

Conference Report

Teaching Sustainability Using an Active Learning Constructivist Approach: Discipline-Specific Case Studies in Higher Education [†]

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Abstract: In this paper we present our rationale for using an active learning constructivist approach to teach sustainability-related topics in a higher education. To push the boundaries of ecological literacy, we also develop a theoretical model for sustainability knowledge co-creation. Drawing on the experiences of faculty at a major Southeastern University in the United States, we present case studies in architecture, engineering, geography, and marketing. Four Sustainability Faculty Fellows describe their discipline-specific case studies, all of which are project-based learning experiences, and include details regarding teaching and assessment. Easily replicated in other educational contexts, these case studies contribute to the advancement of sustainability education.

Keywords: higher education; sustainability; constructivism; active learning; case studies; architecture; engineering; geography; marketing

1. Introduction

“If the integration of sustainability in higher education is closely connected to the development of emancipatory qualities it will need to provide students with a way of understanding and transforming the complex world of which they are part” [1] (p. 225). Teaching students to become environmentally emancipated means preparing them for the real-world challenges of sustainability at the local, national, and international levels. It also calls on them to develop their critical thinking and problem solving abilities in order to tackle modern-day sustainability-related issues and, where necessary, challenge the status quo. Since “emancipatory environmental groups necessarily have a strong social movement dimension” [2] (p. 705), being environmentally emancipated will likely require participation in the broader social movement of environmentalism. Our goal as educators is therefore to train those who will define and redefine the future of the environmentalist movement. With so many issues (e.g., air and water pollution, waste disposal, declining natural habitats, overpopulation, etc.) interacting with and redefining the natural systems that surround us, sustainability education has a significant

role to play in this regard (for an interactive overview of global environmental trends, see National Geographic's EarthPulse).

According to Steinemann, "the call for sustainable development echoes around the world and universities are ideally positioned to answer" [3] (p. 216). One way for universities to do so is to focus on "campus, curriculum, and community" [4] (p. 134). Universities can make campuses an integral part of sustainability education through for example, extra-curricular green events and use of green university facilities for teaching purposes. Universities can also enrich their curricula with meaningful insights into the environmental impact of both the general programs of study and the specific courses. By offering programs and courses that not only acknowledge the environmental impact of various entities (e.g., governments, corporations, consumers), but also advance student learning with the optimism of applied solutions, universities can affect sustainability education and, thereby, the environmentalist cause. As well, universities can have a positive impact on society, including university stakeholders, through community engagement in sustainable development. The three-pronged approach described herein makes universities ideally positioned to meet the global challenges of sustainability education.

In training students to be responsible citizens and good stewards of the planet, universities still have to abide by the standards and regulations of accrediting bodies. Sustainability education has to mesh with the professional guidelines set forth in certain disciplines. For example, the accrediting bodies in architecture, engineering, and business encourage (and for some programs mandate) hands-on training whereby students gain real-world experience through coops, internships, and client projects among others. Teaching students to adjust to situations and solve problems beyond the classroom positions them to solve sustainability-related issues later on. As future decision makers, problem solvers, and change agents, students will benefit from learning about sustainability through full immersion. To this end, we employ an active learning constructivist approach as the overarching instructional framework. According to King, "active learning simply means getting involved with the information presented—really thinking about it (analyzing, synthesizing, evaluating) rather than just passively receiving it and memorizing it" [5] (p. 31). In our discipline-specific case studies, students learn about sustainability through active participation and involvement in the learning process.

We argue that active learning is best suited for teaching sustainability in higher education because it is practicum-based education, experiential by its very nature. Sustainability education is multi-faceted and complex, broad and plural, fluid and amorphous. It is global and local, social and individual. As such, sustainability education and a thirst for learning go hand in hand. Using an active learning constructivist approach, we teach students how to learn and encourage them to be lifelong learners. *'Learning to learn and loving to learn'* is our pedagogical motto. Drawing from architecture, engineering, geography, and marketing, we highlight a number of sustainability-driven faculty efforts. Each discipline-specific case study provides one or more experiential learning activities, intertwines theory and practice, and considers faculty, students, and various stakeholders in the mix. To help others replicate our sustainability-based projects, we also include details regarding teaching and assessment. Forward-looking and student-centered, the case studies tackle real-world problems and call for practical solutions. A common theme among the case studies is the use of an active learning constructivist approach.

The paper's contribution is twofold, to present a novel theoretical model for teaching sustainability in higher education and to provide in-depth case studies of how to go about doing so at the collegiate level. A collaborative, multi-disciplinary effort this paper applies an active learning constructivist approach to projects in architecture, engineering, geography, and marketing. To facilitate replication, each discipline-specific case study includes a detailed overview along with material on teaching and assessment. Ultimately, the paper aims to advance sustainability education at the college level and do so, across disciplines.

We structure the paper as follows: theoretical framework, case studies, discussion, limitations and future research, and conclusions. Beginning with the theoretical framework, we cover constructivism in

instructional design and in teaching sustainability, and present our theoretical model and instructional approach for teaching sustainability in higher education. We then proceed with four discipline-specific case studies. For each case study, we summarize an active learning constructivist approach to sustainability education and provide a detailed account of the methodology employed. In the discussion, we cover the success factors for implementing an active learning constructivist approach in higher education along with the obstacles to doing so. We also discuss ideas for future research and the general and specific limitations of this pedagogical endeavor. The last section presents the conclusions in summary form.

2. Theoretical Framework

2.1. Constructivism in Instructional Design

Constructivism is a student-centered approach where learners derive meaning from experience, contextual framing matters, and multiple perspectives are welcome [6]. “In this view, learning is a constructive process in which the learner is building an internal representation of knowledge, a personal interpretation of experience. . . . Learning is an active process in which meaning is developed on the basis of experience” [7] (p. 21). To engage in active learning, students do not learn from pre-specified content but rather learn through a programmatic process. In other words, they create their own conceptualizations and then validate them in the real world. This process continues until the student achieves an adequate level of expertise (of course, dependent on the course and the level of instruction). Using constructivism, faculty rely on apprenticeships and thereby, force students to learn from those with more experience in the sustainability arena in a mentor (guide-advisor-tutor)/mentee (novice-rookie-protégé) relationship. As noted in the following sections, active learning is a particularly important part of teaching sustainability using a constructivist approach.

