Specialization Clusters as a Design for Sustainability Education: A Flexible Approach to Preparing Undergraduates for Evolving and Diversifying Fields of Practice

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Abstract

An evolution in the sustainability job market toward more differentiated and specialized sustainability work appears to have decreased the usefulness of training undergraduates for careers as sustainability generalists. This case study discusses this change as an impetus for redesign of an undergraduate curriculum that confers a Bachelor of Science (B.S.) in Environmental Sustainability. The redesign was informed by practitioner interviews, employment field assessments, report reviews, focus groups, and academic research. The design feature highlighted in this article is flexible, within-major specializations (a.k.a. clusters) and was developed to match student training and post-college employment opportunities. The discussion explores the thinking that motivated this curriculum revision and why a flexible design might aid student and program administrator adaptation when faced with ongoing, rapid changes in a field of practice.

Introduction: Sustainability as a Moving Target for a Career and a Curriculum

Sustainability in concept provides a discourse for humans to interrogate their use of resources and to pursue a more ecologically balanced and just society. This article reflects on unique features of the discourse and what it means to "do" sustainability work. Using revision to a university sustainability curriculum as a case study, we discuss the ongoing plasticity of "sustainability" as a field of practice and its implications for the design of an undergraduate curriculum attentive to career preparation. Making observations about the changing nature of sustainability jobs, we explore how a flexible curriculum design can improve the relationship between sustainability education and career paths, particularly when the field of practice is rapidly changing.

A first challenge endemic to sustainability as a field of practice is its state as a critical discourse about human development. At least from an academic standpoint, sustainability is a relatively new lens for interrogating the relationship between humans and their environments. The most widely shared conceptual anchor for the discourse still appears to be the Brundtland definition of sustainability and its derivative three-pillar "environment, society, and economy" Venn diagram. While this approach gives some shape to the discourse, the concern for present purposes is its imprecision. Put bluntly, it affords roughly the same

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resolution for teaching and professionalization as a phrase like "producing health and well-being" might for a career in the medical trades.

A second, subsidiary challenge is that sustainability as a named profession is similarly inchoate. Based on field investigations, we can anecdotally share that occupational enactment of sustainability varies considerably across organizations in terms of performance expectations, functional responsibilities, and overall sense of what it means to do sustainability work. Few people have worked with a formal sustainability title or responsibility for more than 10 years, and the majority have little or no formal training in it. What practitioners are doing in companies—from inventorying and reporting sustainability impacts to managing employee engagement, messaging, and communications; from explaining best practices to reducing the footprint of supply chains and operations—is about as varied as the functional position in a firm they do it —for example, in public relations, facilities, environmental compliance, quality, marketing, government relations, process engineering, design, research, general management or special projects. Further, the sustainability marketplace has been experiencing ebbs and flows, with both college enrollment and hiring in flux in recent years.

The growth and evolution of sustainability as a field of practice is exciting, but the indistinct nature of its discourse and the rapid differentiation in practice are challenges for a university curriculum designer. A rapidly changing and diversifying field of practice makes it hard to keep a program match with the field of practice given that a curriculum is prepared years in advance not merely of a student's graduation, but even of her/his matriculation.

These circumstances raise a series of normative questions for the designer of an undergraduate sustainability curriculum: To what extent should a program for undergraduates attempt to prepare professionals with a set of technical skills and knowledge, in the hope that technical know-how will be foundational and durable in the marketplace? Taking this approach might encourage training students in established scientific disciplines and applied engineering, with the goal of making them capable of meticulous environmental characterization and mastery of new tools like carbon reporting and life-cycle analysis. By contrast, a sustainability professional might need to navigate a variety of cultural and work domains, from the factory to the village or from the engineering department to the human resources office. To what extent should a program focus on nuanced and reflexive examination of sustainability in different work contexts, in the hope that this will enable students to engage in and lead community learning and redesign processes? A program organized around this idea might focus on training in social theory and applied practice in policy and management, all with the plan of building student capacity to communicate and manage the complex nature of human-environment interactions.

