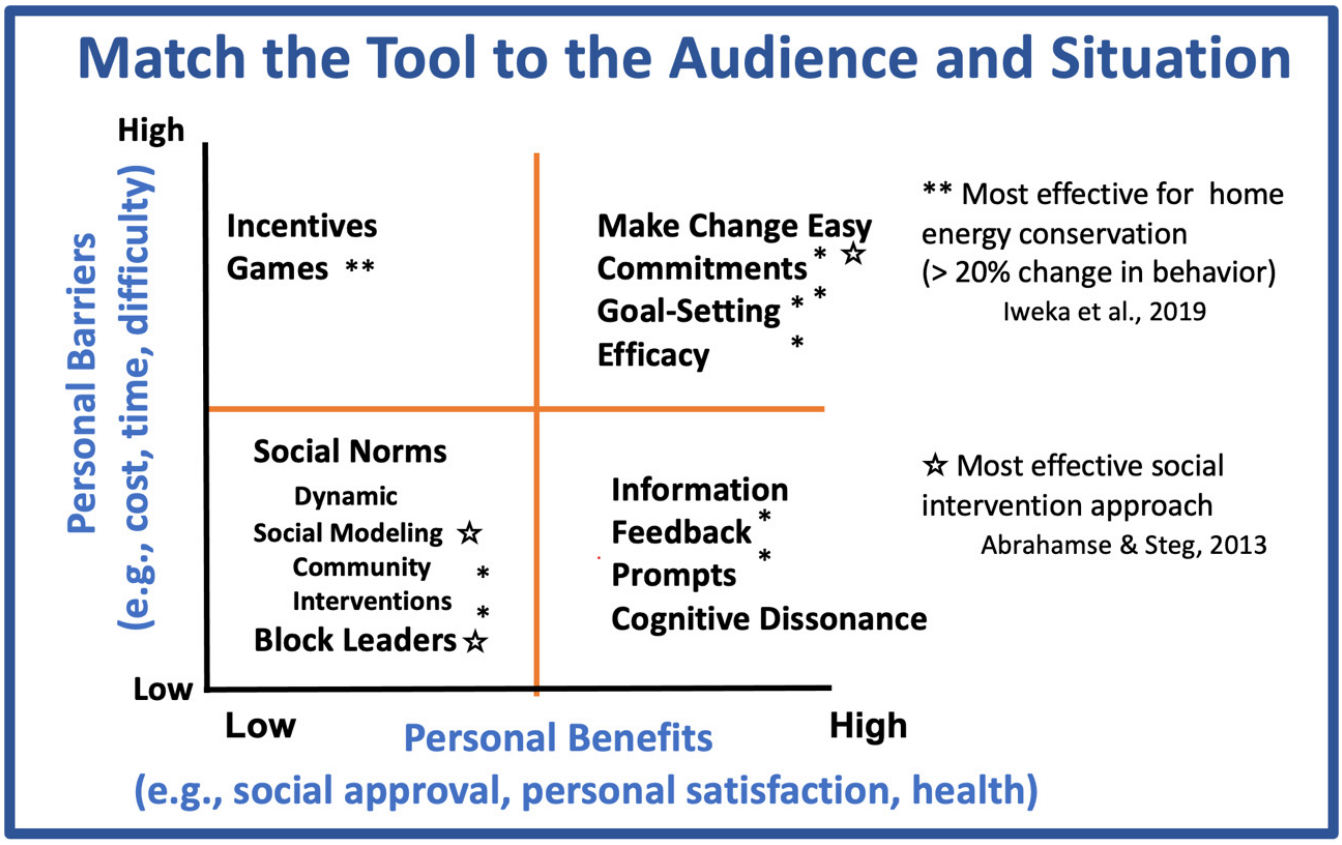

Figure 4. Matching behavior change skills to the barrier and situation. Modified from Schultz, 2013.

2.2. Course Format

The online version of this course comprises four lectures plus eight learning modules. The course is also available as a virtual or live workshop. The lectures present evidence-based behavioral studies across disciplines.

2.3. Exercises

Different types of exercises are offered in the live webinar and online asynchronous versions. In the workshop version, exercises consist of applying behavior change tools to different **case studies** followed by discussion in small group breakout sessions. In the online version, exercises consist of answering multiple-choice and multiple-response questions ranging from foundational skills such as definitions, to more advanced questions involving application and critique of given scenarios as in the multiple-response question in Figure 5.

Exercise

Objective: Select applications of the tool – making habits easier.
Question = Kimia wants to reduce her carbon emissions with a low-carbon diet (eating vegetarian two days/week). But every time she goes to the grocery store, she buys the same food that she's always bought. And even when she buys more vegetables or vegetarian dishes, she doesn't use them. **What would you suggest she do that would make it easier for her to change this habit?**

Correct Answer 1 =	She could identify meals for two days and put the needed ingredients on her grocery list before she goes shopping.
Correct Answer 2 =	She could identify specific days; say, Monday and Wednesday, as her meat-free days.
Correct Answer 3 =	She could hide the meat behind vegetables in her refrigerator and freezer.
Correct Answer 4 =	She could post a reminder on her refrigerator.
Wrong Answer 1 =	She could remind herself just before she starts to make dinner.
Feedback 1 =	You INCORRECTLY selected: She could remind herself just before she starts to make dinner. Rationale: The problem with this approach is that she would need a prompt to select a vegetarian meal at the right time, just before she made dinner (e.g., a meal calendar on the refrigerator door). She may be too tired at that time. A better approach is for her to plan ahead when she is motivated to do so, such that her choices are easier.
Wrong Answer 2 =	She could abruptly switch to vegetarian seven days a week so that she doesn't have to make the choice.
Feedback 2 =	You INCORRECTLY selected: She could abruptly switch to vegetarian seven days a week so that she doesn't have to make the choice. Rationale: While this approach does eliminate daily choice, oftentimes, tinier steps are more long-lasting. The reason is that this change for her may be so extreme that she may well not achieve even the two days that she had originally planned.

Hint = She needs to make her behavior specific and easy to do. She can either make her desired foods **easier** to get (by putting the vegetables in front of her refrigerator) or use (such as with a prepared meal plan or a prompt), or by making her undesired foods (meats for those days) **more difficult** to find.(Fogg, 2019)

Figure 5. Example of exercise used in the online asynchronous course.

3. Pedagogical Principles and Processes

Now that we've covered what we teach, we'd like to now turn to how we teach.

3.1. Our History

Effective teaching takes many forms. Didactic instruction such as a lecture is only one of them. For over twenty years, we've employed a set of teaching strategies, supported by empirical research, to teach applied behavior analysis to masters and doctoral degree candidates sitting for the Board Certified Behavior Analyst exam, all without lectures. The pass rate of first-time exam takers who complete our online course consistently exceeds 91% (Behavior Development Solutions, n.d.), while the overall pass rate for first-time exam takers has been in the mid-60% range (Behavior Analyst Certification Board, n.d.). By providing this instruction online and asynchronously, we've reached tens of thousands of learners. We are now adapting this model of instruction to teach climate action-related material to large

numbers of learners, as well as those with differing backgrounds and skills. One of these adaptations is to include certain pedagogical approaches to sustainability studies, as summarized by Lozano et al. (2017) and as noted in the previous section: project/problem-based learning in class; integrative learning (interdisciplinary and transdisciplinary); and case studies. The other pedagogical characteristics are described below.

3.2. Sustainability competencies addressed in the course

Using the refined framework by Brundiers et al., 2021, we believe that the course content and exercises helps to build strategic thinking competency, implementation competency, interpersonal competency, and integrated problems-solving competency. While acknowledging the infancy of assessment and evaluation of both frameworks and sustainability competencies (Redman et al., 2021; National Academies of Science, Engineering, and Medicine, 2020), we agree that such assessments are invaluable. As defined by a Delphi study by sustainability experts (Brundiers et al., 2021):

- **Strategic thinking competency** is: "*to be able to recognize the historical roots and embedded resilience of deliberate and unintended unsustainability and the barriers to change;*" "*to creatively plan innovative experiments to test strategies.*" Our course describes twelve behavioral barriers to change, and ways to counter them.
- **Implementation competency** is: "*taking conscious action, i.e., doing the actions associated with the solution process that is the (intellectual) result of integrated problem-solving competency in the first place.*" Our entire course is directed toward climate action.
- **Interpersonal competency** is: "*the ability to apply the concepts and methods of each competency ... in ways that truly engage and motivate diverse stakeholders and to 'empathetically work with collaborators and citizens' different ways of knowing and communication.*" Our course helps the student to work with stakeholders across the political spectrum.
- **Integrated problem-solving competency** is: "*to be able to combine and integrate steps of the sustainability problem-solving process or competencies, while drawing on pertinent disciplinary, interdisciplinary, transdisciplinary, and other ways of knowing.*" According to Brundiers et al., 2021, referencing Weik et al., 2016), this competency includes the ability to select and apply appropriate problem-solving frameworks. Our course affords the student multiple opportunities to select and apply the appropriate problem-solving framework, drawing on interdisciplinary and transdisciplinary content.

3.3. Characteristics of the Center for Behavior and Climate's (CBC's) Instructional Design Model

Characteristics of our model include developing a Bloom's taxonomy-like hierarchy of learning objectives, questions that teach to these objectives, immediate and corrective feedback, important discriminations, sufficient practice, and making ongoing revisions based on an analysis of performance data. We discuss each characteristic and its relevance to promoting mastery in the following sections.

3.3.1. Learning Outcomes and Objectives

The Behavior Change for Climate Action 101 course outline comprises two levels: major learning outcomes and learning objectives (Fig. 6). Learning outcomes serve as broad descriptors indicative of what most people would want to know about what is taught in the course. But more importantly, they serve as the superstructure for the learning objectives subsumed under them. For each of the 28 learning objectives, several questions are developed, with a total of 60 questions for the course. Responding to questions in this context is also known as **active student responding (ASR).** Research on ASRs indicate that they are one of the predictors of effective learning outcomes (Tincani & Twyman, 2016).

"*If you don't know where you're going, any road will get you there,*" is a paraphrase of prose from Lewis Carroll's *Alice in Wonderland.* Similarly, if you don't know exactly what you expect a learner to be able to do at the end of instruction, any instruction will get you there. In contrast, well-constructed learning objectives specify, in observable and measurable terms, exactly what learning outcomes are expected.

Learning objectives are based on (modified) Bloom's taxonomy levels: *definitional; example/ identification; application; and critique.* As appropriate, we develop objectives for each level. For each objective, we develop multiple-choice and multiple-response questions that teach to those objectives. Given that our instructional design model is online and asynchronous, we could not adopt Bloom's

Taxonomy *in toto*. For instance, the top level of the taxonomy is "create." We haven't determined a way to automatically score creative behavior, so this level is not part of our instruction. We do, however, offer the choice of selecting from options in multiple-choice questions that critique responses to scenarios, which may be the next best thing.

Learning Outcomes and Objectives

Learning Outcomes for the Course

1. Identify and discriminate the behavioral barriers to pro-climate behavior;
2. Select examples of the proper application of behavioral tools that counter the behavioral barriers;
3. Identify the proper behavioral tool for specific audiences and situations. This includes ideologically different audiences, from liberal to conservative; and
4. Identify effective strategies for outreach and communication tools (framing, storytelling, and social marketing).

Objectives for Learning Outcomes One, Two, and Three

Objective Type	Objective	# of Qs
Definition/ Conceptual	Select definitions, characteristics, and relevant components of the behavioral barriers limiting individual action.	1
	Select definitions, characteristics, and relevant components of habits.	3
	Select definitions, characteristics, and relevant components of prompts, commitments, goal-setting.	1
	Select definition of games.	1
	Select definitions, characteristics, and relevant components of cognitive biases.	6
Example	Select examples/ non-examples of utilizing social norms.	2
	Select examples/ non-examples of effective prompts.	1
	Select examples/ non-examples of effective commitments.	1
	Select examples/ non-examples of effective goal-setting.	1
	Select examples/ non-examples of cognitive biases.	2
Applied	Select applications of habit development by making habits easier.	2
	Select application of perceived behavioral control and efficacy to a story and image.	3
	Select applications of strategy for overcoming cognitive biases.	3
	Select application of tools for overcoming low proenvironmental behavior.	1
	Select application of tools effecting behavior change.	1

Figure 6. Examples of learning outcomes and objectives.

3.3.2. Active Student Responding (ASR)

ASR involves students answering questions or responding in a manner that demonstrates understanding of the instructional content being presented (Vargas, 2013). The most frequent kind of ASR is a teacher asking students questions in a class (Heward et al., 2013). In this form, they are a means of instruction or perhaps an informal survey of how well the class understands what the teacher is saying at that moment. While ASRs are rarely an assessment of learning in any formal sense, such as with tests, ASRs keep students engaged. In this way, they are part of the learning process.

Active student responding is an efficient way to learn (Lambert et al., 2006). In fact, where learners come into a given course with familiarity with the content, we sometimes don't even present instructional material before presenting questions. If the learner doesn't know the answer, they can click on a "Hint" button to view instructional content in a pop-up window. This way they don't have to waste time viewing content they know. Moreover, they can respond to several ASRs per minute. Contrast this with a typical class period where learners might engage in only one or a few ASRs over the entire lesson.

3.3.3. Feedback and Consequences

What follows a response and occurs because of that response is a **consequence.** When consequences are presented as an aspect of performance, we call that **feedback** (Cooper, Heron, & Heward, 2020, p. 257; Miller, 2006, p. 343). Immediate consequences have been shown to be more effective at influencing behavior than delayed consequences (Cooper et al., 2020, p. 36).

One advantage to answering questions as part of a learning process rather than as an assessment is that the student experiences less anxiety in this format. In traditional classroom instruction, a student who incorrectly answers the teacher's question will often receive corrective feedback—e.g., "Two plus three is five—not four." Although necessary for instructional purposes, such feedback has the disadvantage of possibly embarrassing the student in front of their peers, making further responding less likely. This problem is avoided by using an electronic hand-held device or software, which makes responding private. Software can also provide customized feedback depending on the type of error. In fact, we generally recommend that a) feedback be concise, b) indicate why the incorrect option is incorrect, and c) give the learner enough information to figure out why the correct option is correct.

