

Six dimensions of sustainability: a framework for organizing diverse university sustainability curricula at The Ohio State University

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Abstract

Purpose – Integrating sustainability into university curricula brings diverse challenges and conflicts as separate units vie for ownership of courses and topics. This case study presents a six dimensions sustainability framework developed at The Ohio State University to organize curricula under an inclusive strategy.

Design/methodology/approach – An interdisciplinary group of faculty focused on sustainability education engaged in a three-phased process including review of sustainability definitions from diverse disciplines; analysis of key aspects of the definitions in conjunction with course descriptions and learning outcomes; and identification of commonalities across the key aspects. This yielded six foundational dimensions of sustainability which serve as a means to assess curricular contributions across University units and topics. The six dimensions framework has been used in practice in multiple contexts.

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The authors would like to acknowledge the robust and dedicated participation of the SELC members whose collaborative spirit made the six dimensions possible.



Findings – The six dimensions framework provides a way to identify and foster diverse sustainability curricula efforts. It has enabled academic units to describe their disciplinary and interdisciplinary perspectives on diverse sustainability topics and the University to advance a broad sustainability vision.

Originality/value – The six dimensions framework provides a novel “big tent” approach to integration of sustainability into higher education curricula. The framework provides guidance about what counts as sustainability while maintaining the breadth that widens participation.

Keywords Education, Case study, Sustainability, Curriculum, Framework

Paper type Case study

1. Introduction

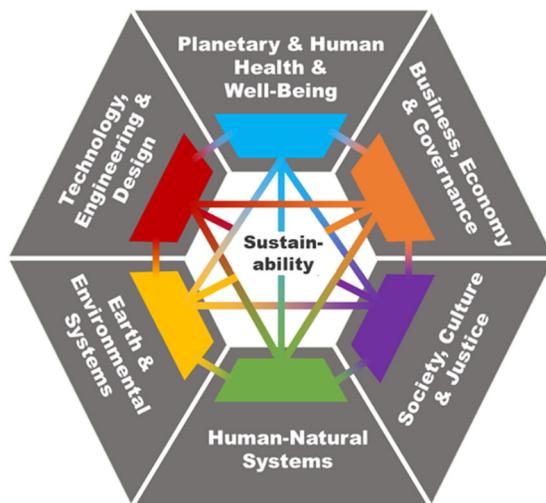
From climate change to water pollution, food insecurity to biodiversity loss, the socio-environmental problems that sustainability addresses are multidimensional and complex. Fostering their understanding and advancing solutions require integrating diverse forms of expertise through multi-, inter- and transdisciplinary approaches. Sustainability education presents an enormous opportunity to simultaneously address the world’s pressing problems and innovate new forms of inquiry. This opportunity is also the challenge, as transdisciplinary inquiry across diverse forms of knowledge and experience is difficult particularly at large universities with strong traditional disciplinary units. As [Evans \(2015\)](#) notes, “power structures and traditions that have characterized the ideal in higher education in the industrialized, globalized world die hard” (p. 92) and need visionary leadership to manifest transdisciplinary sustainability pedagogy. In this case study, the authors address one aspect of the challenge: defining a sustainability framework that encompasses curriculum across the entire university – inclusive of fields as different as history, plant sciences and engineering – in order to innovate truly transdisciplinary sustainability education.

The six dimensions of sustainability framework ([Figure 1](#)) provides a tool for identifying the breadth and depth of sustainability courses and programs that already exist, including those that might not label themselves explicitly as “sustainability.” This detailed and inclusive approach facilitates communication to students, faculty and administrators about available sustainability courses and programs. The tool also helps guide new curriculum development by identifying gaps and redundancy in current offerings and providing a framework for developing holistic curricular programs. Because it reflects knowledge areas rather than specific topics, sectors or challenges, it is not constrained to any particular departments or program.

The authors’ goals are to describe the collaborative and interdisciplinary process through which the novel six dimensions framework was established and provide an example of how it has been applied to identify, categorize and guide sustainability curricula at The Ohio State University (OSU), a large, public university with multiple campuses. To put the six dimensions framework into the context of existing programs and approaches, the paper begins with a review of key ways in which sustainability education has been integrated into higher academia curricula. It then presents the methods used to develop the framework followed by examples of its application. The discussion and conclusions consider successes, challenges, and limitations with an eye to future applications. The authors hope that other universities may learn from the six dimensions framework process as a collaborative tool for sustainability education implementation.