Thinking even longer term, one might contemplate the broad learning skills needed to go through multiple phases of systems change and ask, how much should a program include study of arts and humanities, so that students have a robust set of metaphorical and historical models to draw on? The contributions of environmental history, classics of environmental literature, economic and political philosophy, and art and expression, to name a few, are hard to overstate in understanding and communicating visions of a better world. Lastly, one might ask, should a program combine aspects of each of these approaches or focus on more general literacy and learning versatility, with an assumption that desired competencies might change during the first few years of a career or over the course of a four-year education? While one concern here is watching a university curriculum fall behind, the other is watching it stretch itself to the point of incoherence, so that it becomes a watery combination of everything and, paradoxically, nothing at all.

It is with these challenges and questions in mind that we offer our case study on the redesign of a college curriculum. This case explores a design principle that we call "flexible specialization," which was used to revise a curriculum to improve education-to-career transition. Because sustainability is still emerging and nascent as a field of practice, we present this design principle as a way for program administrators and students to adapt to the relatively rapid evolution and differentiation of sustainability as a profession or career path.

Case Introduction and Emerging Design Challenge

The case discussed in this article is a four-year undergraduate degree

program that grants a bachelor of science degree in Environmental Sustainability. Our analysis of this case explores redesign of its curriculum to improve alignment between student learning outcomes and the competencies assumed necessary to enter the workforce of sustainability practitioners. The impetus for this redesign were findings that emerged during a five-year review of the program that point to changes in the nature of sustainability practice and that signal new challenges for training students for careers in sustainability.

The case context is Philadelphia University, a mid-size, regional university organized to provide students with a professionally oriented undergraduate education. A focus on professionally oriented undergraduate education means that, after students complete a liberal arts-based general education core, the balance of their university coursework emphasizes acquisition of applied knowledge and skills. In this sense the educational orientation and mission of the college is a step closer to that of a training institute than a traditional, liberal arts university. For curriculum designers and administrators, this normative orientation means more conscious attention to training students for entry-level positions in professional practice.

The case program was first developed at Philadelphia University in 2008. To match the university's focus on professionally-oriented undergraduate education, its designers looked to the field of practice as a basis for developing the program. The designers used the generalist "sustainability manager" as a career archetype or ideal for its graduates. This sustainability manager was envisioned as an individual contributor working on environmental and social initiatives in a corporation or municipal government. The curriculum designers imagined that such initiatives added value to the organization in the eyes of customers, shareholders, stakeholders, and the community but still were at least partially outside of standard operating or accounting procedures. It was further assumed that sustainability managers function as bridges across multiple functional specialties (e.g., facilities, operations, public relations, accounting, marketing). Thus, a sustainability practitioner was imagined as a coordinator of initiatives across organizational functions and a variety of professional fields. This understanding motivated the choice of an explicitly interdisciplinary design to the curriculum. While based in scientific understandings of Earth systems, it was designed to help students master sustainability concepts and vocabulary that practitioners in the field might use to enact concepts like sustainable business operations or green building.

Using a backcasting design approach, the designers then isolated core skills and content knowledge used in the field and built key learning outcomes based on them. They developed an initial curriculum with 12 courses that were custom-designed in accordance with the program learning outcomes. They then supplemented these with additional courses taken from the existing university catalog. The end result was a hybrid of a program built from scratch and one that borrows courses from existing programs. This hybridization means that the designers had modest license to imagine and develop a sustainability program synoptically while still evolving it somewhat from conservation studies and environmental science programs.

Despite what appeared to be an auspicious design, after five years of operation and two cohorts of graduates, the program began to observe that its alumni were struggling to break into the sustainability workforce. While the recessionary job market of the last six years was likely a factor, this market's stronger preference for direct and specific experience may also have helped reveal a limitation of training students as a generalist sustainability manager. Namely, graduates were fumbling with ads for increasingly niche jobs in a marketplace that was simultaneously widening and refining practice. For example, as graduates encountered sustainability positions more closely aligned with corporate social responsibility work, they found that they needed background and experience in communications, which our program had not required. As energy management emerged as a sought-after specialty, job ads targeted candidates with technical training in energy physics and engineering or energy management internship experience that the program's graduates had not gained.