3.3.4. Meaningful Discriminations

A discrimination is simply identifying a difference between two or more options (Alberto & Troutman, 2013, p. 296). In a multiple-choice or multiple-response question, the learner must discriminate correct from incorrect options. The discriminations need to be meaningful, as options that are easily dismissed are a waste of time and teach the learner nothing.

Incorrect options that sound plausible but don't challenge learners' understanding are missed learning opportunities (Tiemann & Markle, 1990). Consider the following question, "Which of the following are defining features of a bicycle?" It has

a) handle bars
b) seat
c) pedals
d) two wheels
e) hand brakes
f) basket
g) cargo rack
h) chain guard
i) reflectors

Options a through d are all defining features of a bicycle—all bicycles have them and without them, they are not bicycles (Fig. 7). We call these **must-have attributes**. Options e through i are **can-have attributes**. Any of these features could be removed, and it would still be a bike. There are also **must-not-have attributes**—e.g., an engine on a bike makes it a motorcycle; yet bikes with electric motors are still considered bikes. The best distractors consist of can-have and must-not-have features that are easily confused with must-have features. For example, hand brakes are one of these features because a bike could have foot brakes instead of hand brakes.

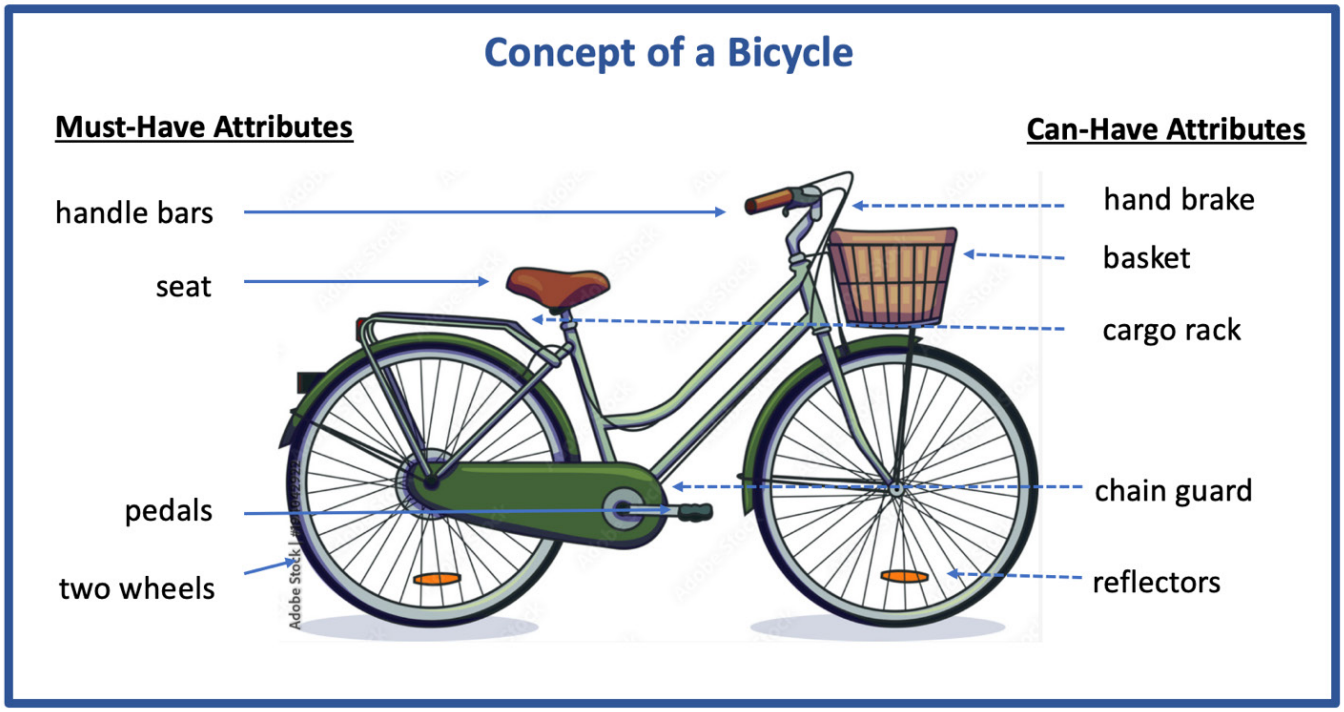

Figure 7. Example of must-have and can-have attributes.

How are meaningful discriminations provided in the course? Consider this question:

> *A practitioner wants to use DYNAMIC SOCIAL NORMS to encourage the purchase of solar panels. Using their data, they send out flyers in a neighborhood stating that "Thirty percent of your neighbors have already purchased solar panels." What should they have said INSTEAD?*

The correct option is:

> *In the last three years, more and more of your neighbors are purchasing solar panels. How about you?"*

One of the incorrect options is:

> *Most of your neighbors use oil for their energy. Make a difference and get solar panels instead!*

This is an important discrimination because it is plausible but missing a must-have attribute: trending information. For the learner who does not know the answer, *a* **hint** button is available which, when clicked, reveals the following:

> *Social norms that are trending or dynamic provide information about how people's behavior changes over time. These are most effective at promoting pro-climate behavior. (Sparkman and Walton, 2017; Mortinsen et al., 2019)*

After reading the hint, most learners should be able to select the correct option. After answering multiple related questions, they will have had enough experience associating "dynamic social norms" with "how people's behavior changes over time," that they are likely to have mastered the concept.

3.3.5. Practice to Fluency

In sports, it is well understood that performance improves with practice. Similarly, when a learner successfully answers a question, we shouldn't assume that the skills that produced that performance are well-established in the learner's repertoire. Practice, particularly to **fluency** (i.e., responding accurately and without hesitation), is likely to foster retention of the skill, make the skill durable in the presence of distractions, and improve application of the skill to real-life contexts (Binder, 1996). For this reason, we have learners practice modules until they get all questions correct and can do so at a rate of approximately four questions per minute. Learners will generally see each question at least twice and often as many as five or six times.

3.3.6. Getting it Right for the Right Reasons: Overcoming Inappropriate Stimulus Control

Answering a multiple-choice question correctly doesn't ensure that the learner is selecting that option for the right reason. When a correct option is selected for the wrong reason, the response is said to be under inappropriate stimulus control. Frequently-applied test-taking tricks work against proper learning—"If you don't know which one is correct, select C, or select the longest option." Similarly, a single word in a hint might match a word in the correct option, thus prompting the student to select that option, but without the student having a thorough understanding of the question. For instance, in reviewing students' responses to one question, learners who selected a particular incorrect option had also used the hint—the exact opposite of our expectation. However, upon closer examination of the hint, we found phrasing that led students to that option. A revision to the hint remedied the problem.

To ensure proper stimulus control, therefore, various strategies must be employed. These strategies include wording questions so that learners must read the question stem and options carefully. For instance, sometimes a correct option might differ from an incorrect option by only a single, yet critical, word. Or a correct option in one question will be an incorrect option in another question. And of course, the position of the options is randomized, and we ensure that correct options are not consistently the longest (or shortest). In other words, to ensure learners are learning what we intend to teach them, questions must be clearly written, and learning objectives constructed in observable and measurable terms.

3.3.7. Data Analysis

Software enables the collection of a plethora of data. Typical measures like percent correct and which options were selected are commonplace and valuable. However, we have found that additional measures such as **latency** (the amount of time one looks at a question before responding), **time spent looking at feedback and hints, how often hints are used**, and the **probability of getting a question correct after viewing a hint** facilitate the understanding of performance on a particular question or a group of questions. Finally, our online course enables professors to analyze their students' progress. For example, a pre-test, followed by a post-test at the end of the course, helps to gauge the extent of learning.

4. Conclusion

Climate scientists have determined that **significant climate action needs to take place this decade** to prevent a climate catastrophe (Intergovernmental Panel on Climate Change, 2018, Ripple et al., 2020, 2022). However, world leaders, their governments, and even much of the public don't seem to appreciate the gravity of the situation. As of this writing, the COP27 climate conferences of world leaders is just finishing up with what appears to be less than satisfactory results. Politics predominated…as expected. Therefore, it is up to other institutions to take up the challenge. The climate education programs within our education system is one those institutions. Given the urgency, large numbers of people must be taught how to effect climate action. As educators, it is incumbent upon us to develop the appropriate instructional resources and bring them to scale in preparation for a substantial increase in demand.

We posit that the asynchronous and scalable model presented here, unique in content and pedagogical design, and based upon empirically validated methods, can teach skills in climate action to large numbers of learners. The course can be incorporated as supplemental university course material or accessed by individual learners. Two future courses include: behavior change and change management--how to scale up action for institutions and how to affect government policies; and a behavior change course for climate adaptation. We are also planning mini-courses: one-hour short courses to enable students from all walks of life to incorporate a given behavior change tool into their lives or careers.

Author Bio

Dr. Shumway received her Ph.D. in marine biology in 1988 from Scripps Institution of Oceanography, focusing on brain and behavior, and was a postdoctoral fellow at Caltech, Boston University, and the Marine Biological Lab. An early proponent of the need to address both human and animal behavior in conservation (Shumway, 1999), Dr. Shumway has 25+ years of experience in behavior change, sustainable

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Dr. Eversole received his M.A. in Applied Behavior Analysis from Western Michigan University in 1984 and his Ed.D. in Special Education from the University of Kentucky in 1995. That same year, Dr. Eversole began dabbling in computer-based training and in 1998 founded Behavior Development Solutions (BDS)—makers of the CBA Learning Module Series, CE products, and other training materials used by thousands annually. He has practiced behavior analysis for over the past 40 years, teaching graduate students and working with a variety of special needs populations including learners with autism or other developmental disabilities, and youth with severe emotional disturbances. Dr. Eversole has also taught classes in behavior analysis and presented research findings at professional conferences. In 2020, Dr. Eversole founded the Center for Behavior and Climate—a division of BDS dedicated to education on climate change. Dr. Eversole's primary research interest is in instructional design and its application to teaching behavior analysis, climate change, and other areas.

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A design-based approach to activating key competencies in sustainability through multifaceted formative assessment

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Abstract

Continuing to build out the range of approaches to developing and assessing the key competencies in sustainability is an essential responsibility of higher education instructors, administrators, and researchers. In this example, I describe the implementation of a set of tools to both cultivate and capture students' emerging competencies, as well as their motivations to apply learning as change agents in the pursuit of sustainable futures. These tools center around a design-based approach that leverages multifaceted formative assessment (among students, peers, and the instructor) to facilitate critical reflection and shared dialogue towards transformative learning outcomes. These different design elements were incorporated into a photovoice activity in which students analyzed causes, impacts, and potential solutions of the urban heat island effect. Ultimately, I aim to assert the capacity for critical reflection and shared dialogue to facilitate competency development and assessment. This process can manifest the interrelated nature of the key competencies in sustainability and contribute to reimagining how the integration of different perspectives can both appraise and advance sustainability teaching and learning in higher education.

Keywords: *Sustainability competencies, Formative assessment, Design-based research, Transformative learning*

1. Introduction

The confluence of accelerating and intertwined sustainability challenges, such as climate change, social injustice, and economic disparities, increasingly demands that individuals possess the capacity to engage with complex problems. Higher education can meet the needs of students and society by providing learning opportunities to develop the abilities and mindsets necessary to grapple with urgent social-ecological challenges. By equipping students with key competencies in sustainability, or "complexes of knowledge, skills, and attitudes that enable successful task performance and problem solving with respect to real-world sustainability problems, challenges, and opportunities" (Wiek et al., 2011, p.204), higher education can enable students to participate as change agents in transformative action towards more just, equitable, and sustainable futures. Advancing strategies to foster these competencies, and appraise their potential impact on broader sustainability efforts, is thus a vital endeavor for instructors, administrators, and researchers in higher education.

However, amidst the reverberations of the Covid-19 pandemic, the evolving needs of students and society, and the myriad other challenges, complexities, and uncertainties faced by both higher education institutions and social-ecological systems more broadly, dynamic pedagogical processes are needed in the pursuit of sustainability education objectives. I respond to this context in this chapter by describing strategies for activating key competencies in sustainability, specifically through a design-based

approach that leverages multifaceted formative assessment to cultivate and capture students' emergent competencies. This approach addresses struggles for sustainability education in higher education to clarify learning objectives, assess learning outcomes, and understand the efficacy of pedagogical strategies (Redman et al., 2021). By examining the learning processes in an undergraduate, introductory sustainability course, I aim to add to the range of approaches to sustainability competency development, while promoting new orientations to assessment that emphasize personal and social transformative learning. Expanding upon the ways that competencies are developed and assessed can support not only transferable pedagogical innovations, but also contribute to fostering competencies that can be applied in a multitude of ways in responding to rapidly growing sustainability dilemmas.

2. Appraising the Competencies Discourse

As sustainability courses and programs have proliferated in higher education, sustainability competencies have come to offer a meaningful framework for possible learning objectives. Since the seminal work of Wiek et al. (2011) established a prominent area of research and practice, instructors and scholars have interpreted and implemented the set of key competencies in sustainability in wide-ranging ways (e.g., Evans, 2019; Lozano et al., 2017; Rieckmann, 2012, Shephard et al., 2019). Building towards a standard yet adaptable reference framework of sustainability competencies has been beneficial across stakeholder groups in higher education programs. The key competencies can be relied upon to support instructors, administrators, and employers in charting what students need, both personally and professionally, to contribute to the creation of sustainable futures. However, even with burgeoning efforts to map and adopt sustainability competencies and their usefulness in higher education, there remain gaps in the discourse which this chapter attempts to address.