2.2. Teaching Sustainability Using Constructivism

Various theoretical frameworks form the basis of instructional design (e.g., behaviorism, cognitivism, and constructivism). While each of these theories has merits, it is important to choose the one that best matches the task: teaching sustainability in higher education; and the cognitive processing required from the learner: a high level of cognitive processing [6]. Since sustainability is a complex, multi-faceted topic, requiring a steep learning curve, constructivism is the instructional design theory of choice. The paper’s conceptual framework draws on constructivism whereby the learner creates meaning by interacting with the environment instead of simply acquiring it. The focus is therefore on actively drawing from one’s surroundings to generate meaning as opposed to passively transferring it from the environs. In higher education, planting the seeds of sustainability means learning by doing not learning by osmosis.

Using constructivism to teach sustainability de facto requires a hands-on approach whereby students learn by experiencing and interacting. By actively engaging in sustainability issues, they gain a deeper understanding of the complexity of the subject matter; for sustainable development is inherently multifaceted and challenging [8]. Student involvement and participation translates into solving real-world sustainability problems, thinking critically about sustainability-related topics, and tackling sensitive sustainability issues. In the process, students become change agents who have a positive impact on campus sustainability matters and, even more importantly, become lifelong sustainability advocates (or potentially reach the advocacy stage). Through an ongoing process of knowledge co-creation and modification, students think and rethink, and then grow with each successive iteration. Grounded in theory, constructivism offers a tried-and-true instructional design tool ideally suited to teaching sustainability in higher education. We discuss our constructivist approach and its relevance to teaching sustainability in the following section.

2.3. Teaching Sustainability Using an Active Learning Constructivist Approach

The extant research on teaching sustainability in higher education is replete with general and discipline-specific publications. Work in the area spans the gamut from the conceptual/philosophical [1,9] to the applied (e.g., university-wide assessment tools [10] and pedagogical methods (e.g., using a systems approach [11], scenarios [12])). Few studies focus on cross- or interdisciplinary approaches [13] and even fewer on transdisciplinary ones [8,14]. Regardless of the approach, a recurring theme in the literature is the inherent complexity of the subject matter of interest, sustainability. To do justice to the topic, educators must approach it from different directions because of its unconventional, multi-faceted nature.

Steiner and Posch note, “sustainable development and the interplay between its ecological, social, and economic dimensions can be regarded as a highly complex task. As a logical consequence, educating for sustainable development also has a complex character” [8] (p. 877). To address the inherent complexity of teaching sustainability, we turn to an active learning constructivist approach. “Active learning, operationalized by cognitive, metacognitive, affective and resource management learning strategies, is necessary for students to effectively cope with the high level of demands placed on the learner in a constructivist learning environment” [15] (p. 349). An active learning constructivist approach emphasizes a higher-order of thinking and student engagement, both required for sustainability education.

According to Prince, “*active learning* is generally defined as any instructional method that engages students in the learning process” [16] (p. 223). Active learning may take place both inside and outside the classroom. Teaching strategies that encourage active learning include but are not limited to problem solving, cooperative learning, guided design, role playing, and simulations (for a comprehensive listing and description of active learning strategies, see Bonwell and Eison [17]). Among these strategies, sustainability educators often use problem solving. For example, MacVaugh and Norton [18] used problem-based learning in business and Steinemann [3] used it in urban development, both with measurable success. Hence, from a curriculum standpoint, sustainability educators have options in terms of their chosen method of instruction.

Beyond offering different teaching strategies, which is an added benefit of active learning, its effectiveness is what prompted us to select it. The literature provides strong evidence that it is an effective instructional approach [16,17]. Active learning, for example, has a positive impact on student performance in undergraduate STEM (i.e., science, engineering, and math) courses [19]. As demonstrated in Freeman et al.’s meta-analysis, it also “appears effective across all class sizes—although the greatest effects are in small ($n \leq 50$) classes” (p. 8410). In his review of active learning research geared towards engineers, Prince states, “considerable support exists for the core elements of active learning” [16] (p. 226). Missing from the extant literature in sustainability education is a theoretical model, which encompasses an active learning constructivist approach. To address this gap, we introduce our theoretical model in the following section.

Proposed Theoretical Model

Our theoretical model reflects a novel and comprehensive approach to teaching sustainability in higher education (see Figure 1). This theoretical model addresses the complex nature of sustainability education by entrusting the professor with creating the right context for knowledge co-creation and revision. It also captures the difficult nature of sustainability education by bringing together different perspectives and instructional tools: context, application, interaction, interpretation, and modification. Active learning forms the dynamic element of the model whereby the process of applying, interacting, and interpreting information in different contexts is fluid, varying over time. The modification process that occurs on an ongoing basis makes the co-creation of sustainability knowledge suitable for different educational contexts. The applicability of an active learning constructivist approach to a wide range of disciplines, underlines the pedagogical model’s academic merit.

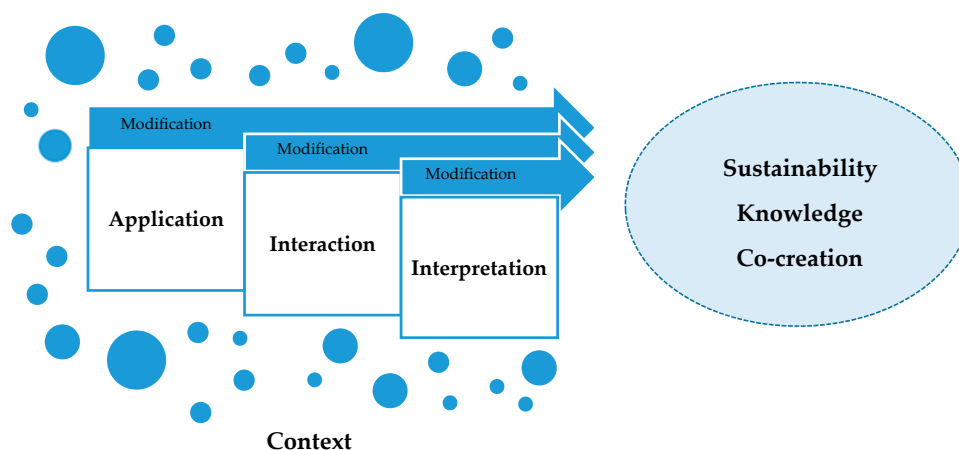


Figure 1. Sustainability knowledge co-creation using an active learning constructivist approach: depiction of key components (context, application, interaction, interpretation, and modification). Source: Kalamas Hedden, Worthy, Akins, Slinger-Friedman, and Paul (2017).