In light of this gap, we began analyzing the field of practice and looking beyond the generalist sustainability manager as an archetype for training undergraduates. Our analysis involved reading sustainability job ads, speaking with sustainability alumni, interviewing practitioners in the field, and reviewing practitioner literature about sustainability skills and staffing.[1,2] We also drew on our own research on sustainability management[3] and attended confer-

ences to discuss our findings with practitioners.[4] Our observations led us to the conclusion that a one-size-fits-all approach was no longer going to provide students with the niche skills that they needed to be attractive and effective in the evolving field of sustainability practice.

Our challenge was figuring out how to respond to this more diverse marketplace. At a college the size of Philadelphia University, student cohorts are too small to develop targeted sustainability curricula for each emerging subspecialty. Given this constraint, we looked for ways to address the increasing complexity of the field by increasing the internal flexibility within the program. We set a dual objective: to refocus the program on a core set of competencies (i.e., skills and knowledge), and to create a flexible and customizable platform that could facilitate more targeted preparedness beyond this core. The ultimate goal was to create enough specializations within the program that students could be encouraged and empowered to align with a market-relevant subfield of sustainability practice, while also maintaining the program's overall coherence.

Basic Elements of the Program Redesign

Drawing on our experiences as educators and sustainability practitioners, we began our revision by writing the following design principles:

- To focus the curriculum on structures and metabolisms of Earth and human systems as foundational knowledge
- To create a more integrated approach and dedicated courses for foundational knowledge acquisition
- To embed foundational knowledge acquisition in the first two years of the curriculum
- To create pathways to professional specialization in the second half of the curriculum
- To increase alignment between the curriculum and the program learning goals

With these goals in mind, we set our minds to writing core competencies for the curriculum. As noted by other scholars and practitioners,[5] a challenge for making sustainability teachable is translating it as a discourse into a set of competencies sufficient, at least, to begin working in the field. In response to this challenge, we looked back and forth from theory to practice to craft a perspective upon which to base the curriculum. We settled on an understanding of sustainability as an inquiry-oriented, project-based, change management practice. We envisioned its day-to-day work as analytical, reflective, and collaborative but also still peripheral to core operations and often advisory. We then wrote out the following list of competencies that people wishing to practice in the field need to develop:

- Science-based inquiry and environmental representation
- Reflexive environmental modeling and communication
- Systems thinking and analysis and
- Life-cycle thinking and analysis
- Options analysis communication
- Project management

Having set these competencies, our next step was to write them into a curriculum. We designed our program to draw on and draw together knowledge and modes of inquiry and analysis from a variety of fields, as fits an interdisciplinary program. We required students to take core classes in physical and social sciences, as well as core courses in management, policy, and the humanities. We also isolated six issue domains represented as wedges in Figure 1 (i.e., energy, food, land, materials, water, and air) and created a core course in the curriculum for each one.

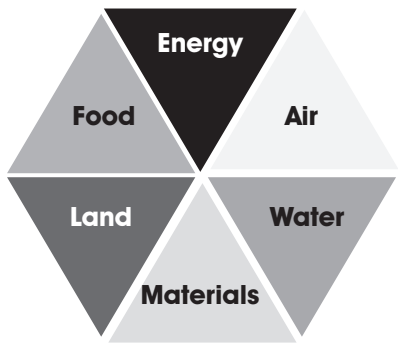

Figure 1. Sustainability issue domains at the core of the curriculum

To facilitate students' development of these foundational competencies, we consciously considered how knowledge and skill acquisition would accrue across courses in the curriculum and culminate in an original synthetic project in the capstone practicum at the end of the program. Figure 2, which summarizes the curriculum and its courses, illustrates how core courses in our curriculum connect to facilitate competency development across the four years of baccalaureate education. The figure's equivalent of an x-axis is a four-step ordinal marking of the years needed to complete a baccalaureate degree. The seeming y-axis groups courses nominally as in the general education core, which all students complete, and in the Environmental Sustainability (SUST) major. The courses in the general education curriculum are represented by the connected boxes at