2. Literature review

The call to integrate sustainability into higher education traces back to at least 1990 and the Talloires Declaration which set forth a ten-point action plan to bring the concept into



Human & Natural Systems: coupled human-natural systems; integration of environmental, economic, and social factors; systems thinking; resilience of human-natural systems; changes in these systems over time

Earth & Environmental Systems: environmental, earth, and natural resource systems; knowledge of planetary or natural systems, e.g., climate, aquatics, soils, forests, wildlife, geology, ecology, agriculture; AND how these relate to human well-being and sustainability or are impacted by human activities

Business, Economy, & Governance: economic, political, business, and policy processes, including: economy, consumption, production; laws, policy, institutions; business, strategy, management; costs, benefits, tradeoffs; AND how these relate to sustainability or the environment

Society, Culture, & Justice: social and cultural processes, including: justice, equity, values, and ethics; history, religion, and the arts; citizenship; behavior and decision making; power and cultural critique; AND how they relate to sustainability or the environment

Technology, Engineering, & Design: engineering processes; technological innovation; systems design; infrastructure and built environment; human-machine interface; manufacturing processes; life cycle; product design; AND how these relate to sustainability, including lower environmental impacts, greater resource efficiency, or improved resilience

Planetary & Human Health & Well-Being: human health, safety, risk, sustainable livelihoods; social well-being for a community, region, or globally; changes in well-being over time AND how these are impacted by environmental conditions

Source: Figure courtesy SELC

Figure 1.
The six dimensions of
sustainability
framework

teaching, research, operations and outreach at colleges and universities worldwide (ULSF, 2024). Though it has been signed by more than 500 colleges and universities in 50 countries, it was not until the early 2000s that broader interest materialized with the growth of organizations such as the Association for the Advancement of Sustainability in Higher Education, focused journals such as the *International Journal of Sustainability in Higher Education*, as well as agreements such as American College and University Presidents Climate Commitment. Further, growing education-based sustainability literature recommends “that the preeminent approach to educating students about sustainability is by infusion throughout the higher education curriculum” (Michel, 2020, p. 355). There has been

a corresponding increase in undergraduate, graduate and certificate sustainability programs, as well as university research institutes and centers (NASEM, 2020, p. 1). The efforts are varied in terms of content and administration and reflect diverse areas of emphasis at the curricular level. To set the case in context, this paper begins with a review of targeted literature focused on how sustainability has been integrated into university curricula.

2.1 Sustainability content

A primary challenge associated with institutionalizing sustainability content in university level curricula is deciding what the content should cover. Sustainability as a concept remains ill-defined (Campbell and Zellner, 2020) and agreement tends to be found on only the most general of tenets: environmental protection, economic development, and social and intergenerational equity.

In their report *Strengthening Sustainability Programs and Curricula at the Undergraduate and Graduate Levels*, the National Academies of Sciences notes that:

the evolving and interdisciplinary nature of sustainability and its dimensions means that sustainability education programs may need to determine core content knowledge somewhat flexibly, and in accordance with context, discipline, and institution-specific requirements (NASEM, 2020, p. 5).

They divide curricular content based on whether the intention is to “orient and guide action for achieving socio-environmental sustainability” or is more theoretically driven, to “envision and understand relationships, linkages, and feedbacks among social and environmental processes that affect sustainability” (NASEM, 2020, p. 25). Curricula organized around goals often focus on the 17 sustainable development goals (SDGs) set forth by the United Nations in 2015 in its *2030 Agenda for Sustainable Development* (United Nations, 2024; Albareda-Tiana, *et al.*, 2018; Franco *et al.*, 2019; Kioupi and Voulvoulis, 2019; Rajabifard *et al.*, 2021). More theoretically oriented sustainability curricula are grounded in the linkages between humans and the natural environment and focus on these interdependencies as well as what aspects of those relationships give insight for sustainable development (NASEM, 2020).