In addition to these gaps in the discourse, it is relevant to consider the insights that have emerged regarding sustainability competencies and their implications for sustainability courses and programs. These insights, gleaned from analysis of the literature and discussion with practitioners, have informed the assumptions and approaches employed in this project. First, sustainability competencies, in their many nuanced versions, represent a relevant framework for courses and programs in higher education that can guide not only learning but action in developing sustainability solutions. It is important to recognize that the key competencies framework outlines valuable abilities and processes for addressing sustainability problems in addition to detailing potential areas from which to derive learning objectives. Second, the competencies are dynamic rather than deterministic or abstract, making them adaptable in place-based and context-relevant ways. While overarching competency frameworks and definitions exist, how sustainability competencies are applied and activated depends on the values and aspirations of unique institutional and community contexts. Third, despite growing convergence on the set of key competencies in sustainability (Brundiers et al., 2021), there remains terminological and technical confusion about what the competencies are and what they look like in practice. The myriad understandings of sustainability competencies, while providing versatility in how they are implemented, have also undermined the rigor in how they are developed and assessed as efforts have emphasized conceptual clarification instead of concrete contextualization of effective practices. Attempting to build from convergence on the key competencies in sustainability, as well as leveraging the range of approaches that have emerged, might help to construct an innovative, robust, and heterogeneous field.

In this example, I draw primarily from the framework developed by Wiek et al. (2011), which has been advanced by Brundiers et al. (2021). They provide the following set of interrelated competencies for individual and collective abilities:

- **Systems thinking**: The ability to analyze sustainability problems and complex systems across different domains and scales.
- **Values thinking**: The ability to map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets, informed, for example, by concepts of justice and equity.
- **Futures thinking**: The ability to anticipate how sustainability problems might evolve and to analyze, evaluate, and craft rich pictures of future visions.
- **Strategic thinking**: The ability to design and implement interventions, transitions, and transformational actions, including mobilizing resources and navigating barriers to reach envisioned outcomes.

- **Interpersonal**: The ability to initiate, facilitate, and support different types of collaboration, communication, and participatory sustainability problem-solving processes.
- **Intrapersonal**: The ability to regulate, motivate, and evaluate one's own emotions, desires, thoughts, behaviors, and personality in relation to sustainability values and resilience-oriented self-care.
- **Implementation**: The ability to realize a planned solution by addressing emerging challenges and adjusting to actualize collective visions of sustainability.
- **Integrated Problem-Solving**: The ability to meaningfully integrate the other competencies and apply them in solutions to complex sustainability problems.

There are significant overlaps between the framework for key competencies in sustainability provided by these authors and the insights offered by Evans (2019) and Lozano et al. (2017). I find both the interlinkages and nuances of these different approaches valuable in outlining how sustainability competencies come to be explored, expressed, and evaluated in practice. Though I have emphasized the work of Wiek et al. (2011) and Brundiers et al. (2021), interpretations from these other frameworks remain valid in appraising the approaches and outcomes of this example. However, I am less concerned with conceptualizing specific competencies and more with examining ways of cultivating and capturing competencies in the context of learning outcomes related to sustainability in higher education. While the learning experience described in this example guided students to consider a range of competencies, it was ultimately open-ended in which competencies students would find most meaningful in the context of their experience and personal emergence as sustainability change agents. In the following sections, I consider the approaches and processes that supported students to develop, reflect on, and appraise their sustainability competencies, while examining the value of sustainability competencies in framing the design of pedagogies and assessments, as well as the learning outcomes of students, related to sustainability in higher education.

3. Design Elements & Rationale

The discourse on sustainability competencies suggests an evolving yet complex field in both theory and practice, defined by both shortcomings and opportunities for progress. This chapter seeks to engage with these opportunities for research and teaching on sustainability competencies in order to advance pedagogical strategies that can equip students to become sustainability change agents. Building from the insights described above, this example explores four elements (design-based research, formative assessment, transformative learning, and photovoice reflection) as tools to promote competency development and assessment. Examining these elements provides insights on ways to strategically design experiences for students that align pedagogical approaches, learning activities, and assessment processes. While each element contributes uniquely to sustainability competency development and assessment, together they function to enhance opportunities for individual and interpersonal reflection that enable students to consider their emerging competencies and how they might apply them in creating sustainable futures.

The elements were implemented in an introductory, undergraduate sustainability course at Mesa Community College in the Phoenix, Arizona, metropolitan area. The course, "Sustainable Cities", is open to students of all majors, as it functions as a required course for certain environmental-focused programs and as an elective for more general social science and humanities programs. The course serves as an overview of sustainability for students who may or may not pursue professions in this field. It also contributes to a general education program that many students utilize as a foundation to transfer to the larger, research-intensive institution in the area, Arizona State University, which has a range of sustainability-related courses and programs. During the project described in this example, the course had 15 students who participated in a synchronous online format due to the Covid-19 pandemic, though the course is typically conducted in-person. The following sections provide background on the design elements before describing how they were implemented in this context. These sections provide details on practical application and a rationale for how each element addresses opportunities related to the development and assessment of sustainability competencies.

3.1 Design-Based Research

In seeking to examine the relationships between theory and practice, design-based research (DBR) approaches can be used to develop profiles of pedagogical processes in all of their complexity, while tracing the connections and consequences of design components such as pedagogies, learning experiences, and assessments (Barab & Squire, 2004). Though design-based research has been underutilized in sustainability education (see Wals & Alblas, 1997 or Cremers et al., 2016 for exceptions), it offers an appealing strategy for analyzing how key competencies are developed and assessed. One method that DBR provides for this endeavor is conjecture mapping. Utilizing conjecture maps to organize the relation between design elements and outcomes helps in "articulating the joint design and theoretical ideas embodied in a learning environment in a way that supports choices about the means for testing them" (Sandoval, 2014, p.20). In this way, DBR and the tool of conjecture mapping can facilitate design and analysis of a process to cultivate students' sustainability competencies.

This example explores the following conjecture (as detailed in Figure 1):

A multifaceted formative assessment approach will function to activate critical reflection and shared dialogue that enable transformative learning processes to facilitate the development of students' key competencies in sustainability.

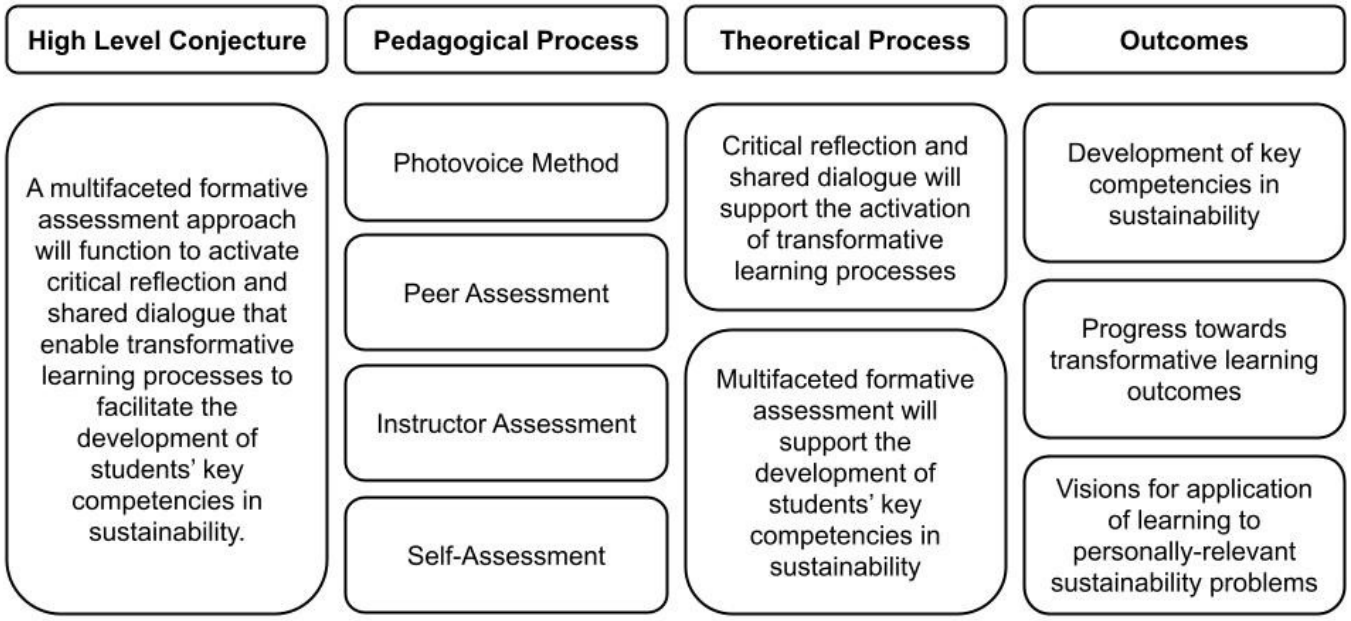


Figure 1: Conjecture Map (Based off Sandoval, 2014)

3.2 Formative Assessment

Though there remain issues in assessing sustainability competencies, especially in orienting practices beyond assessment *of* learning towards assessment *for* learning (Wiliam, 2011), there are established approaches to formative assessment outside of sustainability education. Formative assessment contributes information to the learning experience that teachers can use for instructional decisions, and that students can use in improving their experience, while also generating motivation and community among learners (Brookhart, 2007). More specifically, formative assessment supports learners in coming to understand what good performance is, how current performance relates to good performance, and how to close the gap between the two (Tan, 2013). The assessment process, rather than a static endeavor, can be approached as dialogic and dynamic, the positive effects of which can be amplified by integrating peer- (Boud, et al., 2014) and self-assessment (Boud, 2013) processes that stimulate critical reflection and shared dialogue. Critical reflection entails looking inward and outward (in relation to oneself) and backward and forward (in relation to time) to appraise and adapt one's perspective (Liu, 2015; Taczak & Robertson,

2016). Meanwhile, the process of shared dialogue in the context of assessment involves different types of exchanges such as feed up (clarifying the purpose of the activity), feedback (responding to the student's work), and feed forward (insights for modification or improvement) (Hattie & Timperley, 2007). Together, fostering critical reflection and shared dialogue can lead to formative assessment that supports students in analyzing the emerging sustainability competencies of themselves and others, negotiating meaning for these competencies, and considering ways to apply them.

3.3 Transformative Learning

The personal and interactive processes prompted by formative assessment are also factors that can contribute to transformative learning. Established by Jack Mezirow (1978), transformative learning theory outlines ten phases through which learners progress, tracing a path through "a deep, structural shift in basic premises of thought, feelings, and actions" that "dramatically and permanently alters our way of being in the world" (Transformative Learning Centre, 2004). In this process, self-examination, questioning of sociocultural assumptions, and exploration of new perspectives, roles, and actions are essential to changing one's ways of being, thinking, and doing. These objectives align with the aspirations of sustainability education (Michel et al., 2020), particularly its emphasis on the connection between individual and collective transformation towards more sustainable futures (Sterling, 2011). Critical reflection in collaborative learning spaces has been associated with these transformative learning outcomes that help students to alter their perspectives regarding sustainability assumptions, values, and objectives (Schnitzler, 2019). Transformative learning experiences have also been linked to the development of competencies such as systems thinking, values thinking, and interpersonal capacities, as well as motivations and agency to implement them (Aboytes & Barth, 2020). From these insights, it is apparent that transformative learning operates as an effective frame to support competency development and application.

3.4 Photovoice Reflection

The final element of the design described in this example was the use of photovoice as a method to encourage reflection upon sustainability challenges and one's role in devising strategies to address them. Photovoice entails taking photos, often while immersed in one's community context, and explaining the rationale and implications of those images and one's relation to the concepts, thoughts, and feelings that they evoke. This personal yet social process can contribute to individual and collective change processes (Coronado et al., 2020), including in sustainability courses in higher education (Konrad et al., 2020). Thus, photovoice reflection can be used to spark cognitive, social, and emotional processes of learning that may contribute to the development of key competencies in sustainability.

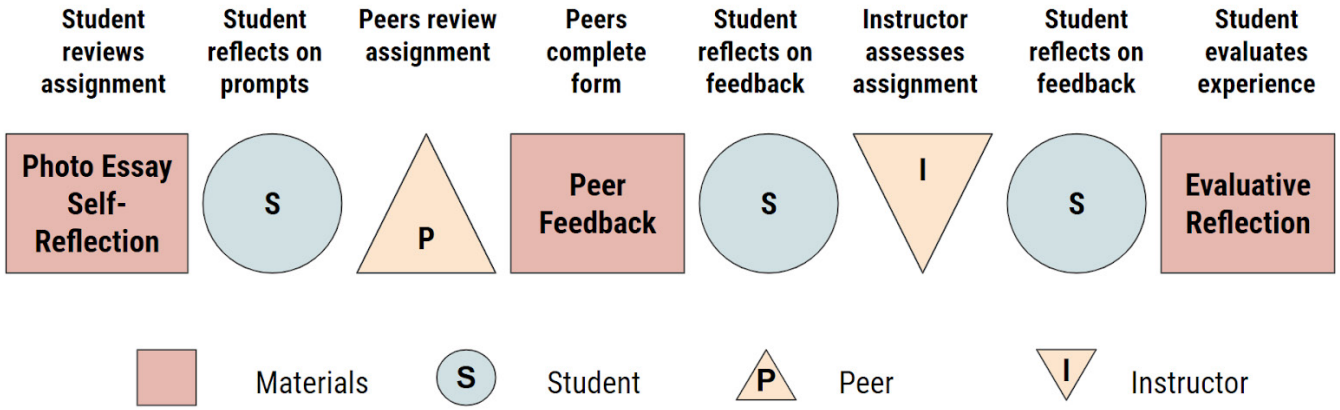
4. The Pedagogical Process

Building from the design elements, a multi-phased pedagogical and multifaceted assessment process was employed in the "Sustainable Cities" course. This process aimed to cultivate competency development by supporting students to investigate a sustainability problem (the urban heat island effect) and by facilitating an exchange of feedback and reflection between students, peers, and the instructor. The activity and subsequent assessment phases were implemented asynchronously via an online learning platform. Students advanced through four phases of the pedagogical process:

1. Urban heat island effect activity
2. Peer assessment
3. Instructor assessment
4. Self-assessment.

The basic details of this process are presented in Figure 2 which demonstrates the interactions among students, peers, instructors, and the materials involved in their learning activities. Students were introduced to their assignment through an overview video that described some of the key concepts they would be exploring and how they would engage in an interactive learning process (see Box 1 for assignment description and objectives). The assignment was administered over the course of two weeks towards the end of the semester. In this way, students were intended to leverage their knowledge, attitudes, values, and skills developed throughout the course toward deeper reflection, exchange, and application. The sections below describe the learning process and considerations in each phase.