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the bottom of the diagram that are grouped as curricular "stalagmites." This curriculum is taken in the first two years of undergraduate study, save the three darker boxes for free elective courses anticipated for years three and four. Courses in the SUST curriculum are represented by the connected boxes at the top of the diagram that are grouped as curricular "stalactites." There are four medium gray-colored boxes in the third and fourth year of the sustainability curriculum that create room for the within-major specialization discussed in the next section. To draw attention to the core sustainability topics represented in Figure 1, we have marked the six courses that introduce them. Note that all of them are slated to be taken in the first two years of study.

In Figure 2 we have also put numbers in various boxes and drawn arced dotted lines between them. These numbers and lines illustrate deliberate connections made across courses to facilitate cumulative knowledge and skill development. Training thus begins with an introductory course (1) and proceeds through intermediate courses (2 and 3) and culminates in a capstone course (4) the final year of the program. The underlying intent is to link and integrate knowledge and skills across the course set and avoid teaching "a mile wide and an inch deep" – a common problem for interdisciplinary programs that combine courses from around the university. For example, our students take Biology I (microbiology) as part of their general education curriculum. The curriculum then follows with Biology II (macrobiology and evolution) and Biodiversity (ecology). The overall learning objective is to build student proficiency in scientific inquiry and literacy in ecological and evolutionary analysis.

Similarly, our students take Physics I (classical mechanics) as a foundational course and then proceed to our physics- and engineering-based Energy Systems course and also a chemistry-based Air course (about the atmosphere and climate change)