Curricula may also be organized around a set or sets of core competencies supporting sustainability. These competencies are “complexes of knowledge, skills, and attitudes that enable successful task performance and problem solving” (Wiek *et al.*, 2011 in NASEM, 2020, p. 4). Competency-focused sustainability curricula can help overcome the disciplinary silos that hinder transdisciplinary inquiry. While there remains no universally accepted set of sustainability education competencies, Wiek *et al.* (2011) proposed five that serve as the foundation for Arizona State University’s (ASU) School of Sustainability (NASEM, 2020, p. 36): systems thinking, future thinking (anticipatory), values thinking (normative), strategic thinking, and collaborative (interpersonal). A 2023 report on the sustainability skills gap, based on feedback from over a dozen large, sustainability-minded companies, emphasizes “sustainability fluency,” which it defines as core competencies and foundational knowledge of sustainability science, change management, transdisciplinary skills, and digital skills (Lesser *et al.*, 2023).

Also critical for broad integration of the concept is understanding the “conflicts and tradeoffs between the social, economic and environmental dimensions integral to sustainable development” (Menon and Suresh, 2020, p. 1025). Yet curricular connections across a spectrum of majors appear most solidly grounded in environmental considerations of sustainability, while economic and social aspects are less frequently addressed (Menon and Suresh, 2020).

This finding is corroborated by [Buckley and Michel's \(2020\)](#) review of institutional-level sustainability learning objectives from 47 U.S. institutions.

Regardless of the approach, diverse exposure routes, such as general education courses, electives, and required program offerings, provide a broad body of students with insights into the ways in which sustainability is relevant to their lives. Ideally, such exposure reinforces key concepts and enhances creativity regarding the complex challenges associated with sustainability. As [Michel \(2020, p. 366\)](#) writes, "Regardless of the topic, repeated exposure, reiteration of ideas, and application of the topic to different contexts are essential for deep learning."

2.2 Sustainability administration and assessment

Integration of sustainability considerations into curricula is influenced by the manner in which the integration takes place. Analyzing ways that colleges and universities implement education for sustainable development, [Weiss et al. \(2021\)](#) identify six patterns:

- (1) collaborative paradigm change;
- (2) bottom-up institutional change;
- (3) top-down institutional change;
- (4) externally driven initiatives;
- (5) isolated initiatives; and
- (6) limited change.

Initiatives may be in response to or despite challenges regarding acceptance of the concept at the university level, administrative and disciplinary barriers to course development (especially for inter- or multi-disciplinary offerings), and faculty workloads ([Hooey et al., 2017](#)). Patterns vary in terms of the amount of time, funding, and coordination needed versus the potential extent and depth of impact on students. Patterns may also result in different student outcomes because of curricular design and because they reflect and result in different campus culture and extra-curricular opportunities.

Increasingly, universities are choosing to provide sustainability education through top-down creation of new sustainability academic units (pattern 3 from [Weiss et al., 2021](#)), as in the case of the new Doerr School of Sustainability at Stanford University and the Climate College at Columbia University. These initiatives require not only strong university leadership, but also a large influx of resources, which may be beyond the capacity of many institutions. Two smaller scale examples provide alternative approaches. The University of Pennsylvania initiated a limited but broad-based effort (pattern 6) with their Integrating Sustainability Across the Curriculum (ISAC) program ([Dmochowski et al., 2016](#)). Undergraduate researchers paired with faculty who volunteered to update their courses with sustainability material; the University also developed a sustainability course inventory based on the initiative. By contrast, the University of Vermont in 2010 began a bottom up, student-driven effort (pattern 2) to institute a "university-wide sustainability curricular requirement for all incoming undergraduate students" ([Hill and Wang, 2018, p. 706](#)). They first established the concept in general education courses as a step toward embedding it throughout students' coursework ([Michel, 2020](#)), and they created a Sustainability General Education Assessment Committee to provide oversight, assessment, and professional development ([Hill and Wang, 2018, p. 713](#)).

An acknowledged challenge with sustainability in higher education is assessment of course and program goals (Redman *et al.*, 2021). Accreditation boards are often responsible for evaluating programs based on disciplinary competency standards. However, sustainability, whether as its own program or as an aspect of another, lacks a unifying body to facilitate such comparisons (NASEM, 2020). The diverse array of content and administrative approaches leads to inconsistent assessment of common competencies (Redman *et al.*, 2021). Therefore, designing a sustainability course or program is best done with the end in mind; aligning expected learning outcomes with one or more assessment tools provides consistent longitudinal evaluations (Krytus *et al.*, 2021; Redman *et al.*, 2021).