Since “constructivists view reality as personally constructed, and state that personal experiences determine reality, and not the other way round,” students learn about sustainability through active participation or co-creation [20] (p. 16). Using an active learning constructivist approach, instructors encourage students to define their own realities regarding sustainability and not let ‘what’s out there’ determine their viewpoints. In so doing, they become knowledge producers instead of information consumers. To illustrate how this occurs, we use our host institution, Kennesaw State University, and the work of four Faculty Fellows as the proving ground. Given the awarded fellowships, we also take a multi-disciplinary approach to the subject matter.

Getting academics from different disciplines to agree on a common constructivist approach is a difficult but not impossible task. Part of the difficulty rests on the inherent risk associated with a new instructional approach—in this case, an active learning constructivist approach. Bonwell and Eison describe the risk involved with active learning as “perhaps the single greatest barrier of all” [17] (p. 7). To overcome the risk, faculty must be open to trying a new way of teaching. Creativity in acquiring needed resources and faculty commitment to more preparation time are also determining factors. As well, the host institution must encourage and reward innovative teaching. For well-intentioned faculty to commit to a risky undertaking, institutional support and academic freedom to choose the instructional approach and the type/scope of their projects are critical. With the requisite institutional backing and for the sake of sustainability education, the four Faculty Fellows embarked on an exciting yet somewhat risky venture.

The fellowships awarded by Kennesaw State University empowered the authors to venture into uncharted instructional territory. Charged with developing sustainability-related projects, the Faculty Fellows took both a short-and long-term perspective. The first objective was for each faculty member to come up with a year-end deliverable and the second was to develop a project with a positive and lasting impact on campus sustainability. Keeping the university’s strategic plan and key stakeholders in mind, the Faculty Fellows embarked on a campus sustainability quest. All four Faculty Fellows settled on an active learning constructivist approach because of the practicum required in their core disciplines. Architecture, engineering, geography, and marketing all necessitate hands-on training and real-world problem-solving experience. As the following discipline-specific case studies demonstrate, impact on student learning also determined the choice to use an active learning constructivist approach.

3. Discipline-Specific Case Studies in Higher Education: The Case of Kennesaw State University

To understand sustainability efforts at the host university, Kennesaw State University, we first provide an overview of key milestones, seminal events that have led to a campus-wide sustainability

focus. We then proceed with discipline-specific case studies, all of which have a sustainability focus and use active learning in their instructional design. The case studies stem from the yearlong work of the 2016–2017 Sustainability Faculty Fellows. With the resultant long-term initiatives that each Faculty Fellow continues to develop, it is clear that despite external pressures or difficulties, sustainability will remain an ethical calling for some educators at the host institution.

3.1. Sustainability at Kennesaw State University: An Overview

Kennesaw State University became a signatory of the American College and University Presidents' Climate Commitment (which is now Second Nature's Carbon Commitment) in 2007 and created the position of Director of Sustainability in 2008. The director's responsibilities include overseeing sustainability across the curriculum (e.g., presenting an annual in-house *Sustainability across the Curriculum Workshop*), teaching sustainability in formal and informal settings, carrying out greenhouse gas inventories, and coordinating with facilities personnel and others on sustainability-focused projects and initiatives.

In 2016, Kennesaw State University created a joint Office of Campus Planning and Sustainability and the Facilities Department hired a Sustainability Coordinator. The same year, the university also launched the Sustainability Faculty Fellowship Program, which proved to be a strong addition to the institution's campus sustainability efforts. The program's initial cohort included five Faculty Fellows, three sponsored by the Office of Academic Affairs and two by the Office of Diversity and Inclusion. Selected from a variety of disciplines, including architecture, engineering, geography, and marketing, the Faculty Fellows have initiated scholarly projects that advance sustainability education and promote student involvement in campus sustainability activities. We summarize their efforts herein.

3.2. Discipline-Specific Case Studies Using an Active Learning Constructivist Approach

Drawing from the experiences of the 2016–2017 Sustainability Faculty Fellows, we describe a number of discipline-specific case studies where active learning forms the basis of the instructional design. The objective of each project is to use active learning to teach sustainability. To allow others to replicate these projects, we provide practical details along with explanations of the intended learning. Each project includes discipline-specific information regarding the curriculum and in particular, teaching and assessment. We cover projects in architecture, engineering, geography, and marketing in the following subsections.

3.2.1. LEED Lab in Architecture

In early 2007, Ed Mazria and his non-profit *Architecture 2030* hosted the 2010 Imperative in an attempt to transform the landscape of architectural design education. With a measurable and aggressive road map to building industry greenhouse gas (GHG) reduction by 2030, through education and policy, Mazria's plan sounded an alarm that the solutions to our global environmental crises could only be found through a multifaceted approach engaging students, faculty, interns, practitioners, design clients, and governments. The impact on the design studio curriculum was to include sustainable metrics in design studio syllabi, essentially moving the studio culture towards more sustainable practices. Architecture schools went from having only an occasional 'eco-centric' project to a more integrated approach to ecological design, infused within a majority of studio instruction. This long view, active learning approach to solving our environmental woes is essential if we are to create lasting change in our design culture.

The introduction of ecological literacy, as a bridge to ethical practice, has continued beyond Mazria's initial efforts. As a thought leader for sustainable practice, the United States Green Building Council (USGBC) created a points system for building sustainability, called the LEED rating system. This system identifies measurable and prescriptive design strategies that improve building performance and reduce the resources used in construction, maintenance, and operations. Developed by the USGBC and organized around the LEED EB+OM (Existing Building: Operations

and Maintenance) rating system, the LEED LAB allows students to acquire practical understanding of the building rating system. Students and faculty participating in the lab select a building on their campus and, working with the USGBC, analyze the building and recommend modifications that will allow the building to be certified (proven attainment) within the LEED EB+OM points system. The certification of buildings and refinement of operations and maintenance lowers and reduces the overall environmental footprint of the university. Additionally, all participants, including facilities employees and staff, learn the nuances of the rating system while providing students with hands-on learning opportunities that have a direct and meaningful impact on their campus environment.