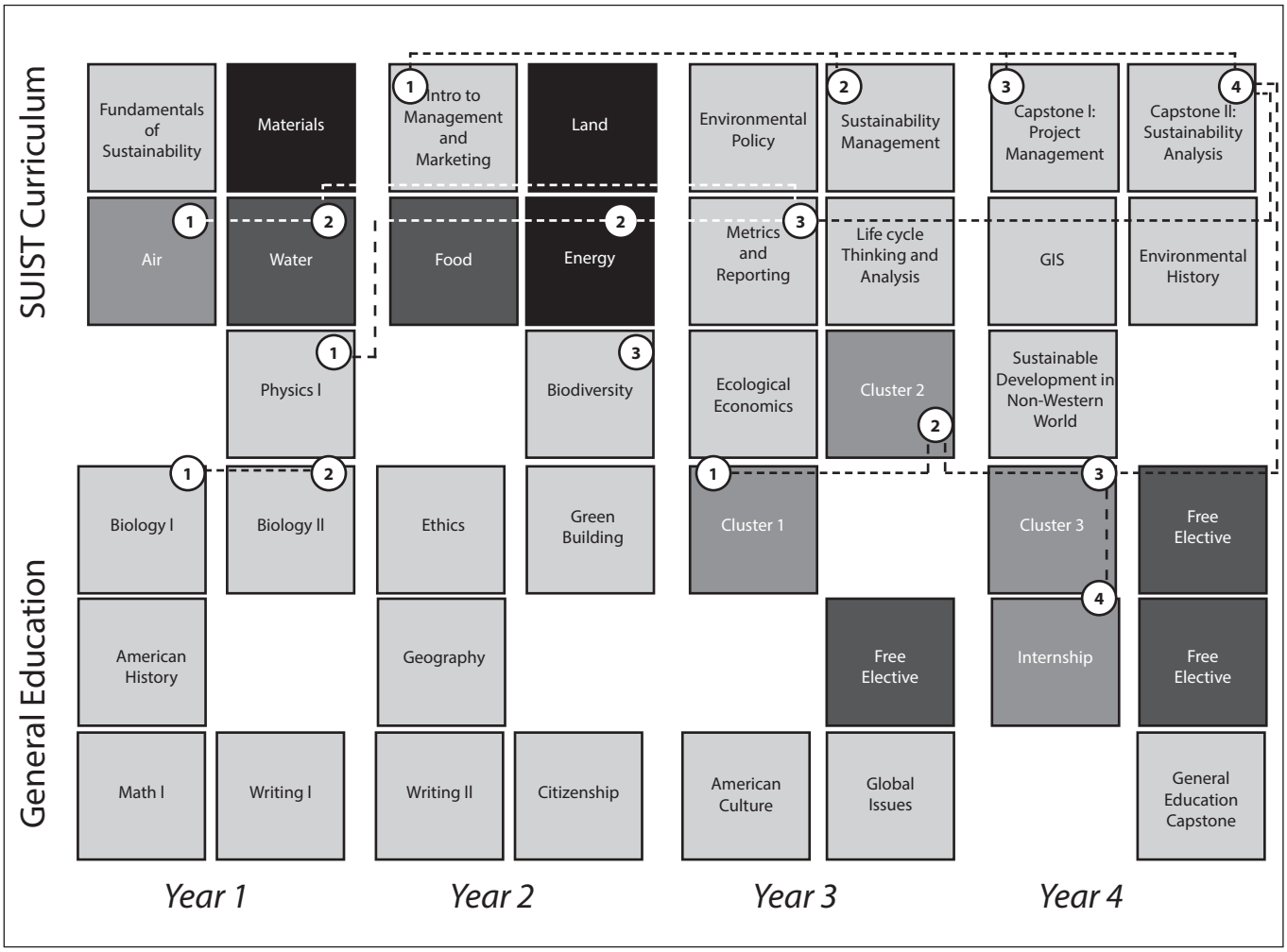

Figure 2. Curriculum and courses designed for within-major specialization

and Water course (about water quality and availability). The skills gained in these courses feed into our course in Metrics and Reporting, where students learn and practice energy and carbon accounting.

Following common practice in educational administration, we also organized this curriculum for regular assessment using the following five categories: environmental analysis; societal understanding; assessment and modeling; versatile communication; and sustainability leadership. Under each of these broad headings, we defined three assessment subcategories that break proficiency into introductory, intermediate, and advanced levels. We then distributed these subcategories across all courses in the curriculum to create a progressive learning sequence for each of the five learning areas. The resulting matrix serves as a detailed guide for our program assessment and a basis for evaluating learning attainment. The detailed outcomes in our assessment matrix convert into the criteria built into rubrics that are used to evaluate samples of student work, course assignments, and other evidence used for the assessment process on a rotating cycle.

Flexibility through Specialization Clusters

The most significant change, and the redesign feature highlighted in this article is: the integration of flexible specialization paths within the curriculum. A specialization path is a set of three topic-specific courses and an internship that help students develop niche skills and provide hands-on experiences. The goal is to build a specialization that could satisfy more niche entry-level job opportunities or align with a subspecialty in the field. Because this process aggregates from multiple sources, we refer to these specialization paths as clusters.

The goal of each cluster is to improve student preparedness for employment and even capacity to lead in areas of sustainability work emerging within organizations. As we developed each cluster, we strove to do so within dual design constraints. One constraint was the need to build this flexible specialization platform from existing courses in the university catalog. That meant drawing from other academic programs on campus. The second constraint was assuring that the set of courses from other academic programs synergize well enough with each other and with the sustainability program to make a cluster coherent and meaningful.

To develop our clusters, we drew on our analysis of potential sustainability career trajectories and a list of university courses already available on campus to develop four broad categories:

- Science and technology
- Design and innovation
- Business and management
- Policy, outreach, and communication

Within each category we then developed individual clusters (Figure 3). Each cluster progressively builds a specialization or triangulates a competency. Students are empowered to pick from the defined clusters or to customize their own, as long as it is formed from at least three related and progressive courses. For example, within the broad category of science and technology a student might pick a cluster in conservation biology or landscape science and design. Similarly, within the category of design and innovation a student might pick a cluster in design thinking and entrepreneurialism or sustainable design.