Figure 2: Phases of the Pedagogical Process



Box 1: Assignment Description and Objectives

Description

In this assignment, you will explore the causes and effects, as well as mitigation strategies, related to the Urban Heat Island (UHI) effect. UHI is a significant sustainability challenge in many regions but can be an especially significant issue in the Phoenix area. You will analyze UHI and how it impacts Phoenix area communities, reflect on how this relates to your understanding of sustainability, and consider how you can contribute to addressing these negative impacts. You will do this through four phases: composing a photo essay, providing peer feedback, receiving instructor feedback, and completing a final reflection.

Objectives

By the end of this activity, you will have had the opportunity to:

1. Describe the Urban Heat Island effect, the negative impacts that it creates, and possibilities for mitigation.
2. Consider the perspectives of your peers and provide critical feedback to support increased group learning.
3. Reflect on your role in creating a sustainable future and the skills that you have to contribute to collective action.

4.1 Urban Heat Island Effect Activity

In this first phase of the assignment, the students utilized a photovoice method to create a photo essay by selecting relevant images, explaining their rationale behind each selection, and responding to prompts about key concepts. The prompts related to two categories of concepts: (1) causes, effects, and potential solutions of the urban heat island effect (see Image), and (2) students' potential roles and abilities to address this and other sustainability challenges. By exploring these two categories, the activity aimed to initiate a process of critical reflection through which the students contemplated their motivations for contributing to sustainable futures, as well as their emerging competencies to help actualize transitions towards these outcomes. Students completed the activity by responding to each prompt (see Box 2) with a brief paragraph, selecting a relevant image that represented their thoughts and feelings, and then providing another brief paragraph to explain the rationale behind their image.

Image: Urban Heat Island Effect in the Phoenix Area (Photo by Rebecca King)

Box 2: Urban Heat Island Effect Activity Prompts

1. What is the urban heat island effect? What causes it?
2. What are the effects of the urban heat island effect? What are examples of impacts in the Phoenix area?
3. What are mitigation strategies to address the urban heat island effect? What are examples of strategies in the Phoenix area?
4. What does sustainability mean to you?
5. What does a sustainable future look like to you?
6. How can you contribute to creating a sustainable future?
7. How is the urban heat island effect related to you?
8. What skills do you have to contribute to mitigating the effects of the urban heat island effect, or to creating a sustainable future?
9. What changes need to happen in society to address the urban heat island effect, or to create a sustainable future?

4.2 Peer Assessment

In the second phase of the assignment, students shared their work with two peers who then provided feedback. To do so, students completed a brief form (see Box 3) that facilitated their analysis of their peer's work. The form suggested offering feedback in two areas: (1) the quality of the photo essay and accompanying insights, and (2) the reflections that the essay stimulated for students regarding their own assignment. This process aimed to elaborate upon the critical reflection initiated in the first phase by activating shared dialogue among peers to expand upon the learning process. By reviewing the work of two peers and receiving feedback from two others, this activity supported the maturation of a learning community in which students demonstrated their capacity to appraise learning in the context of sustainability problem-solving.

Box 3: Peer Assessment Prompts

1. What did you appreciate about their description of the urban heat island effect, sustainability, and the skills and actions needed to create a sustainable future?
2. What did you think of the images that they selected and how they related to their descriptions?
3. In what ways did their post help you to think about your role or skills in addressing the urban heat island effect or creating a sustainable future?
4. Please add any other feedback or questions that you have.

4.3 Instructor Assessment

In the third phase of the assignment, the instructor assessed the students' photo essay assignment, drawing from peer feedback to inform a more comprehensive and nuanced evaluation of the students' work. The instructor provided open-ended feedback on both the quality of the students' assignment and potential implications for sustainability challenges and strategies. While the instructor performed an assessment of student learning in this phase, it was less about providing a grade than delivering feedback that furthered a process of shared dialogue and critical reflection among students, peers, and the instructor. This distinction between grading and assessment helps to illustrate the range of approaches to assessment that surpass merely capturing learning to spurring and amplifying it.

4.4 Self-Assessment

In the final phase of the assignment, the students integrated feedback from peers and the instructor with related insights stemming from participating in the multifaceted assessment process to deepen and extend their learning. This contributed to a self-assessment activity in which students reflected through a series of questions (see Box 4) upon their learning outcomes and how the process helped to facilitate them. Students considered how their learning translated to their motivations and competencies to act as sustainability change agents. Thus, students attempted to both assess and contemplate ways to apply their learning.

Box 4: Self-Assessment Questions

Note: Odd numbered questions were closed responses on a scale ranging from "very" to "not at all". All other questions were open-ended responses.

1. How motivated are you to create a sustainable future?
2. In what ways do you feel motivated to create a sustainable future?
3. How strong do you think your skills are to create a sustainable future?
4. In what ways do you think your skills can contribute to creating a sustainable future?
5. How much do you feel a part of a broader effort by society to create a sustainable future?
6. In what ways do you think society is progressing towards a sustainable future?
7. How confident are you in your ability to take action to create a sustainable future?
8. What are your intentions in taking action to create a sustainable future? Do you feel able to take these actions? Why or why not?
9. How helpful was the photo essay activity in supporting you to reflect on your role in creating a sustainable future?
10. What did you like, or not like, about the photo essay activity?
11. How helpful was the peer feedback activity in supporting you to think about the skills or actions needed to create a sustainable future?
12. In what ways did the peer feedback activity contribute to your learning?
13. How helpful was the instructor's feedback in supporting you to think about how to apply your learning?
14. In what ways did the instructor's feedback support you to think about how to apply your learning to create a sustainable future?

5. Insights

The pedagogical process yielded insights concerning which key competencies were developed and became most relevant to students in the context of their assignment on addressing the urban heat island effect. The project also illustrated how critical reflection and shared dialogue can support competency development, while providing lessons for how they might be assessed. After students completed the assignment, their responses were analyzed to determine which competencies were expressed throughout the different phases and which interactions and reflections contributed to their development. The

key competencies in sustainability framework (Wiek et al., 2011; Brundiers et al., 2021) was used as a deductive coding scheme to identify which competencies surfaced throughout the students' experience. An interactional analysis approach (Ajjawi & Boud, 2017) was then used to map the individual and collective reflective processes that supported the development and assessment of students' sustainability competencies. Specifically, this approach looked at the intersection of different feedback functions, reflection types and directions, and the characteristics that students demonstrated to represent progress through different stages along the transformative learning continuum. Preliminary insights in these areas are presented below to suggest which sustainability competencies were articulated by students and how they were cultivated and captured through a transformative and collaborative approach.

The findings demonstrated systems thinking and futures thinking as key foundations for students as they considered the challenges of the urban heat island effect and potential actions to address them. As others have described, these competencies were important for students to holistically analyze complex problems (Mehren et al., 2018; Sandri, 2013), such as the urban heat island effect, while cultivating hope to envision ways towards more sustainable futures (Ojala, 2017). Underlying these abilities was values thinking, which was highlighted as central to understanding the root causes of sustainability problems as well as the individual and collective change processes necessary to advance towards sustainable futures. Students emphasized how the mindsets, attitudes, and aspirations that people bring to sustainability, as well as how they evolve over time, are fundamental to motivating personal and social actions towards sustainability (Komasinski & Ishimura, 2017; Maina-Okori et al., 2018) In addition to these competencies, interpersonal and intrapersonal competencies were expressed as pivotal in being able to engage others in generating action while navigating the personal and professional demands of these endeavors. Students emphasized the importance of being able to collaborate with others from diverse backgrounds and perspectives (Brundiers & Wiek, 2017), as well as the need for the personal awareness and adaptability to negotiate the inner processes that can support external efforts to foster sustainability (Frank, 2021). These insights affirm the interrelated nature of the key competencies in sustainability and suggest that developing them requires a blend of targeted and diverse, open-ended approaches.

Sustainability education research and practice has identified many relevant approaches that can contribute to competency development in higher education. This example elaborates on another approach by exploring the role that multifaceted formative assessment can play in cultivating key competencies in sustainability and capturing the processes behind their development. Through the use of a design-based approach, this example illustrates the possibility of collaborative pedagogical and assessment strategies to facilitate personal and collective reflection that leads to transformative learning experiences. By supporting critical reflection within and among students, this approach to assessment captured the learning progression at different phases while facilitating learning as well. Meaningful reflections looked inward upon personal values, beliefs, and behaviors, outward upon social assumptions and their consequences for sustainability, and forward to possibilities for action. These reflections sparked feelings of motivation and agency to act as change agents, which were amplified by shared dialogue. The feedback between students, peers, and instructors helped to stimulate self-examination and exploration of new perspectives and possible behaviors along a transformative learning process oriented towards sustainability. Thus, multifaceted formative assessment can facilitate not only competency development but broader outcomes that can support the application of learning in the individual and collective pursuit of sustainability.

6. Conclusion

Advancing towards sustainable futures will demand more than a broad and diverse population equipped with key competencies in sustainability to act as change agents. Multilevel changes that engage institutions and industries in addition to individuals are necessary to ensure that sustainability solutions are commensurate with the challenges that they encounter (Bamberg et al., 2021). Higher education can drive change across these levels, beginning with implementing pedagogical strategies to activate key competencies in sustainability in students and assessment approaches to effectively evaluate students' emergent capacities to contribute to creating sustainable futures. Design-based approaches, formative assessment, critical reflection, and shared dialogue represent a set of tools to add to the diversity of resources for activating and assessing key competencies in sustainability. In meeting

the needs of students and society and the imperative of a more sustainable future, being able to rely upon these tools to support learning and action will prove valuable in maximizing the opportunities for transformation.

Author Bio

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Specifications Grading to Support Sustainability Competencies

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Abstract

Traditional grading systems can focus students on a grade rather than on mastery (Smeding et al, 2013). But sustainability competencies are not about a grade. For example, systems competence, transdisciplinary competence, interpersonal and communication competence, along with the others described by Evans (2019) are better supported by an innovative approach to grading called specifications grading. Specifications grading, developed by Nilson (2014), focuses on reaching a set level of mastery. Assignments are graded as complete/incomplete, with the possibility of revision. Grades are determined by set bundles or groups of assignments. Higher grades require that a student completes more bundles of work and/or more challenging work. Nilson argues that this approach has many benefits including increased rigor and greater transparency. In this chapter, author Tai Munro will look at the process of changing a sustainability course from traditional grading to specifications grading, discuss why specifications grading is more conducive to supporting students in developing sustainability competencies, and examine how this approach changes the experience of teaching and learning sustainability.

Keywords: *Specifications grading, sustainability competencies,sustainability education, alternative assessment, equity*

1. Introduction

Traditional grading systems typically have a collection of assessments, each worth a certain percentage of the course grade. Each assessment is graded by the instructor and awarded a certain number of points, percentage or otherwise, based on how well it meets an articulated set of criteria. Assessments may be labelled as formative or summative within this system; however, the grade on each assessment contributes to the final grade in the course based on the weight of that assessment. There may be variations on this theme (for example, marking homework based on completion rather than performance), but generally speaking they are all just variations on a theme.

I taught in these traditional grading systems for many years in science, education, and sustainability courses ranging between 10 and 70 students at both universities and technical institutes, and still do when I don't have the option today. But my discomfort with this approach has been steadily increasing. In face-to-face courses I watched as papers and exams filled the class recycle bin following a cursory look at the grade. All that time spent providing feedback, was there even any point? My tipping point though

came in an introduction to sustainability course offered at a medium sized, undergraduate university in Edmonton, Alberta, Canada.

Systems thinking is identified as a key competency for sustainability in frameworks by both Wiek, Withycombe, and Redman (2011) and Evans (2019). And yet, a "passing grade in a course does not certify competency in *any* of the outcomes" (Nilson, 2014, p. 4-5). Within traditionally graded courses, students were successfully passing the course without achieving competency with systems thinking. Moreover, Nilson suggests that students don't necessarily realize that they are lacking a key competency because their final grade doesn't distinguish one competency from another. How could I say that my students were capable of moving to the next sustainability course? How could I assure them that they had achieved a basic level of competence within sustainability?

Around the same time, I also started exploring how course design, including grading, could influence equity. Feldman (2018) describes some of the ways in which traditional grading is inequitable including setting over half the scale as a fail (<50%) and including formative assessments in the final grade, which punishes students who take longer to learn a concept or skill. He also points out, as Nilson (2014) did, that grades do a poor job of specifying which concepts students are successful with and which ones they still need support on.

Smeding et al. (2013) found that switching from a selection orientation to a mastery orientation in assessment reduced the achievement gap due to socio-economic factors. Traditional grading supports a selection orientation, which focuses on comparing people and their work. The extreme version of selection is "grading on a curve" where student marks are adjusted based on comparisons with other members of the class, but it also shows up in less overt ways such as when a faculty member declares that they know their assessment is good because only a few students got A's. What they are really saying is that they know their assessment was good because an appropriate number of people failed.

Mastery orientations, on the other hand, suggest that all students can achieve mastery; they may just vary in the amount of support required and the time it takes. Achieving sustainability requires that all individuals, from all backgrounds participate in meaningful ways. Developing these competencies should not be dependent on the privilege or background that a student enters a course with.

We can also apply Dweck's lens of growth versus fixed mindsets. While it is clear that it is more than just someone's mindset at play when they are overcoming challenges like lower socioeconomic status (e.g. Bernardo, 2021), it is also apparent that having a selection orientation can encourage the belief that someone either can or can't: "I'm a C student" for example. A mastery orientation, on the other hand, supports students in believing that they have the ability to learn and develop even if it is currently challenging (Dweck, 1986).