Although LEED is a globally accepted program for sustainable buildings and the positive outcomes of the program are well documented, the acceptance of the USGBC rating method is neither universal nor without controversy. In recent years, this has been most evident in legislation passed in many southern US states under the guise of local business protection. Strong lobbying efforts by chemical, plastics, and timber industries have resulted in a growing perception that the LEED rating system does not allow specific products and materials to be included in the construction process. Furthermore, the anti-LEED legislation insists that the best way to protect the interests of these particular corporations is to block the use of the LEED rating system for any publicly funded building. Alabama, Florida, Georgia, Maine, Mississippi, North Carolina, Oklahoma, South Carolina, and Tennessee have all passed legislation against the use of the LEED rating system. Essentially, in the state of Georgia, the passing of HB255 (anti-LEED legislation) in 2015 made it illegal for operators and managers of publicly funded buildings to pursue LEED performance ratings, rendering the LEED LAB outcomes and learning objectives somewhat illegal by association. An inventive, yet still legal, solution is therefore to find a privately funded campus seeking to modify one of their buildings using the LEED rating process and allow Kennesaw State University students and faculty to provide analysis and certification services. Our solution, outlined below, is to work with one such institution, Agnes Scott College (a privately funded academic institution in the state of Georgia). This approach not only maintains legality but it also allows students of a publicly funded institution access to the academic benefits of the LEED LAB.

Working with Agnes Scott College and their director of sustainability, students of both academic institutions maximize their exposure to the LEED LAB while remaining fully compliant with the law. Cooperation between the two universities allows Kennesaw State University to enhance its architecture, construction, and engineering curricula with real-world building analysis of one privately funded building, Agnes Scott's McCain Library. Additionally, students interested in sustainability and architecture from the Agnes Scott campus can expand their educational opportunities by cross-registering for the LEED LAB at Kennesaw State University. Broad-based exposure thus gives students the opportunity to learn from others in differing contexts and do so, under the guise of an apprenticeship program—an ideal active learning constructivist approach to sustainability education.

Methodology

In an effort to maintain exposure to professional practice and collaboration, the Department of Architecture is actively pursuing the use of the LEED rating process as a learning tool for Kennesaw State University students. Following the department's curriculum, students must abide by the standards of the National Architectural Accrediting Board (NAAB). In this regard, they have to demonstrate evidence of adequate preparation for both professional internship and architectural licensing (for more information, see the NAAB's Web site: <http://www.naab.org>). According to the NAAB, "The accrediting process is intended to verify that each accredited program substantially meets those standards that, as a whole, comprise an appropriate education for an architect. Since most state registration boards in the United States require any applicant for licensure to have graduated from a NAAB-accredited program, obtaining such a degree is an essential aspect of preparing for the professional practice of architecture" [21]. We consider the LEED LAB an opportunity to integrate hands-on learning into the curriculum and thereby expose future architects to an active learning

constructivist approach to sustainability (directly aligned with architectural practice). The LEED LAB allows accredited schools of architecture to meet several of the NAAB accreditation criteria. As per the NAAB guidelines (for additional information, see page 11 of this link: http://www.naab.org/wp-content/uploads/01_Final-Approved-2014-NAAB-Conditions-for-Accreditation.pdf), the defining characteristics of an approved program include evidence of “Collaboration and Leadership, Design, Professional Opportunity, Stewardship of the Environment, and Community and Social Responsibility” [22]. Because of the real-world analysis performed in the LEED LAB and the supporting documentation required, it is an excellent vehicle to meet many, if not all, of these specifications.

3.2.2. EcoPartners in Engineering

As they design solutions to solve technical problems, engineers traditionally follow their applicable code of ethics to guide their decision-making. Many of these problems center on sustainability challenges affecting the viability and suitability of solutions well beyond the engineer’s lifetime. In fact, the National Society of Professional Engineers’ Code of Ethics encourages the use of equitable and sustainable development principles to protect future generations. In preparing prospective engineering professionals, educators should thus emphasize equity and sustainability from a practitioner’s standpoint but also model and provide experiential activities to practice these concepts.

The Department of Civil and Construction Engineering at Kennesaw State University offers four degrees within the discipline: Civil Engineering, Construction Engineering, Environmental Engineering, and Surveying and Mapping. Graduates of these majors will ultimately apply their technical skills in a wide range of legal, institutional, and environmental settings where problem solving is their primary concern. Decision-making, while less emphasized, is an equally important skill required of future engineers. Moreover, constraints to decision-making are often uncovered while engaging in workplace projects, leaving novice practitioners ill-prepared to balance technical, economic, environmental, social, and ethical considerations. In an effort to start this conversation early on and continuously through the academic process, we established the EcoPartners initiative. This effort sought to connect the civil engineering curricula with student organizations and campus operational entities to provide students with interactive experiences where they could practice sustainable decision-making, with a focus on social and equitable sustainability.

The EcoPartners program is important and worthwhile because it proactively addresses equity issues by collectively training environmental change agents from diverse backgrounds using a values-based engagement model, placing emphasis on equitable decision-making. It is the goal of the program to equip faculty, staff, and students with the necessary tools to become forward-thinking change agents, not just on campus but also within their broader community. We model the EcoPartners after similar programs, touted by the Association for the Advancement of Sustainability in Higher Education (AASHE), as a best management practice for universities across the country [23]. In fact, one study concluded that when examining faculty/staff and student partnerships for change, success arose from the ability to identify the everyday, common, and humble ways that these groups work to create change—an important point often missed in literature that focuses on dramatic and radical events of student activism [24]. These interactions expose students to multiple viewpoints and in the process, allow them to create their own interpretations. Because these interactions can occur regularly, another goal of the program is to investigate how we can create ongoing opportunities to practice activism and foster good citizenship among campus stakeholders. Linked to active participation and engagement, the projects described below follow an active learning constructivist approach. Faculty and other mentors guide the students, but the students perform the needed work. Ultimately, students learn about sustainable engineering practices through hands-on involvement.

Projects and Methodology

To model and emphasize equity and sustainability, the EcoPartners initiative uses three implementation methods: direct curriculum, co-curriculum, and extra curriculum implementation.

Direct curriculum implementation replicates traditional methods identified in previous research but includes changes to course activities that provide hands-on, experiential practices. The emphasis is not on changing the course learning outcomes but rather the activities performed to achieve these outcomes. For this purpose, we use the *Orientation to the Civil Engineering Profession* course. Traditionally, students get an overview of the profession and then identify, research, and write about a career of interest. We modify this approach to address equitable and sustainable decision-making. Figure 2 illustrates the previous semester's topics as well as the new/altered topics (e.g., Sustainable Design Principles) for the spring of 2017. We also take a thematic approach in introducing the equitably sustainable decision-making paradigm. Although we cover the same material in both semesters, we emphasize equity and sustainability in the latter. To provide a hands-on, experiential component to the course, and adhere to an active learning constructivist approach, we include a sustainable design project. We cover the details regarding our implementation methods in the rest of this section.