To help students identify a cluster of interest, each category has a gateway course within the required curriculum. These gateway courses introduce students to each cluster category before they choose one in the third year of the program. For example, the gateway for clusters in policy, outreach, and communication is the curriculum's required course in environmental policy. As another example, the gateway course for clusters in design and innovation is a required systems thinking course that students take in Philadelphia University's design and engineering college.

To add some insights into these clusters, we offer the following examples. Imagine a sustainability student interested in corporate social responsibility and green product certification. She might choose the accounting and reporting cluster in the business and management category and take a first course in managerial accounting, a second in financial accounting, and a third in strategic communication. We would anticipate working with this student to obtain an internship working for a third-party certifier of products or working on a corporate sustainability report inside a large company.

As another example, imagine a student who hopes to join or start a company producing skateboard decks and surfboards with sustainable materials. He might choose the

Categories	Specialization Clusters
Science and Technology	• Landscape Science and Design • Ecology and Environmental Science • Physical Systems and Engineering
Design and Innovation	• Design Thinking and Entrepreneurialism • Sustainable Design • Life-cycle Assessment and Design
Business and Management	• Accounting and Reporting • Finance and Economics • Management and Human Resources
Policy, Outreach, and Communication	• Public Outreach and Engagement • Advocacy and Policy Studies • Strategic Communication

Figure 3. Example cluster categories and specialization in each cluster

sustainable design cluster in the design and innovation category and take a first course in green materials, a second in advanced visualization, and a third in adaptive design from our master's program. We would anticipate working with this student to obtain an internship in product or business development and, like the previous student, to demonstrate this specialization in his senior project. As a third example, consider a student interested in a more traditional environmental science approach to sustainability based in ecological science. Imagine that she has aspirations to pursue a master's degree in marine biology or aquatic studies. She might choose the conservation biology cluster and, from a menu of six possible courses, take a first course in ecology, a second in oceanography, and a third in conservation planning. We would anticipate working with this student to obtain an internship in habitat conservation or environmental protection and to have her bring this specialization in as a dimension of her senior project.

In addition to deepening the student's expertise in a selected field, the cluster approach provides structure for the development of our internship network. It also defines a specific focus and role for each student as he or she enters our two-semester senior capstone sequence. Over the course of the senior year, the capstone process helps students identify and frame a client-based project, apply project management skills, and work individually or collaboratively to complete an initiative that includes their cluster specialization.

As a final comment, we would like to explain that clusters as a design approach are different from traditional university specializations like minors. Clusters are not formalized in a registrar's office or university catalog. This feature allows the program and its students to design and adapt clusters rapidly. As such, the clustering approach allows the potential both for more targeted career preparation and for easier administrative adaptation as the jobs market evolves.

Conclusion

This case study explores the use of flexible specializations in customizable course clusters as a way to teach core sustainability competencies and prepare students for the evolving field of practice and the diversifying nature of sustainability careers. The case study was among the first sustainability-specific undergraduate curricula, and its revision offers a second design iteration for students of higher education and the field of practice. The integration of specialization clusters affords greater flexibility to target skills and knowledge emerging in a rapidly changing and increasingly niche job market. The key challenge when basing a curriculum on a flexible platform is in striking a balance between a coherent unified curriculum based in flexible professional development and a more targeted training program focused on jobs-ready skills. In this sense it parallels a broader discussion about the value of university education and the utility of focusing training on ready-to-go

skills for specific career paths versus providing a broad liberal education. We offer no specific advice on this issue, recognizing that oscillation may occur between the two as professionals face and adapt to increasingly global, frequently disrupted 21st century fields of practice.

Author Disclosure Statement

No competing financial interests exist.

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