The question then is how can we structure grading and assessment to promote mastery learning AND ensure that students are meeting all required outcomes? Nilson's (2014) approach to specifications grading has four components. First, grades are determined by bundles of work. To get an A you complete additional work, or different types of work, than required for a lower grade. Students know what the different bundles involve from the beginning of the course and can make choices based on their goals, as well as their current capacity. Second, all assignments are marked as complete or incomplete based on a clearly articulated standard or specifications. This aspect does away with the time an instructor might spend figuring out whether an assignment was worth 75% or 80%, a determination that Feldman (2018) identified as contributing to overall inequity. Third is the opportunity to revise assignments that don't meet the standard. This enables students to work towards mastery rather than accept the mark they received and move on. The fourth component of specifications grading is a token economy. In the token economy, students are given a set number of tokens at the beginning of the semester, sometimes with an opportunity to earn additional tokens. They then exchange these tokens for their revision attempts and other potential things like submitting an assignment late, or to miss a class if attendance forms part of their grade package. I have not used a token system, but I have implemented the other three components.

2. What changes between traditional grading and specifications grading?

To demonstrate the process of implementing specifications grading, I am going to use a systems thinking assignment and associated competency as an example throughout this section. As such, it is pertinent to provide a brief overview of the assignment and how it supports development of systems competence.

The first major assignment that students complete in the introductory sustainability course discussed here is to create a basic system map about a sustainability challenge of their choice. The purpose is to apply systems thinking -- elements, interconnections, balancing and reinforcing feedback loops, leverage points, and purpose/function (Meadows, 2008) -- to a sustainability challenge. I have developed the material that guides them to this point over several semesters, resulting in the creation of an open educational resource (OER): Introduction to Systems Thinking (Munro, 2021).

The development of the systems map directly contributes to the development of the systems competence described by Evans (2019). Systems competence is the "ability to collectively analyze complex systems across multiple domains (cultural, environmental, economic, political, etc.) and at varying scales (local to global) through considering cascading effects, inertia, feedback loops, emergence, and other systemic features in order to develop insights related to sustainability issues, challenges, and opportunities (past, current, and future)" (p. 7). Given that the course is at the introductory level, the competence level set for the map is also at an introductory level, but it meets many of the component knowledge and skill requirements identified by Evans such as "recognition of interconnections, interdependencies, and relationships", "basic understanding of how to think in terms of systems and their elements, characteristics, and behaviors", and "establishing system boundaries" (p. 7).

Systems thinking goes against the more common reductionist approach of breaking problems down and tackling individual parts of the problem (Davis & Sumara, 2006; Bowers, 2001). Further, the concepts of systems thinking, particularly balancing and reinforcing feedback loops, are difficult for students to understand in a way that lets them identify examples without support immediately. As a result, scaffolding is an important part of this assignment, and you will see in the OER that an entire page is dedicated to completing practice systems maps that feature decreasing levels of support so that students are prepared to complete an independent map at the end.

Using traditional grading approaches, a student completed their systems map and then received a percentage grade on the assignment. Unless a student submitted their map for feedback prior to the deadline, or met with the instructor, feedback was deferred until they completed the summative task and submitted their assignment. This is a problem because "feedback that is deferred until after the summative task has been completed is unlikely to affect student understanding because students' attention is now focused on a new topic" (Frey & Fisher, 2013, p. 66). In addition, "making comments and marking a paper with a letter grade does little to encourage our students to learn from mistakes rather than fear them" (Walsh-Moorman, Ours, Deaton, & McGinty, 2020, p. 21). As a result, unintentional as it may be, traditional grading can send the message that systems thinking is something that you can either do well, or you can't. This supports a fixed mindset about a key competency for sustainability and can undermine the idea that effort is part of both learning and being sustainable. In this system, a student moves onto the next assignment, regardless of their mastery, or lack thereof, of systems thinking. This then impacts future coursework and assignments as systems thinking is foundational to the rest of the course. As a result, other key competencies of sustainability like transdisciplinary competence, creative and strategic competence, and critical and normative competence may also be hindered.

With a specifications grading approach, however, we see a different pattern develop. A student completes their systems map and submits it by the deadline and the instructor provides feedback. An assignment that doesn't meet the specifications is returned to the student for revisions based on the feedback provided. This requires that the feedback includes clear directions for improvement, rather than just evaluative feedback (Elkins, 2016). The student assesses the feedback and their original assignment to determine what they need to improve or alter their understanding of. Then they revise their assignment, potentially in consultation with their instructor, and resubmit. In the process, the student works on critical transferable skills like listening and responding to feedback and self-assessment, skills that contribute to other sustainability competencies described by Evans (2019) like critical and normative competence and interpersonal and communication competence. The experience also sends the message that learning takes work and failing is okay because it is something to learn from. And finally, they continue to work on achieving competence with systems thinking until they are successful at reaching the standard for the course.

Specifications grading allows for certain assignments to be set as required, as the systems map is in the course discussed here. A student cannot pass the course unless they achieve a complete on the systems

mapping assignment. This means that any student, whether they have earned a D or an A+ has met a B level standard, the standard set for the course, in systems competence. Thus, with specifications grading a passing grade does certify competency. This is supported by others who have studied specifications grading such as Vitale and Concepción (2021), Blackstone and Oldmixon (2019), and Elkins (2016). As an additional benefit, it is possible to add more advanced achievement to higher letter grades. In the course discussed, earning an A requires the completion of a second systems map, this time completed as a group with peers from other programs, faculties, and backgrounds contributing to additional skills and knowledge from Evans' (2019) competencies.

3. The process of conversion

The process of changing the entire grading structure can be overwhelming. In this section, I'm going to describe some of the key elements that I used to make this transition manageable.

First, a little about the context. During the Covid-19 pandemic the introduction to sustainability course moved from face-to-face to online and from a co-taught model to a single instructor. The class size also increased from 40 to 50. I became the sole instructor for the course, but I had co-taught the course previously. The course is housed within the School of Continuing Education in order to preserve the interdisciplinary and transdisciplinary nature of sustainability. The course is commonly taken by students from all five faculties at the institution -- Arts and Sciences, Health and Community Studies, Nursing, Business, and Fine Arts and Communication. Despite the course sitting at the sophomore level, students come from every year of study. The one commonality that all students share is that the course is an elective.

4. Assessment Menu

Prior to adopting specifications grading, I had developed a set of required assignments, including the systems map, and a selection of assignment options that ranged in both complexity and topic area. The required assignments ensure that all students address all learning outcomes. However, I also wanted to encourage students to connect sustainability with their own personal and professional interests. This led me to develop an assessment menu from which students can choose their optional assignments. These options vary in both size and topic allowing students to choose between breadth and depth, which is often mentioned by students in their learning contracts, discussed below, as motivations for choosing one style of menu option over another. The assessment menu activities are all tied to the course learning outcomes but provide students greater choice in the topics that they investigate further and the type of assignments they complete as part of their learning.

5. Single point rubrics

I had developed detailed rubrics for each required and optional assignment prior to adopting specifications grading. This was perhaps the most beneficial component when making the switch. Changing the assignments from traditional grading to a complete/incomplete classification as required by specifications grading was a matter of identifying the appropriate level of the rubric and using that to create a single point rubric (Gonzalez, 2015) for each assignment. A single point rubric identifies the minimum requirements or specifications for each assignment rather than a range of levels of achievement. The instructor then provides feedback to students regarding where they may not have met the minimum requirements or where they have exceeded the minimum requirements.

6. Grade bundles

Identifying the grade bundles appropriate for each grade level was, for me, the most challenging aspect of switching the grading structure. To do this, I employed the process of backwards design described by Wiggins & McTighe (2005). I took the learning outcomes and identified what students needed to do to achieve the minimum level with regards to these outcomes. That became the D level. I continued to work backwards from the learning outcomes until I had four levels of grades defined. I continue to tweak these bundles each semester. One thing to note is that, although I know what a D would look like, I do not offer it as an option to the students. My most recent rendition of these bundles from a compressed semester course is included below for reference.

Minimum requirements for an A:

1. Learning contract
2. 6 weekly blog entries/responses
3. 2 Learning summaries
4. Individual systems map regarding a sustainability related system
5. Interdisciplinary systems map with your classmates
6. 40 points chosen from the assessment menu

Minimum requirements for a B:

1. Learning contract
2. 6 weekly blog entries/responses
3. 2 Learning summaries
4. Individual systems map regarding a sustainability related system
5. 30 points chosen from the assessment menu

Minimum requirements for a C:

1. Learning contract
2. Weekly blog entries/responses for weeks 2-4 + 1 from weeks 5-7
3. 1 Learning summary
4. Individual systems map regarding a sustainability related system
5. 30 points chosen from the assessment menu

7. Setting it up with students

Nilson (2014) indicated that introducing the approach to students is key to its success and acceptance. I find that, while it does require explicit explanation, students are generally very amenable to this approach. Three elements that I have found most helpful are a video explaining what the approach is and why I have chosen it (example video), completion and review of a learning contract by each student at the start of the term, and frequent check-ins throughout the semester. I will describe the latter two in more detail next.

8. Learning contract

With so many choices, between the grade bundles and the assessment menu, I needed to have a way to check in with students at the start of the term before they have time to get too stressed about the approach. As such, the first assignment the students submit is a learning contract. In it, they indicate what grade they are aiming for, list the required elements for that grade, and identify what they think they will be choosing from the assessment menu. They can change this, but I want to make sure there are no misunderstandings regarding the amount of work that they need to complete.

9. Check-ins

It is difficult to set up this grading system within the gradebook of the learning management system. I found the easiest way to set up the gradebook was using a spreadsheet, but this created barriers as students couldn't see where they were sitting during the semester. My solution has been to set up my spreadsheet in Excel and use Microsoft's mail merge feature to email all students at key points during the semester (typically three to four points depending on the length of the semester). Mail merge lets me email the entire class a personalized email within about 10 minutes. In this email, I generally include a personalized greeting based on their preferred name, which I asked for at the start of the term, and then list the activities that we have done so far and their current status (not submitted, needs revisions, completed). I also track the menu points that they have completed to that point in the term. If you are interested, here is my template spreadsheet modified as a Google Sheet.

10. Discussion

Nilson (2014) claimed that specifications grading will restore rigor and motivate students. Wasniewski, Munro, and Tandon (2021) conducted a case study analysis of two sections of the course described in this chapter: one traditionally graded and one graded with specifications grading. The results support increased rigor. One hundred percent of students who passed the specifications graded course achieved

a B or higher on all completed assignments, including the systems thinking assignment. In contrast, 71% of students achieved a B or higher on all completed assignments, with 85% of students earning a B or higher on the systems thinking assignment. These results confirmed my observations that students were more likely to achieve base levels of competencies related to sustainability with the specifications grading approach.

It is also worth discussing student motivation here because motivation can contribute to the students continuing to pursue learning opportunities within sustainability. Collecting formal data is an area of future study but anecdotally there is evidence for increased motivation. Students frequently respond to feedback given on their assignments even when they have met the requirements and completed the assignment. With traditional grading I typically only heard from students about feedback when they were challenging the grade I had assigned to the work. This matches what Nilson (2014) describes as well. In addition, students frequently elect to complete additional assignments, with one student earning more than double the required number of menu points. This corresponds with Weimer's (2013) observation that creating opportunities for autonomy and choice led to students engaging in more work. Finally, in letters to the next class of students, the current semester's students often describe how they completed extra activities or explored the optional resources because their goal was to learn rather than earn a grade. This seems to indicate that these students are more likely to continue their journey and continue to challenge themselves towards developing greater competence in the field of sustainability.

11. Conclusion

The sustainability competencies identified by Evans (2019) are identified because they are fundamental to preparing "students to address converging socio-ecological crises that permeate virtually all facets of human life and institutions, as well as the natural world" (p. 1). The goal of sustainability education should be to support students in developing these competencies. However, as I have laid out here, traditional grading structures can undermine this development, making students, institutions, and employers believe that students have competencies that they have not achieved. They may also turn people away from sustainability, believing that it is too hard, and they just don't have the ability to do it. Given the scope of the sustainability challenges we are facing, from climate change to systemic racism, we can't afford for anyone to turn away from sustainability. We also can't afford for anyone to think they have a competency that they do not. Specifications grading provides a means of focusing students on a mastery approach to sustainability competencies which is something that has the potential to inspire and motivate current and future professionals to implement the drastic changes necessary for a sustainable future. While the task of converting a course to a new approach to grading can seem daunting, I assure you that it is well worth the effort. Hearing from students about how they have been better able to focus on their learning rather than grades and have reduced anxiety contributes to my motivation to continue with this approach to create meaningful learning experiences.

Author Bio

Tai Munro, PhD has designed and taught multiple sustainability-related courses in general sustainability,education, and sciences. Recognizing that sustainability will take everyone's participation, Dr. Munro's goal is to engage all learners through flexible learning environments and equitable assessment practices. She agrees with educational psychologist Benjamin Bloom who wrote that "learning mastery is theoretically available to all, if we can find the means for helping each student" (1968, p. 3). With this in mind, she aims to enable students from all backgrounds to develop sustainability competencies and become leaders for sustainability in their current and future careers.

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Teaching Transformative Leadership for Sustainability: Integrating Culture, Content & Pedagogy

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Abstract

In response to the scale, complexity, and urgency of the sustainability challenges societies face, there has been a recognition of the profound importance of developing sustainability leaders and a concomitant rapid growth in sustainability education globally. There is a need for greater understanding, innovation, and alignment in sustainability education to ensure programs are effective in cultivating agents of change with capabilities pertinent to and commensurate with the nature of the challenge. While the sustainability education literature has widely cited the importance of "sustainability competencies," there is increasing recognition of other aspects that must be nurtured in students, including the development of their sustainability identity, agency, and perspectives conducive to working in a complex, diverse, and volatile world. This chapter describes the curriculum and pedagogy of a Stanford University master's course, *Leading Change for Sustainability*. The course cultivates a psychologically safe classroom culture in order to foster the development of student identity, agency, capabilities and perspectives. The two-prong curriculum integrates the "how" of sustainability (transformative leadership orientations) with the "what" of sustainability (models and approaches that align social and economic systems with the goal of intergenerational well-being). This curriculum is taught using diverse pedagogical approaches, including visioning, case study analysis, modeling, reflection, and practice to optimize learning outcomes. Anonymous evaluations from course participants and alumni indicate the achievement of learning objectives and the relevance of their learning to their careers as sustainability leaders.