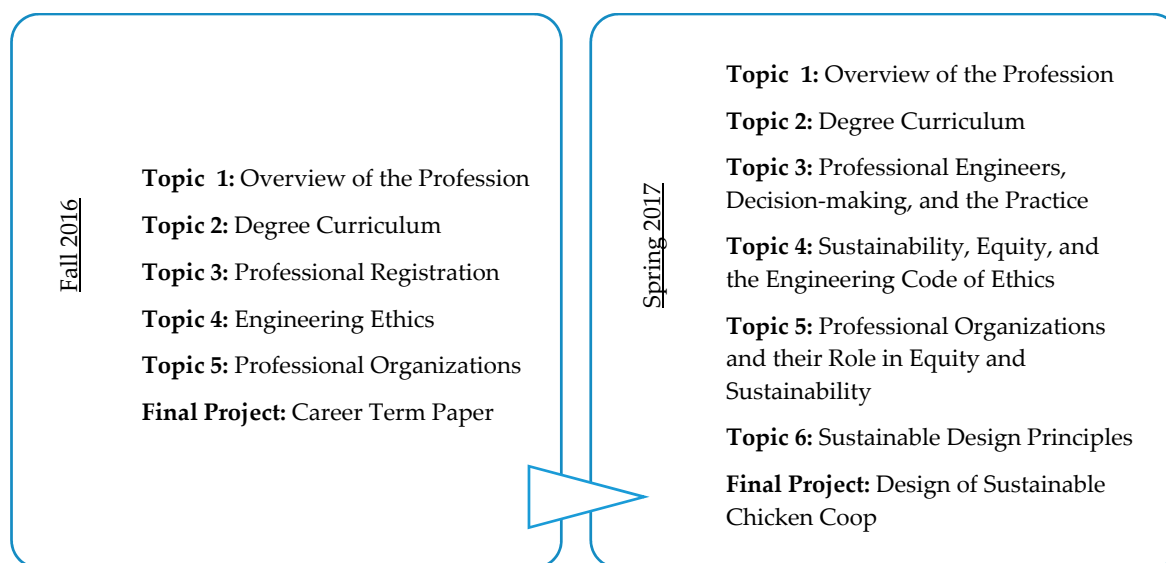


Figure 2. Orientation to the Civil Engineering Profession: topics and final projects.

We align *co-curriculum implementation* with a student internship with Kennesaw State's Office of Sustainability, a de facto apprenticeship. The student receives course credit and payment for services rendered—both of significant value to the project apprentice. This approach allows more time for student engagement but also puts additional demands on the student. Greater student commitment is necessary to achieve project tasks, which ultimately necessitates more university resources.

The *extra curriculum implementation* utilizes the existing relationships between faculty and student organizations. This implementation strategy provides the most experiential interaction of the three methods. The student chapter of the American Society of Civil Engineers (ASCE) engages in a campus service project with the university-owned farm. The faculty member sets up the partnership and ensures its continuity, but students take ownership. This part diverges from the direct and co-curriculum implementation methods, where either faculty or staff lead and manage the initiative. Below is a detailed discussion of each project, as well as faculty and student perceptions of the impact of the implementation methods. These projects highlight student engagement and active learning in an engineering context.

Direct Curriculum Implementation: Orientation to the Profession Course

Introduction to Civil and Construction Engineering students design sustainable chicken coops to house 200 chickens at the KSU Hickory Grove Farm. Their design considerations include protection of the natural and built environment, construction using sustainable building materials as well as the

ability for one person to move the coops. This partnership provides an opportunity for students to gain hands-on, real-world experience in design while solving a farming problem of stressed chickens with little to no greenery in their diets. This initiative is consistent with several university-wide activities that promote sustainability implementation into the curriculum. While chicken coop design might not be an ongoing project for subsequent course offerings, it presents a generalizable, scalable model that students can adapt to other contexts. Context-based learning is an inherent part of the active learning constructivist approach. Faculty identify problems specific to the campus and students come up with solutions by working with operational staff, faculty, and other students. This implementation approach provides little flexibility in course content changes and ultimately centers on a thematic approach to incorporating an equitably sustainable decision-making paradigm. Throughout the design process, students receive feedback from farm staff and their course instructor to help guide their decision-making. As reported by the course instructor, students provided positive feedback in course evaluations and cited the implementation of sustainability as a topic of interest, but no feedback referenced equity or decision-making as a learned principle or practice. This outcome is consistent with previous research findings on this topic and emphasizes the continued difficulty of improving student understanding of social justice and equity in a technical context.

Co-Curriculum Implementation: ARC II Energy Competition

The ARC II Energy Competition is an initiative to collaborate with the Austin Residence Complex (ARC), a residential community within the Kennesaw State campus. This project involves collaboration between the Office of Campus Planning and Sustainability (OPCS), a sponsored student intern from the Department of Construction Management, as well as a faculty adviser from the same department. Staff from OPCS launch a real-time energy-monitoring dashboard that tracks energy consumption in wireless metered buildings across campus. The student intern designs the dashboard interface using an equitably sustainable decision-making paradigm. Specifically, the interface should make the interpretation of data easy for all types of users and it should provide a sustainable educational tool. By collaborating with the Office of Residence Life, which includes Residence Directors and Residence Assistants (RAs), the campus community then engages in a competition (ARC II Energy Competition) to determine which ARC building could use the least amount of energy over a one-month period. The OPCS student intern works with RAs to create and post weekly energy-saving videos on the dashboard thereby educating residents. By sharing the energy dashboard with the campus community, visible results in energy reduction also occur during the competition. This co-curriculum implementation approach provides an opportunity for students to engage in equitably sustainable decision-making towards the end of their academic career. The increase in student responsibility and commitment aligns with the expectations of a student preparing to enter the workforce. In addition, this approach provides the student with multiple opportunities of evaluation and assessment. Not only does the student participate in formative evaluations throughout the project with both the OPCS and their Senior Capstone adviser but s/he also receives a summative assessment in the end.

Extra Curriculum Implementation: Bee House Construction and Repair

In this initiative, civil engineering faculty advisers, KSU Hickory Grove Farm staff, and the ASCE student chapter work together to identify a project where students can engage in environmental activism (e.g., loss in the bee population). Students are able to relate their engineering and sustainability coursework to real-world applications and engineering design solutions. This implementation approach relies on the leadership of the student organization to manage the project and work in conjunction with the farm staff. Learning assessment occurs through a nontraditional mechanism. The ASCE student chapter at Kennesaw State presented their project at a regional competition with favorable results. The impracticality of this student learning assessment does not negate the existence of learning by students. Despite its usage limitations, the extra curriculum approach received the most positive results from a student vantage point. Students interested in helping to rebuild the

farm's bee population viewed the service project as a worthwhile community effort. Not only did students construct bee houses to relocate and promote new bee populations, they also performed needed upkeep and planting at the farm, adding to the intrinsic value of community across the campus. Moreover, students engaged in an altruistic experience that allowed them to apply their curriculum-based knowledge.

3.2.3. Owl Planet Project in Geography

Bridging the physical and social sciences, geography is connected to sustainability through its focus on human/environment interaction at various levels (local, regional, and global), including the study of the relationships between people and their environments. The connection between geography and sustainability is highlighted by "The National Research Council, National Council for Geographic Education, National Science Foundation, The Environmental Protection Agency, and other organizations [who] have made calls for the inclusion of geographic theory and tools in sustainability studies" [25] (p. 2). The Owl Planet Project heeds this call for sustainability education in geography and does so using an active learning constructivist approach. Specifically, the Owl Planet Project is an undertaking to promote environmental awareness, and to implement, highlight, and/or support projects that help green the campus and make the institution more sustainable.

"Central to the vision of constructivism is the notion of the organism as "active"—not just responding to stimuli, . . . but engaging, grappling, and seeking to make sense of things" [26] (p. 49). Inspired by constructivist learning theory, which focuses on the creation of knowledge and meaning by learners through activity, The Owl Planet Project engages both students and student organizations. Individuals, groups, or student clubs, conduct research and implement solutions, and/or highlight sustainability-related issues. Through demonstrations and presentations to the campus community, students display their work and raise public awareness. Modeled after the Environmental Protection Agency's On Campus EcoAmbassadors program (currently suspended by the EPA due to lack of funding), the Owl Planet Project aims to teach the institution's population about things they can do to live more sustainable lives on and off campus. Through the Owl Planet Project, students can explore a wide variety of sustainability-related issues (for examples of the issues addressed by the students and the projects they undertook, see Table 1).

Table 1. Owl Planet Project: overview.

Sustainability-Related Issues Addressed	Project Title and Description
<ul style="list-style-type: none"> • Food deserts • Food security • Sustainable agriculture • Equity • Health 	<p>Title: Farm to table sustainable agriculture</p> <ul style="list-style-type: none"> • Displays and handouts promote sustainable and healthy eating habits, including information on the farm and student-run permaculture garden associated with the institution. • Sample dishes use food from the garden and the farm (this helps draw people to table setups). • Students volunteer at the farm and permaculture garden (optional).
<ul style="list-style-type: none"> • Waste reduction • 3Rs (reduce, reuse, and recycle) • Upcycling 	<p>Title: Reducing, reusing, recycling, and upcycling</p> <ul style="list-style-type: none"> • Displays show what is currently being done at the institution to reduce waste and include an assessment of what still needs to be done in order to further reduce waste. • Demonstrations and samples show ways to upcycle (i.e., reuse objects and/or materials that may typically get tossed). • Take away maps illustrate the location of various local recycling centers.

During the semester, students involved in the Owl Planet Project research environmental activities, such as increasing energy efficiency, reducing water use, implementing composting, and improving recycling. Students consider these activities in relation to what is currently being done or what could be done at their institution and, more broadly, in their region. Based on these research findings, students highlight environmental issues at the host institution and where necessary, suggest alternative ways for the institution or individuals to address them. A public exhibit to university constituents allows students to not only present their findings but also raise awareness about sustainability-related issues both on campus and in the local community.

The purpose of the Owl Planet Project is to educate the campus community and to increase environmental awareness. To raise awareness, students research sustainability-related issues at their institution and where necessary, come up with potential/alternative solutions (and in some cases even implement them), and then disseminate their findings. Students also educate the campus community through hands-on, interactive displays and presentations. Faculty, staff, and students learn that even the simplest, daily choices can have a lasting impact on the environment. By providing campus stakeholders with information and raising awareness regarding sustainability, the Owl Planet Project aims to cultivate sustainably minded citizens and future change makers at Kennesaw State University and beyond.

Methodology

An end-of-semester course survey showed that the Owl Planet Project was a worthwhile activity, with 73% of the students strongly agreeing and 23% of them agreeing that it continue to be an integral part of the class. Students overwhelmingly felt that the Owl Planet Project was the course activity that was the most effective in helping them apply their knowledge of sustainability to real-world issues. They also felt it was most effectual at allowing them to engage with other students, faculty, and staff regarding sustainability. In the commentary, one student said about his involvement in the Owl Planet Project, "I felt I had done something important." This sentiment highlights the empowering nature of being able to influence others' attitudes and behaviors regarding sustainability by informing and educating them. An unsolicited e-mail from an Owl Planet Project attendee also shows the potential of the project to engage local campus constituents, "I went to [the] Owl Planet Project Day on the green today, and I wanted to let you know that I found the students informative and passionate about their subjects. I enjoyed hearing about what (the institution) does to support our environment and am now thinking about making my own "green" cleaning products and possibly even attempting apartment composting." Reaching an even wider audience, Kennesaw State University's media department captured the event on the campus green and posted it on the university Web site (the short promotional video is available at this link: <https://www.youtube.com/watch?v=v8uu8QNzUZU&feature=youtu.be> [27]). These preliminary results point to the ability of the Owl Planet Project to create a more active and engaging environment than the classroom lecture. Through this immersive instructional activity, students learn about sustainability and become change agents for their local community, and potentially lifelong sustainability advocates.

3.2.4. Green Campus Campaign in Marketing

Marketing is very much like other disciplines within business schools (e.g., accounting and finance) in that the primary focus is on profitability instead of sustainability. In other words, sustainability matters if it fuels economic growth and does not impede it. Referring to faculty in business and/or management, MacVaugh & Norton state "B/M educators are rarely so motivated by an awareness of sustainability issues that they would care to upset their faculty's applecart by radical course redesign" [18] (p. 73). If faculty teach sustainability, they instead tack it on to existing courses rather than give it the attention it deserves. The Green Marketing course is therefore an attempt to upset the applecart. It is the first such course to be developed and eventually offered at the host institution's Department of Marketing and Professional Sales.

Operating within the Coles College of Business and bound by the standards of the American Association of Collegiate Schools of Business (AACSB), the Department of Marketing and Professional Sales at Kennesaw State University offers a wide variety of required and elective undergraduate and graduate courses. Until now, the department did not offer a dedicated course in sustainability education. The development of the Green Marketing course and the related Green Campus Campaign in marketing are a direct result of the Sustainability Faculty Fellowship received by one of the authors. To introduce a large number of students to the subject matter, we will offer the course as an undergraduate marketing elective open to both business non-business majors.