Keywords: *Sustainability; curriculum; education; innovative pedagogy; intergenerational well-being; systems thinking; transformative leadership; social-environmental systems; systems change; collaborative leadership; multi-stakeholder partnership; transdisciplinary research*

1. Introduction

Whether you consider global effects of our linear, take-make-waste economic model or local effects such as the Indian government's withdrawal of Coca Cola's license to operate in Kerala after depleting water aquifers and incensing local communities, it is clear that a new kind of leader capable of transforming 21st century challenges into powerful opportunities is essential. This is what I refer to as sustainability leadership throughout this chapter.

As we face wicked problems of unprecedented scale and urgency, we must consider how to develop sustainability leaders with self-awareness, empathy, adaptability, vision, and an understanding of complex systems (1-6). Leaders who are self-aware and exercise empathy are more able to meaningfully engage diverse stakeholders in collaborative visioning and problem-solving, generating long-term solutions that address the root causes of our challenges. Cultivating such leaders requires intentional education. Students represent our emerging sustainability leaders. They must learn about the complex dynamics of social-ecological systems and be able to understand and engage with these systems in ways that support inclusive thriving. As we know, this requires the development of widely cited "sustainability competencies" (4). Yet this chapter proposes that our education of sustainability leaders must go beyond skills and competencies: it must nurture the identity, perspective, and agency of learners in order for them to become change agents capable of transforming economic and societal structures so that they can advance well-being around the globe, and across generations (7-10).

While there is increasing awareness of the critical importance of sustainability curricula in higher education (11-14) as well as burgeoning global demand from students seeking to become effective sustainability leaders (16-17), there is a need for greater understanding of the approaches that are most effective in developing sustainability leaders (2-4, 10-15). Historically, sustainability programs have tended to emphasize content and acquisition of knowledge pertaining to sustainability science, the social sciences, and problem-solving. Current and new programs must expand on this focus by also developing the mindset of students in ways that builds their capacity to deeply understand and navigate the complex contexts in which all sustainability challenges play out and to create enabling conditions for collaborative problem-solving with diverse stakeholders. This chapter seeks to contribute to the discussion regarding educational pathways for developing the mindsets, knowledge and competencies of future sustainability leaders by examining a Stanford University course taught by the author, *Leading Change for Sustainability,* designed to develop "New Leaders" (see Figure 1) (7).

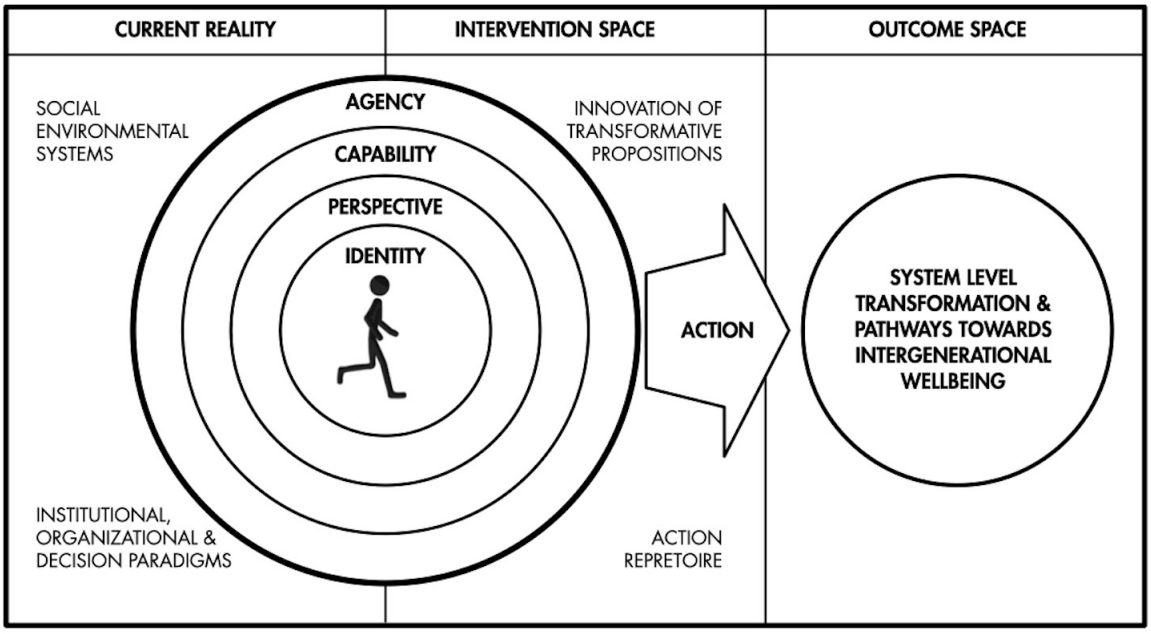

Figure 1: A Framework depicting the "New Leader", and the structure of their attributes to enable pathways towards intergenerational well-being, from Novy, Banerjee, and Matson, 2021.

Following this introductory first section, Section 2 discusses the purpose and learning objectives of *Leading Change for Sustainability*. Section 3 describes the methods used for co-creating a culture conducive to personal transformation. Section 4 reviews the structure and content of the course, and Section 5 shares the diverse pedagogical approaches used to support the development of sustainability leaders. Section 6 closes with a few reflections on what we can learn from *Leading Change for Sustainability* to guide us in developing New Leaders.

2. Purpose and Learning Objectives of *Leading Change for Sustainability*

Leading Change for Sustainability is a required course for Stanford University's Sustainability Science and Practice Master's Program (referred to as "SUST"). It complements courses that delve deeply into systems thinking, sustainability science, design thinking and innovation, storytelling, negotiation, and the art and science of decision-making by illustrating how these competencies can be integrated and put into practice to drive systemic change. The course attracts students from over 30 undergraduate majors, master's and PhD students from several programs (including business, law, education, engineering, and natural sciences), and mature students from Stanford's Distinguished Careers Program. The course is open to all interested students to convey that building a sustainable society requires diverse perspectives, broad participation, and collaboration.

The class has evolved over the past decade and offers a broad perspective on what is required to build a sustainable society. It is founded on the premise that the best intentions, combined with deep content knowledge, if poorly implemented, do not yield societal transformations aligned with inclusive well-being. The course emphasizes sustainability strategy and essential mindsets that enable leaders to effectively advance sustainability. By integrating the "*what*" and the "*how*" of sustainability, the course mirrors the synergy of strategy and culture in business: exceptional strategy isn't sufficient. To be successful, companies must have positive cultural norms that support and drive strategy. As Peter Drucker said, "Culture eats strategy for lunch."

In its early years, the course focused more on strategy – models and approaches, such as circular economy or benefit corporations – that align with the goal of sustainability. Yet, as we spoke with students and evaluated course outcomes, it became increasingly clear that learning these practical models wasn't sufficient. In order to cultivate sustainability leaders – individuals capable of leading change at scale – we needed to build a culture and offer a pedagogy that would create space for personal transformation. This would enable students not only to learn sustainability competencies and practical approaches, but to evolve their perspectives and develop their identity and sense of agency, so they learned *how* to approach work in complex systems and felt confident and empowered to do so. I challenged myself to teach not only sustainability strategy, but to help students understand how to create enabling conditions for collaboration and innovation among diverse people, so they would be more successful in their efforts to advance sustainability strategy.

The course pursues three learning objectives:

1. Understand effective strategies and models for advancing intergenerational well-being by evaluating practical approaches that generate social, ecological and economic value;
2. Cultivate transformative leadership mindsets and understand the critical importance of these mindsets in leading change in complex, dynamic social-ecological systems; and
3. Develop identity and agency as a sustainability leader.

The course uses an inclusive and holistic definition of sustainability: securing the well-being of all people, and not just a privileged few, across generations (18). Implicit in this definition is that to do so, we must nurture a thriving planet. Expanding on Bass's definition of *transformational* leadership which emphasizes a leader's capability to inspire, intellectually stimulate, and individually support followers (19), the course defines *transformative* leadership as also including an emphasis on self-transcendence, systems change, and the goal of intergenerational well-being.

3. Co-Creating a Culture for Personal Transformation

Personal transformation requires a psychologically safe environment where students reflect on their personal values and intentions, share freely, and feel comfortable taking risks as they practice change agency and develop confidence as leaders. This requires a foundation of trust. The course relies on a co-creative process between students and the instructor to build a culture that fosters personal evolution through four key approaches described below: 1) Trust-building through the course application process; 2) Establishing and maintaining cultural norms; 3) Student sharing of personal reflections and experience; and 4) Connecting on a personal level. The course seeks to create alignment between what we learn and how we relate: how we act in class, how we interact with one another, the social norms we manifest, the models we study, and the sustainability leaders we meet must align and be consistent in order to support learning and identity formation.

Trust-building through Course Application Process: The course begins the culture building process by inviting students through a brief application to articulate: a) their intentions for the course, b) what they would like to contribute, and c) a significant challenge they faced and how they navigated it. I respond to each student application individually, acknowledging their intentions, welcoming the contributions they offer, and affirming where they have already applied the transformative leadership orientations we will learn in class. These communications prior to the launch of the course develop students' sense of ownership for their experience in the course, set an expectation of contribution, and develop their comfort with personal sharing. They also allow me to nurture an initial foundation of trust with each student by illustrating my appreciation of their experience, as well as the level of commitment and engagement they can expect from me. In my replies, I thank them for supporting the cultural norms essential to creating a space for personal transformation, such as openness to diverse perspectives and willingness to reflect on and share things of personal significance. While responding individually to each student is time-consuming, it allows me to underscore the foundational values of the course and set the tone that the course aims to be transformational.

Establishing and maintaining cultural norms: During the first class period, I appreciate and acknowledge the meaningful ways in which students shared their experiences through their applications, and we brainstorm cultural norms that we would like to uphold in order to co-create an environment conducive to personal transformation. Norms that are frequently identified include: openness to diverse perspectives, lively and analytical debate without personal criticism, willingness to share personally, active listening, engagement, empathy, creating space for everyone, accepting awkwardness of silence, and being fully present. We reference our cultural norms throughout the quarter and evaluate at the end of the course how they supported achievement of class learning objectives. Collaborative class project teams share the role that norms played in their class project outcomes as part of their self-evaluations.

Student Sharing of Personal Reflections and Experience: Students share insights and reflections on the assigned readings and videos through a 250-word blog post they write each week. In addition to writing their own blogs, students comment on two other posts each week. The class blog site creates space for students to deeply consider how to apply their learnings and develop themselves as change agents. The site is open only to our class members, and students agree not to share content with people outside of class. Students connect their learning to personal experience, often being quite vulnerable with what they share and how they respond to each other in their peer comments. This allows them to learn from one another and feel supported, as peers affirm their experiences, insights, and conclusions, fostering a sense of community and trust.

This level of reflection and sharing facilitates a deeper understanding of the course material and develops students' identity and agency by asking them to assimilate and apply what they've learned to enhance their approach to leadership. For example, during week 4 when we examine implicit bias, adaptability, and growth mindset, students reflect on times when they found themselves outside of their comfort zones or challenged by a family situation, an injury, or an action they took that they regret. They discuss how the tools they studied that week would have enabled them to learn more deeply from those situations and make better decisions. They reflect on how they intend to harness those tools in the future.

Students recognize universality in human experience as they discover that their peers have faced similar challenges, creating a positive feedback loop for sharing and enhancing our collective intelligence as students learn from one another and broaden their perspectives. As students choose to be vulnerable, connection and trust is built among class members, and blog reflections deepen as the quarter progresses. Each week, I share my reflections on the blogs, highlighting important insights and reinforcing our cultural norms by emphasizing blogs that describe transformative experiences. I acknowledge each student at least once before the end of the quarter.

Connecting on a Personal Level: To build on the rapport fostered through the class blog site, time during class is structured to encourage students to connect with themselves and each other. In addition to more standard methods such as small group discussions and open class dialogue, we use several, less common approaches to cultivate community. We begin class with a check-in question relevant to that week's content posted on a white board, to which students respond as they enter the classroom. During week 7, for example, when we focus on creative capacity, the question might be "what are you most

excited to innovate?", or during week 4 when we focus on adaptability: "what is one habit you want to develop?" We have a brief dialogue about our answers to these questions, and then when students are seated, we take a pulse of how we're all doing by pointing our thumbs up, horizontal, or down. A few individuals volunteer exciting news, while others share challenges they're facing. This becomes a co-created platform for connection at the start of class, bringing us together on an emotional level before getting into the intellectual content for the day.

Perhaps the most significant is our break and mindfulness practice, which take place halfway through the three-hour class period. Students contribute food each week, often making home-made treats, and mingle with each other. They report that they value this aspect of the class for several reasons: 1) it gives them a natural and informal space to get to know each other, 2) they develop trust and familiarity with one another, which gives them more courage to express themselves in class; and 3) they build lasting relationships with peers that continue after the course ends.

Following the break, I lead a 10-minute mindfulness exercise, integrating classic breathing and meditation techniques with core themes from the week, often asking students to set an intention or reflect on a change they'd like to make. Students report that the mindfulness exercise helps them maintain focus and enhance learning and retention during class; supports their personal transformation by improving self-awareness and reducing stress; and deepens their appreciation, trust and comfort with one another.