The Green Marketing course exposes students to the opportunities and challenges marketers encounter with respect to sustainability. As part of the course, students learn about sustainability from organizational and consumer-driven perspectives. Inherent in this two-sided pedagogical approach is the idea that businesses and individuals both produce and consume, and are therefore willing or unwilling sustainability participants. Furthermore, these two entities are economic and social drivers, and they can potentially serve as sustainability change agents. Using active learning as the backdrop for the course, students take on the role of apprentices and learn by 'being on the job'.

Undergraduate students engage in a two-step process whereby they conduct a sustainability survey and then design a campus-wide awareness campaign. To gain an understanding of marketing research, students conduct in-person focus groups with campus constituents: undergraduate and graduate students, faculty, and staff. Using the insights from the focus groups, students then develop a comprehensive survey of important campus-wide sustainability issues. These may include, but are not limited to, commuting in single-occupancy vehicles, carpooling, recycling, composting, and consuming farm-to-table or locally sourced food. Designing the right assessment tool and analyzing the resulting data requires proficiency in survey design and data analysis. Students go through a trial-and-error process until they grasp these important skill sets. By understanding the environmental, economic, and social aspects of sustainability, students can then develop a sound advertising campaign. The Green Campus Campaign raises awareness about on campus sustainability efforts. It also highlights the role of the institution and the individual in 'greening' the campus. Taking students full circle, from the theoretical to the practical, the Green Marketing course teaches students how to conduct marketing research studies and develop advertising campaigns. By working as marketers, students put into practice classroom instruction and gain real-world experience. At the end of the course, students can show prospective employers their deliverables and use them to position themselves as hireable talent.

Methodology

In the Green Marketing course, students apply core marketing concepts and theories to sustainability and modify them where necessary. Following an active learning constructivist approach, the course aims to engage students and help them to become critical thinkers and problems solvers. Training tomorrow's business and non-business professionals, the course develops students' written and communication skills. It also emphasizes teamwork along with individual accountability, just like in the business world. Co-op co-op is the implementation method employed here (for a step-by-step overview, see King [5]; for a variation of cooperative learning also see Kagan [28]). "Students cooperate within their teams to produce something of benefit to the class; they are cooperating in order to cooperate" [5] (p. 34). The faculty member serves to guide the students individually and in groups at each stage of the process from the selection of team members to the final group presentation of the campaign flyer. Several components comprise the course assessment: in-person focus groups, survey design, data collection and analysis, a one-page flyer for advertising purposes, and in-class group presentations of findings (focus group and survey results, and campaign flyer). These deliverables are staggered throughout the semester so students can incorporate instructor feedback and build their marketing and sustainability knowledgebase. Since the course is brand new, formal assessment of student learning has not yet taken place.

4. Discussion

Decision makers often silence and/or disregard the voices of stakeholders. As many campuses endeavor to implement sustainable practices in the state of Georgia, university stakeholders may perceive some of these applications as inequitable. In fact, research shows that issues of environmental quality and human equity are inextricably linked [29]. While most people consider race, gender, and socio-economics as the more common equity identifiers, we challenge this notion within a campus environment. Higher education does not negate race, gender, and socio-economic issues, but it often ignores a new identifier, rank and/or position. In spite of studies that indicate how faculty and staff interactions positively influence student success and persistence, academia makes little effort to increase partnerships between these three groups, eliminating the problem with rank and/or position [30]. Moreover, with the changing role of faculty shifting from sage to guide, it is timely to transform the role of students from passive recipients to active participants in the campus planning and decision-making nexuses, especially when sustainability and environmental activism is considered [31]. To this end, the discipline-specific case studies presented here used an active learning constructivist approach to sustainability education.

The consistency in exchange of ideas concerning environmental activism makes the discipline-specific case studies sustainable due to the collective efforts of both students, faculty, and staff. The ability to traverse rank and positional stigma to effect positive change is key to ensuring the viability of the program. Furthermore, to promote collaboration and address overlap in efforts, learning communities and monthly campus-wide communications are essential. In addition, to adopt an environmental activism culture within the campus community, it is essential to provide sustainability awareness and education early in the college experience (e.g., new student orientation, freshmen seminar, etc.). With a concerted effort, the increase in environmental activism across the campus will ultimately expand outwards to the broader community and region. As demonstrated herein, active learning provides a worthwhile model to implementing sustainability practices within an academic campus community.

In higher education, the success of a comprehensive active learning constructivist approach to sustainability requires both top down and bottom up initiatives. In the Faculty Fellows' experience, administrative support and faculty buy in are two determining factors. Strategic initiatives with a sustainability focus along with policies that incentivize faculty to pursue sustainability-driven efforts are critical. Course releases and sabbaticals for example, give faculty time to focus on sustainability-related research, course planning, and community engagement. Faculty immersed in sustainability issues can use their knowledgebase to enrich the classroom experience and similarly, contribute to scholarly publications. Administrative support in the form of fellowships, professional development workshops, grants, and other funding opportunities also help faculty pursue different sustainability-related ventures, including active learning. Likewise, top down initiatives that promote innovation both inside and outside the classroom encourage faculty to try new instructional approaches and devote time to pedagogical research. As important as administrative backing is, faculty commitment to sustainability is still necessary.

Faculty not only have to believe in sustainability education and the broader environmentalist movement, they have to be willing to go the extra mile and assume some level of risk. The time and effort investment is significant, especially upfront. Planning, developing, and implementing an active learning constructivist approach is also fraught with obstacles. Some are institutional and others are discipline-specific (for a comprehensive discussion of the obstacles to active learning, see Bonwell and Eison [17]). Institutional barriers to implementation include a lack of resources and outdated or backwards policies. If the institution does not view sustainability as part of its strategic plan and does not support sustainability-related efforts (e.g., using an active learning constructivist approach) then faculty are left wanting. Some disciplines may also not be amenable to sustainability education, let alone an active learning constructivist approach. Without previous exposure to an active learning environment, students' learning curves will likely be greater, making it more difficult for

them to buy in to an active learning constructivist approach. As Anthony points out, “we cannot expect students to cope with the cognitive demands of constructivist teaching goals, nor can we expect active learning activities to automatically result in ‘strong acts of construction’, if their learning is of a predominantly passive nature” [15] (p. 366). To compound matters, course evaluations may not measure or reward those who stray outside accepted norms; notably, those who use active learning (this is the case in business schools where “objectivist measures dominate teaching evaluation instruments” and “questions grounded in constructivist . . . learning models are notably missing” [32] (p. 23)). Although these barriers may seem daunting, faculty can try to overcome some of them through sheer determination and steadfastness. The ones engrained in the institutional systems are obviously more difficult to surmount and require a longer, concerted effort and a change in vision. Even so, the rewards of using an active learning constructivist approach far outweigh the drawbacks. As shown here, the four Faculty Fellows’ pursuit of an active learning constructivist approach to sustainability education was gratifying from personal and professional standpoints.

5. Limitations and Directions for Future Research

As 2016–2017 was the inaugural year of the Faculty Fellows Program at Kennesaw State University, our emphasis was on developing a novel way to teach sustainability (i.e., using an active learning constructivist approach) and then implementing it using discipline-specific projects (or planning the future implementation thereof). Our overall goal was not to conduct formal research on student learning. To address this shortcoming in the future, we will carry out empirical research to test our theoretical model and measure each project’s impact on student learning. For this purpose, suggested qualitative and quantitative methodologies include but are not limited to conducting interviews and focus groups, administering surveys, and gathering insights from reflective journals. To assess the short- and long-term impact of our approach on student learning, we will also conduct longitudinal studies. While the limited measurement of student learning is an important limitation, the paper provides useful information for educators.

Faculty and administrators interested in sustainability education can learn from the various discipline-specific case studies and adapt them to their particular college campuses. They can also gain insights from the inherent limitations of each discipline-specific project, be they subject-related or otherwise. We cover some of these limitations here, beginning with the LEED Lab in architecture where the biggest impediment was the change in state legislation, preventing the use of the LEED rating system for publicly funded buildings. As we noted earlier, this hurt the built environment by reducing opportunities for academic learning through student exposure to professional practice, collaborative project analysis, and environmental stewardship. We now turn to another professional discipline, engineering and the limitations of the EcoPartners program.

While the EcoPartners initiative provides evidence that an emphasis on equitable and sustainable decision-making is possible, there are some limitations to this tripartite approach. When it relates to *direct curriculum implementation*, course learning outcomes have precedence over thematic topics. This fact will often guide faculty in course planning and preparation. Smart course development, time management, and changes in homework assignments may be suitable solutions to addressing the dilemma of additional topics within an already packed course syllabus. When presented with a choice to cover required topics versus alternatives, it is in the best interest of the faculty member to do the former. The *co-curriculum implementation* method presented here is also somewhat limited. Largely driven by the availability of funds to pay the apprentice, its usage is restricted to this one project. While students are capable of realizing the intrinsic value of hands-on experiential learning in equity and sustainability, the motivating factor of self-sustenance ensures commitment beyond good will. Lastly, *extra-curriculum implementation* has its limitations. Student interest and motivation is pivotal to the sustainability of extra-curricular activities (e.g., student organizations and their involvement in semester-long projects). It is unlikely that this implementation method will result in much progress

if student engagement and willingness to continue working outside the confines of the classroom are missing.

As with the EcoPartners in engineering, significant time and effort outlays are necessary in the Owl Planet Project in geography. At the outset, the project requires much preparation and planning on the part of the faculty member. It calls for working with students early in the term to figure out their sustainability projects and guiding their research throughout the semester. One limitation is finding topics that students are excited about so they stay motivated and committed. Another difficulty is connecting students to relevant resources both on and off campus. Finally, students' ability to exhibit their projects publicly and to have an impact on the wider community is dependent on the availability of an appropriate space on campus and effective publicity. While such efforts are laudable, it is often hard to reach a wider campus or local community audience. We can say the same for the Green Campus Campaign in marketing, the culmination of the Green Marketing course. Students' efforts to raise awareness regarding campus sustainability efforts may not be as fruitful as expected.

As a stand-alone entity, The Green Marketing course is unlike the other case studies where existing classes incorporate sustainability-related projects into the curriculum. As well, it focuses on marketing research and advertising instead of other subareas such as services marketing, international marketing, and/or business-to-business marketing. While this emphasis limits the applicability to some marketing units, the course itself has merit for it fills a major gap in the marketing curriculum. The Green Marketing course helps students build their core competencies in two important areas, marketing research and advertising. Depending on departmental requirements, one or both of these subjects are often required for marketing majors. The course also exposes students to sustainability, which is an underrepresented area at the host university and, more importantly, across marketing departments in the United States. Addressing this knowledge gap both in the classroom and through pedagogical research, faculty can broaden sustainability education in marketing and beyond. Another is through cross- or interdisciplinary research where various disciplines can benefit from differing paradigms.

In the current paper, we applied an active learning constructivist approach to specific disciplines: architecture, engineering, geography, and marketing. While discipline-specific case studies emphasize a hands-on approach to sustainability, a higher level of learning will take place with interdisciplinary or transdisciplinary foci [8]. The cross- or interdisciplinary approach allows for the transfer of knowledge across disciplines, breaking down silos in the process. The transdisciplinary approach is even more powerful, for it calls for extensive cooperation between disciplines and the creation of radically new ways of thinking.

Proponents of transdisciplinary case studies (e.g., [8,14]), call for dynamic, real-world learning. The goal is to dismantle traditional teacher-student roles and to break down barriers to learning in order to generate new perspectives that transcend disciplines. One way to accomplish this is to use the scenario method whereby students come up with innovative yet realistic future-oriented solutions [12]. Another 'thinking out of the box' option would be to use case studies, like the ones described here, but to tackle them differently. Problem solving will occur by integrating perspectives from various academic and practical fields, and then pushing the envelope to produce yet undiscovered solutions. Thinking outside discipline-constrained or societal-manufactured boxes, learners will become sustainability champions.

6. Conclusions

Reflecting on the inaugural year of the Faculty Fellows Program at Kennesaw State University, the fellows engaged in or planned varied sustainability-related efforts: LEED Lab in architecture, EcoPartners in engineering, Owl Planet Project in geography, and Green Campus Campaign in marketing. In the process, participants identified the everyday, common interactions between stakeholders and the environment, and utilized these to form practical solutions. The multi-disciplinary case studies immersed participants in sustainability-related topics (or will further do so in the future) and promoted active learning. Using an active learning constructivist approach to teach sustainability

in higher education, this paper offers a usable model with concrete examples. To further sustainability education, faculty at other universities can implement and/or improve upon the pedagogical efforts presented here.

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