4. Structure and Content: The "What" and the "How" of Sustainability Leadership

The Connect-Adapt-Innovate (CAN) transformative leadership orientations identified through my 25 years of work as a sustainability leader form the basic structure of the 10-week course (see Figure 2) (20) and represent the "how" of leading change for sustainability. Each three-week unit is dedicated to one CAN orientation, enabling students to begin to master one orientation at a time and become more effective change agents by the end of the quarter. Unit 1 (weeks one through three) begins with the Connect orientation, which is foundational to the other two (Adapt and Innovate). Unit 2 (weeks four through six) examines the Adapt orientation, and Unit 3 (weeks seven through nine) explores the Innovate orientation. The course takes an "inside-out" approach, requiring students to learn how each orientation manifests at different scales: first at the level of the self; second, at the level of the team or organization; and finally, at the level of community or complex system. This allows students to first consider how to develop the orientations in themselves, and then how they might apply these orientations at larger scales to teams and organizations, and to complex systems and communities.

During my career as an executive in non-profit and philanthropic organizations and a collaborator with change-makers around the world, I observed that many thoughtful people and organizations failed in their well-intended sustainability efforts, while successful leaders manifested the CAN orientations consistently. The CAN orientations emerged from this experience, as well as a multi-disciplinary examination of resilience. Given the need for 21st century leaders to work in highly volatile, complex contexts, I was interested in distilling common orientations of resilient people and systems to serve as a compass for leaders navigating and seeking to create durable change in these dynamic systems.

An examination of ecology, psychology, neuroscience, and military strategy reveals that resilient people and systems consistently orient to connect, adapt, and innovate (CAN). A look through the lens of ecology reveals that natural systems are highly *interconnected*, with species interacting with one another to provide services to the broader ecosystem, such as through pollination, seed dispersal, and nutrient cycling (connect). Species continuously *adapt* through natural selection, and *innovate* through the process of genetic mutation, trying out new approaches to surviving and thriving. Similarly, through studies in the field of psychology, we know that resilient people have a strong sense of self and meaningful relationships that give them strength (connect); view challenges as opportunities for growth (adapt); and draw on their ingenuity to shape their future (innovate). From the perspective of neuroscience and military strategy, we've learned that people in high-stakes environments – such as extreme athletes and fighter pilots – also connect, adapt, and innovate. They are fully absorbed in their environment (connect), continuously upgrade their orientation to suit the changing context (adapt), and make intuitive, split-second, and insightful decisions about how to act (innovate). Finally, effective sustainability leaders build trust with diverse stakeholders (connect), remain open to modify their interventions to align with context

(adapt), and design meaningful interventions by integrating diverse forms of knowledge and breaking frame to examine things in new ways (innovate). Combined with a clear purpose, the CAN orientations enable leaders to build resilience and drive transformative change in complex systems (see Figure 2).

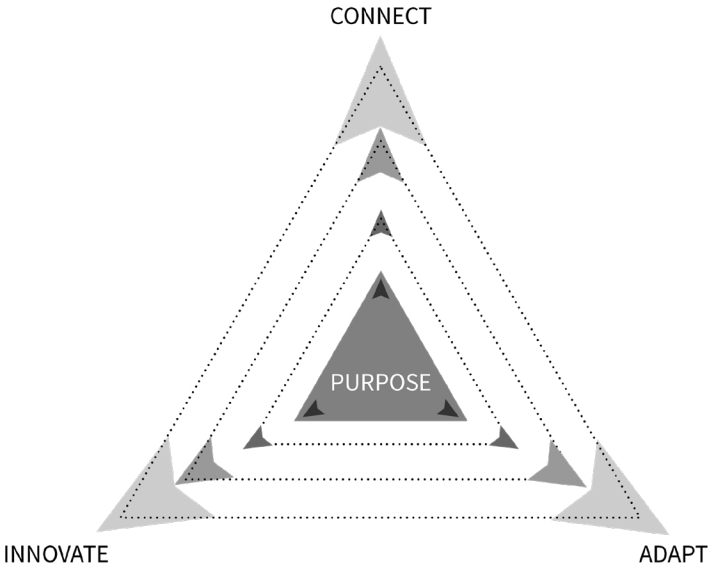

Figure 2: The Connect-Adapt-Innovation CAN Orientations

To complement teaching the "how" of sustainability by analyzing and practicing the CAN orientations, *Leading Change for Sustainability* teaches the "what" of sustainability by examining seeds of transformation: strategies and models that integrate social, ecological, and economic priorities and provide mutual benefit. These include circular economy, collaborative consumption, the sharing economy, benefit corporations, social entrepreneurship, sustainable value chains, biomimicry, ecotourism, industry-community partnerships, metrics of progress beyond GDP, environmental, social and governance (ESG) reporting, impact investing, pre-competitive problem-solving, and multi-stakeholder partnerships that emphasize sector-wide collaboration, policy interventions, market-based mechanisms, and international frameworks for cooperation and accountability.

To ensure that students learn the "what" and the "how" of sustainability in a synergistic manner, each class examines case studies that illuminate how particular leadership competencies are reflected in and enhance the viability of the seeds of transformation being studied that week. In Unit 1, for example, students learn about and develop proficiency in the Connect orientation across the three scales of study, practicing associated leadership competencies and analyzing relevant sustainability strategies (seeds of transformation) (see Figure 3).

UNIT 1: CONNECT ORIENTATION	Leadership Competencies:	Seeds of Transformation:
Week 1: Self	• Self-awareness • Authentic leadership • Resilience Thinking	• The leverage of orientations • Storytelling
Week 2: Organization	• Empathy • Engagement • Trust-building	• B Corporations • Circular supply chains • Business built on relationship
Week 3: System	• Systems thinking • Reflective conversation • Co-creating the future	• Ecotourism • Business-community partnerships • Sustainable livelihoods

Figure 3: Connect Orientation – Leadership Competencies and Seeds of Transformation Across Three Scales

As noted in Figure 3, during week one (Connect-Self), students read about the significance of authenticity and self-awareness in leadership and work on developing it in themselves. They write their life stories, identifying crucible moments that shaped their values and motivations. They consider the power of orientation and storytelling in driving transformative change by examining leaders who harness these approaches to advance sustainability. In week two (Connect-Organization), students study Sustainable Harvest, a coffee importing company exemplary of the "connect" orientation. Sustainable Harvest is a social enterprise and benefit corporation that developed a "relationship coffee model," emphasizing the primary importance of trust and mutual benefit in business (21-23). The company advances equity, transparency, and sustainability in the global coffee industry through its circular value chain, in which all stakeholders share information on pricing, cost, and revenue. It convenes annual "Let's Talk Coffee" events to allow stakeholders to learn from one another, develop empathy, forge partnerships, and innovate mutually beneficial solutions. By examining how a business exemplifies trust, empathy, and collaboration, and by evaluating the social, economic, and environmental value generated by the business, students develop an understanding of how the connect orientation is central to a company's capacity to advance intergenerational well-being.

During week 3 (Connect-System), students analyze a multi-stakeholder effort to advance conservation and development in the Amazon. The case study of Posada Amazonas, a partnership between a native community and a Peruvian eco-tourism company, highlights the importance of the connect orientation in driving systems change (24-25). With equal voting (1:1), all decisions were made by consensus, and trust was forged over a long period of time. Together, the partners built an eco-lodge owned by the community with a profit-sharing agreement of 60:40, community:company for 20 years, in which both parties committed to building the community's capacity to take over management of the lodge. After 20 years, with significant community profits and increased areas under conservation, the parties renewed their agreement because of their strong relationship, this time with 80% of revenue going to the community who had taken over management, and the remainder to the company for its marketing work.

5. Pedagogical Methods: Visioning, Analysis, Modeling, Reflection, and Practice

The content of *Leading Change for Sustainability* is delivered through a variety of pedagogical methods, including: 1) visioning, 2) systems analysis of case studies, 3) engaging with role models, 4) reflection, and 5) practice. These methods support Bloom's six levels of learning (26-27) and the achievement of course learning objectives (28-51).

Visioning: Because the capacity to envision a sustainable future is essential to leading change (52), the course begins by asking students to create a vision of a sustainable society and publish it as their first blog post. They imagine going to sleep and having a miracle occur overnight: they wake up to a new world - a sustainable society - but no one told them that the miracle took place. Their assignment is to describe how they know they are now living in a sustainable society. In the present tense, students describe in vivid detail what they see, hear, smell, taste, and touch, as well as who they are interacting with, what they are doing, and where they are living – any and all indications that that the miracle has occurred. During the first class, they explore their visions in pairs and then we discuss them as a group, creating a white board collage of the features students have noted. Students revisit their visions throughout the quarter, and during a culminating exercise on the last day of class, they reflect on what they've learned and how they would like to evolve their visions as a result.

Systems analysis of case studies: Students learn the fundamentals of systems thinking through authors including Donella Meadows, Peter Senge, and David Stroh, and then apply them to analyzing global case studies. Many of the cases are "systems case studies" written by Stanford's Change Leadership for Sustainability Program, which illustrate complex relationships and leverage points essential to systems change efforts. Students examine companies such as Unilever and Sustainable Harvest that have fully integrated sustainability as a core strategy. They also evaluate multi-stakeholder efforts to advance sustainability regionally, nationally, and globally. Students work in small groups and map actors involved, evaluate causal relationships, and identify factors of success, sharing conclusions with the full class.

In a case study on sustainable seafood, for example, students analyze root causes of global fisheries collapse and analyze the role of different actors in creating and resolving the complex challenges, including governments, the fishing industry, non-profit organizations, consumers, and foundations.

Students identify positive feedbacks between consumer awareness of the global fisheries crisis, demand for sustainable seafood, and incentives for fisheries to improve their practices. They evaluate efforts of specific actors, such as the role of philanthropic organizations in convening diverse stakeholders to agree on a global standard for sustainable fishing, funding consumer awareness campaigns, and investing in new organizations to support fisheries improvement projects and advise retailers on sustainable sourcing. Students also interact directly with sustainability leaders involved in the case studies to deepen their analysis, understanding why certain approaches were more or less effective and evaluating how well the leaders involved manifested the connect, adapt, and innovate orientations.

Engaging with Role Models: It is essential for students to engage with diverse role models and explore a multitude of pathways to sustainability leadership in order for students from myriad backgrounds to develop their identity and agency as sustainability leaders. As noted above, the class engages global sustainability leaders directly, including Unilever's former head of sustainability; the founder of Sustainable Harvest; the former President of Peru; several stakeholders from the Posada Amazonas case study, including the leader from the Ese'eja native community and the founder of Rainforest Expeditions; and an innovator-entrepreneur from Ethiopia who began his journey as an impoverished child, sorting recyclables from a local trash pile, later becoming the entrepreneur who converted that garbage into Africa's first waste-to-clean energy plant serving millions with clean energy. The sustainability leaders exemplify mastery of the connect, adapt, and innovate orientations. They join us in-person or online, and students learn from their life stories, strategies for success, failures they've experienced, nuances of their approaches, and the insights and advice they offer.

I also seek to model the connect, adapt, and innovate mindsets in my interactions with students, connecting authentically with them and showing care and empathy; being open-minded and encouraging diverse and conflicting viewpoints in the course materials as well as class discussions; and giving space for their creativity and ingenuity through the collaborative class projects. I offer examples from my career as a sustainability leader working in marine conservation, innovation, impact investing, and international development in Africa, Asia and Latin America, sharing how I learned about the importance of the CAN orientations through my work.

Reflection: The weekly sharing on the class blog site is one of the most consistent touchstones for student reflection throughout the quarter. Formulating a blog each week requires students to assimilate content and relate it to their past as well as to their future, by considering how they want to apply learnings to their future leadership. In addition, writing their life stories and sustainability visions, and participating in weekly mindfulness exercises uses reflection to foster self-awareness, growth, and emotional self-regulation, as noted above. During week 4 (Adapt-Self), students take an implicit bias test and reflect on their own biases, applying learnings from that week to explore how they might become increasingly aware of their biases. During week 2 (Connect-Organization), students reflect on empathy and listening, doing an interactive exercise on different levels of listening. We explore the difference between inquiry and advocacy, as well as sympathy and empathy. Students reflect on why empathy leads to a deeper connection with others by building greater trust and seeking to overcome power inequities.

Practice: Students develop their agency and confidence as sustainability leaders by collaborating in teams throughout the quarter to engage in sustainability leadership. They practice the CAN orientations as they implement a concrete sustainability project. Students develop their ideas and form teams early in the quarter, outlining their objectives, activities, and timelines, as well as team norms and processes to support their project. They are required to create tangible sustainability impact within the quarter and must describe a pathway to scaled impact had they been able to continue beyond the course.

One team in 2021 sought to reduce the threat to horseshoe crab populations. Horseshoe crabs are harvested because their blood contains a unique compound that is used to test for endotoxins in vaccines. Inspired to spur a change amidst a massive increase in global vaccine production due to COVID-19, the team wrote a white paper outlining the threat to horseshoe crabs and the rationale for alternatives, connected directly with and presented a letter to CEOs of pharmaceutical companies, and launched a social media campaign and accompanying petition to encourage pharma companies to switch to the synthetic alternative.

Another team brought awareness to the social and environmental justice issues related to mining minerals for lithium-ion batteries, including child slavery, poor working conditions, and environmental degradation of local environments. They gained support from Stanford's Storage.X Initiative (a research program focused on battery storage technology) to design, convene, and facilitate a global, online symposium with the Storage.X community to explore these issues. As a result, Storage.X, dedicated to accelerating the global development and implementation of revolutionary energy storage technologies, forged a commitment to integrate social and environmental justice issues into their research efforts moving forward (53).

6. Conclusion

It is of critical importance and urgency that we successfully prepare New Leaders to tackle the complex and daunting challenges we face this century. As Bill Drayton, founder of Ashoka, says, "we are in an 'everyone a change-maker' world." Universities have an essential role to play in ensuring students graduate prepared to engage as citizens in advancing the goal of intergenerational well-being. This chapter offers one approach for teaching sustainability leadership by integrating culture, content, and pedagogy. Through a cultural foundation that emphasizes openness, engagement, and empathy, *Leading Change for Sustainability* creates a psychologically safe and intellectually rich environment in which students learn leadership competencies and sustainability strategies through a variety of pedagogical methods, including visioning, systems analysis of case studies, modeling, reflection, and practice.

My aim in *Leading Change for Sustainability* is to inspire and prepare students to become New Leaders by developing their identities, perspectives, capabilities, and agency as change agents. The vision for the course emerged from the mirroring I perceive between individual attitudes, identity, well-being, and resilience on the one hand, and planetary and societal well-being and resilience on the other. I seek to instill hope and confidence in students that they can radically accelerate progress toward a sustainable society by developing mastery of sustainability strategies and the CAN transformative leadership orientations, and in so doing, also enhance their own lives.

Author Bio

Julia Novy is Professor of Practice and Faculty Co-Director of the Sustainability Science and Practice Master's Program in the Stanford Doerr School of Sustainability. She leads curriculum development and oversees the Strategies for Sustainability professional education program. Julia has 25 years' experience leading non-profit and philanthropic organizations where she has fostered multi-stakeholder partnerships to design and scale entrepreneurial solutions to global challenges and guided over $200 million in investment to sustainability innovators and entrepreneurs globally. Julia has been recognized as a Young Global Leader by the World Economic Forum and Topic Leader by the Clinton Global Initiative, and has published in the areas of sustainability education, transformative leadership, and innovation. Julia earned her B.A. in Human Biology and a minor in African Studies from Stanford University, and her M.Phil. in International Development Studies from the Institute for Development Studies at Sussex University. A Fulbright and Marshall Scholar, Julia speaks French, Spanish and Kiswahili.

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Fostering Key Competencies for Sustainability: Development of a Higher Education Teaching Format based on Service Design*

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Abstract

Against the background of severe global sustainability challenges, higher education institutions (HEIs) are called to integrate sustainability aspects into research and teaching, hereby supporting the development of sustainability competencies of students (UNESCO, 2017). Within this context, a new teaching format, that applies the Service Design methodology to tackle sustainability-related real-world challenges, was designed and conducted at a German University of Applied Sciences in autumn/ winter 2021. The teaching format was evaluated by participating students respective its contribution to the fostering of their sustainability key competencies. This paper describes the developed format and outlines how and why it helped students to develop these competencies. It thereby contributes to a highly relevant and increasingly considered research stream dealing with teaching effectiveness and the impact of pedagogical approaches on sustainability-related competencies (Cebrián, Junyent, & Mulà, 2020).

Keywords: *Education for Sustainable Development (ESD); Service Design; Design Thinking; Key Competencies for Sustainability; Teaching Effectiveness.*

1. Introduction

Higher education institutions (HEIs) are pivotal for preparing their graduates to cope with an increasingly complex and turbulent environment and to develop future decision-makers' competencies to transform our political, social and economic systems towards a sustainable future (UNESCO, 2017). Hence, a growing number of literature is dealing with the effectiveness of different teaching pedagogies and their use within classroom for such a competency development (Redman, Wiek, & Barth, 2021). Within this context, approaches such as active and collaborative learning (Evans, 2019) as well as experiential learning (Lozano, Barreiro-Gen, Lozano, & Sammalisto, 2019; Molderez & Fonseca, 2018) have been highlighted in the past. Recent studies are investigating the potential of Service Design teaching for sustainability education (e.g. Pimpa, 2019; Earle & Leyva-de la Hiz, 2021).

Based on these findings and developments, a new teaching format called "Engaging for Sustainability" was designed, conducted and evaluated in terms of contributing to the development of students' sustainability competencies. This paper aims a) to introduce the designed teaching format in order to showcase the application of Service Design and connected recommended teaching approaches and pedagogies in higher education practice, namely active, collaborative and experiential learning, and b) to assess the potential of this teaching format to enhance sustainability key competencies based on students' self-assessment.

2. Developing and Fostering Sustainability Key Competencies by Service Design

In line with the call for HEIs to enable the acquisition of competencies related to sustainability (UNESCO, 2017), a growing stream of literature addressing questions concerning these competencies can be observed (Lozano et al., 2019). Competencies can be defined as "functionally linked complex(es) of knowledge, skills, and attitudes that enable successful task performance and problem solving" (Wiek, Withycombe, & Redman, 2011, p. 204 based on Spady, 1994 and Baartman, Bastiaens, Kirschner, & Van der Vleuten, 2007). The UNESCO (2017) identifies eight key competencies for sustainability which are seen as "…essential for individuals ... to contribute to societal transformation towards sustainability" (Rieckmann, 2018, p. 42). Table 1 lists those key competencies and presents definitions for them.

Service Design can be conceptualized as a service-specific application of Design Thinking and design methodologies to immaterial products, i.e. services (Clatworthy, 2017). Design Thinking refers to a human-centred 'open' problem solving process for complex, multifaceted problems, so-called 'wicked problems' (Buchanan, 1992). Service Design targets on designing services and balances the needs of the customer with the needs of the business, aiming to create seamless and quality service experiences (Miller, 2015). It is increasingly perceived as a catalyst for innovation in national policy, regional development and business and may contribute to social innovation (Yang & Sung, 2016) and sustainable business model innovation (Prendeville & Bocken, 2017).

Table 1. Key competencies for sustainability

Key competency	Definition (from Rieckmann, 2018)
Systems thinking competency	"The ability to recognize and understand relationships, to analyse complex systems, to perceive the ways in which systems are embedded within different domains and different scales, and to deal with uncertainty" (p. 44).
Anticipatory competency	"The ability to understand and evaluate multiple futures – possible, probable and desirable – and to create one's own visions for the future, to apply the precautionary principle, to assess the consequences of actions, and to deal with risks and changes" (p. 44).
Normative competency	"The ability to understand and reflect on the norms and values that underlie one's actions and to negotiate sustainability values, principles, goals and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions" (p. 44).
Strategic competency	"The ability to collectively develop and implement innovative actions that further sustainability at the local level and further afield" (p. 44).
Collaboration competency	"The ability to learn from others; understand and respect the needs, perspectives and actions of others (empathy); understand, relate to and be sensitive to others (empathic leadership), deal with conflicts in a group; and facilitate collaborative and participatory problem-solving" (p. 44).
Critical thinking competency	"The ability to question norms, practices and opinions; reflect on own one's values, perceptions and actions; and take a position in the sustainability discourse" (p. 44).
Self-awareness competency	"The ability to reflect on one's own role in the local community and (global) society, continually evaluate and further motivate one's actions, and deal with one's feelings and desires" (p. 45).
Integrated problem-solving competency	"The overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solution that promote sustainable development - integrating the above-mentioned competencies" (p. 45).

Source: Rieckmann (2018).

When using Service Design in sustainability-related teaching, students are in the role of designers that actively and collaboratively search for solutions for real-world problems brought in by companies or other organizations. Hereby, teaching inherently builds on learning approaches that have been identified as effective for sustainability-related teaching, such as active, collaborative (Evans, 2019) and experiential learning (Lozano et al., 2019; Molderez & Fonseca, 2018). Furthermore, certain characteristics of the Service Design process are nourishing selected competencies of the described UNESCO framework: For example, by following the so-called Double Diamond Process (Design Council, 2019), students explore a wide problem space, which allows delving into multifaceted problems. Students recognize that sustainability-related design challenges involve and affect diverse stakeholders and that their proposed solutions need to consider different subsystems and fit into existing ecosystems. Service Design – especially when used for solving 'wicked problems'– therefore potentially enhances the systems thinking competency as defined by the UNESCO (2017). By giving students space for experimenting with new and innovative ideas, going through multiple iterations of understanding a human need, and transforming this understanding into new ideas and evaluating the ideas (through prototyping and testing) with the users (Clatworthy, 2017), Service Design possibly also fosters the strategic as well as integrated problem-solving competency. Service Design teams are ideally multi-disciplinary teams composed of experts in different domains and with different demographics, backgrounds and experiences. It is pivotal for Service Design to foster empathy and collaboration among the team members and with users and stakeholders, e.g. by means of interviews, observations and immersions (Miller, 2015) such that a positive impact on collaboration competency is probable.

3. Case Example: Teaching Format "Engaging for Sustainability"

3.1. Teaching Format Description

The teaching format "Engaging for Sustainability", taught at a faculty for cooperative business administration studies at a German University of Applied Sciences, is linking two originally separated modules – one focusing on sustainability aspects, the other on Service Design – with the specific intent to facilitate "education for sustainability" and reach the following objectives: increase business students' awareness of issues related to sustainability; foster the development of students' (key) competencies related to sustainability and equip them with creative problem-solving techniques to tackle 'wicked problems'; as well as encourage students to turn theory into practice and behave in a more sustainable manner.

To accomplish those objectives, the format is divided into three parts that are supplementing each other and are partly conducted parallel. In the first part students work in teams of four to five persons on real-world sustainability-related challenges brought in by project partners. Each project aims at solving a sustainability challenge by collaboratively applying the different techniques of Service Design. The project work is facilitated by a lecturer with long experience in Service Design and other creativity and innovation methods. 40 hours in presence teaching and approximately 110 hours of self-study are allocated to this part, which mainly aims at developing collaboration, strategic, integrated problem-solving, systems thinking and – to a minor part – anticipatory competency. The project work is framed by the second part of the course, which consists of theoretical inputs and group discussions on the topic of sustainability. Students get acquainted with basic concepts such as sustainability and the Sustainable Development Goals (SDGs), responsibility, ethics and social entrepreneurship and explore selected sustainability issues and their implications. This part should mainly enhance the awareness for (interconnected) sustainability issues and an understanding of the responsibility of different actors for solving them. The third part consists of reflection tasks and discussions. Students are asked to question their own behavior and attitudes and their role for contributing to a sustainable development. They are motivated to contextualize their project work in relation to the grand sustainability challenges and stakeholder needs and evaluate the impact of their work on the SDGs. The second and the third part of the course aim more on developing students' self-awareness, critical thinking and normative competency. These parts are guided by a lecturer of the field of management and sustainability and encompass 20 lecture hours and approximately ten hours of self-study.

3.2. Student Evaluation

3.2.1. Methodology

The teaching format was conducted between October and December 2021 at a German University of Applied Sciences. Participating students were asked to complete an online questionnaire after the last session of the teaching format has taken place, representing a reflection on their learning process as well as abilities and competencies gathered throughout the teaching format participation. Overall, 26 students completed the questionnaire. Of those, four students needed to be taken out of the data analysis due to quality reasons (i.e. finishing the survey within less than ten minutes). The remaining 22 students were on average 23 years old; eight of them were aged 20 years or younger, ten students were aged between 21 and 25 years and four students were aged above 25. The majority of students was female (i.e. 15 female and seven male students) and almost all students (except three) already had work experience. In one part of the questionnaire students were presented with definitions of the eight key competencies for sustainability and asked to assess respective each competency how strong the teaching format participation contributed to its fostering for them personally using a 5-point Likert scale (ranging from "not at all" to "extremely"). In order to stimulate a thorough reflection and evaluation of the teaching format contribution, students were additionally asked to describe where they had opportunity/opportunities to practice and apply the competency in question throughout their teaching format participation (within or out of the classroom). The definitions provided to the students were developed based on the above introduced definitions presented in Rieckmann (2018), taking other works such as Wiek et al. (2011) and especially results from expert interviews conducted by the authors into consideration. The expert interviews were completed in 2021 with the general goal to develop a comprehensive and sound questionnaire for the student evaluation.

3.2.2. First Results

The analysis in this paper focuses on the question how strong the participation in the teaching format contributed to the fostering of the sustainability key competencies assessed by the students themselves (see above). First results are presented in Table 2.

Table 2. First empirical results

Competency	Average	Median	Frequency (number of students)				
			1[a]	2[b]	3[c]	4[d]	5[e]
Systems thinking competency	2.95	3	0	6	11	5	0
Anticipatory competency	3.05	3	0	5	11	6	0
Normative competency	3.18	3	0	5	9	7	1
Strategic competency	3.32	3	0	5	7	8	2
Collaboration competency	3.09	3	1	4	9	8	0
Critical thinking competency	2.91	3	0	7	10	5	0
Self-awareness competency	3.14	3	1	4	10	5	2
Integrated problem-solving competency	3.05	3	0	5	11	6	0

[a] not at all, [b] slightly, [c] moderately, [d] very, [e] extremely. Source: Own analysis.

Students indicated on average a moderate contribution of their participation in the teaching format to the enhancement of all sustainability key competencies, which is underlined by the given median values (i.e. for all competencies a median value of 3). There were only two statements that

attending the teaching format does not at all contributed to a key competency: one time in the case of the collaboration competency and one time in the case of the self-awareness competency. Overall, this suggests that the teaching format in general has a moderate but positive impact on all key competencies. Comparing the frequencies of statements respective the strength of the impact of the teaching format on the single sustainability competencies, some differences can be detected: A very high or extremely high impact of the teaching format was indicated by ten students for the strategic competency and by eight students for the normative and collaboration competency. Only five students believe that there was a high impact on the critical thinking and systems thinking competency and only six reported this impact for the integrated problem-solving and anticipatory competency.

4. Discussion and Conclusion

The present paper aimed at discussing the impact of a teaching format that employs the Service Design methodology for solving sustainability-related real-world problems on the development of eight key competencies needed by "...individuals... to contribute to societal transformation towards sustainability" (Rieckmann, 2018, p. 42). The results of a students' self-assessment indicate - in overall terms - a moderate, but positive impact of the teaching format on all eight sustainability key competencies. This might be explained with characteristics of the Service Design process and its inherent use of active, collaborative and experiential learning approaches as well as its combination with reflections and discussions about responsibility and ethics. Further investigation on potential drivers of competency development is necessary in order to further improve the effectiveness of the teaching format especially for those competencies for which the impact of the teaching format was less strongly evaluated. An important limitation of the presented study is the subjective nature of the empirical assessment of the teaching format's contribution to the sustainability key competencies: students evaluated by themselves whether taking part in the teaching format has contributed to foster their competencies. Although this approach yields important and interesting insights, it should be complemented by more objective evaluations (e.g. analysis of exam performance) to gain a comprehensive picture in terms of competency development.

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