The OSU approach builds on this range of existing knowledge about sustainability education. The impetus was not to seek a single integrated curriculum or program – which would require competencies – but instead to assess the landscape of sustainability at the University and provide an inclusive platform for building coordinated curricula, which does not require competencies and assessment. In terms of the pattern of implementation, the team explicitly adopted a collaborative, paradigm shifting pattern (pattern 1 from Weiss *et al.*), which was neither entirely bottom-up nor top-down. In contrast to a solely top-down or bottom-up approach, they expect this to result in a broader set of coordinated sustainability courses and curricula that will support more opportunities for inter- and transdisciplinary learning. This approach was driven by the context of the University. In the following section the authors describe the overall approach and, importantly, the process through which the framework emerged.

3. Methodology

Individual units at OSU have long taught sustainability-related material, but these efforts have largely been independent and uncoordinated. A concerted effort to organize sustainability education across the University started with the 2018 founding of the Sustainability Education and Learning Committee (SELC). The creation of SELC followed a university-wide effort in 2015 that established a comprehensive set of university sustainability goals to guide decisions in campus facilities management, research, and teaching. A subsequent university-wide effort in 2017 led to hiring dozens of new faculty in sustainability areas and the creation of the university's Sustainability Institute (SI) in 2019. Upon its inception, SI became the entity that facilitates and supports SELC.

SELC was charged by the Office of Academic Affairs (OAA) to "establish a framework for sustainability education at Ohio State that provides a coordinated approach and supports cross-unit collaboration to strengthen existing programs and pioneer new programs" (SELC, 2019, p. 1). An invitation to join SELC was extended to academic units through OAA and college curricular deans. Fourteen units from eight of the University's 15 colleges [Arts and Sciences; Business; Engineering; Food, Agricultural, and Environmental Sciences (FAES); Law; Public Affairs; Public Health; and Social Work] elected to participate. Over time the committee has grown to 20 representatives from 18 units, including the College of Medicine. SELC members include faculty from multiple campuses, tenure track and clinical faculty, as well as assistant through full and administrative faculty.

3.1 Motivations and influences: sustainability goals and turf wars

While earlier efforts at OSU sought to advance sustainability, and a high-level definition of sustainability was provided in the SI strategic plan, they were insufficient for categorizing and guiding sustainability curricula. Those working on the 2015 goals recognized that they were unlikely to agree on a common definition. By avoiding the thorny issue of definition, they were able to identify common goals with which everyone could agree. In this way

sustainability served as a “boundary object”: the very elusiveness of a shared definition created space for collaboration across communities without requiring full agreement (Star and Griesemer, 1989). The task of developing a working definition of sustainability that could be used to guide academic programs was left for later.

The motivation to develop a fundamentally inclusive framework, and the formation of SELC, was borne from longstanding tensions at the University about which departments and colleges could rightfully claim the “environment” as their purview. Efforts to “own” a topic or an approach are driven by many factors, all of which were the headwinds against which SELC was working. One factor is intellectual conviction over who is qualified to teach a particular type of course. Another is the incentive structure adopted by many universities, in which departments and programs compete for students, discouraging cooperation and interdisciplinarity while rewarding units for developing a wide range of courses that capture as many students as possible (Readings, 1997). These tensions are magnified at large universities such as OSU, which have so many programs and faculty that broad topical overlap seems inevitable.

For SELC, cross-disciplinary overlap about “environment” and “sustainability” was not only inevitable but desirable, and it was this conviction that drove SELC’s desire to explicitly address and productively overcome past turf battles. SELC itself came together after one of these conflicts, this time over a proposal for an environmental studies minor. The sense coming out of meetings about that proposal was that to avoid these pitfalls the University needed to take a proactive approach to fostering a more collaborative environment. This recognition, along with the commitment of faculty from multiple colleges willing to volunteer their time and effort into realizing a more inclusive approach, led to the creation of SELC.

3.2 The process of developing the six dimensions framework

Development of the six dimensions framework took place over the course of SELC’s first eighteen months in three primary phases: definition review, common themes assembly from definitions and course offerings, and six dimensions framework generation.

3.2.1 Definition review. While the lack of a shared definition created space for alignment on the articulation of the 2015 sustainability goals, it became clear to SELC members that without a shared definition they would have no criteria for cataloging sustainability education or guiding units in determining whether and how they contribute to sustainability education. Given that SELC itself is interdisciplinary, SELC members also wanted to maintain an openness that facilitated collaboration. The committee therefore sought a broad definition that could encompass a wide range of topics, approaches, and even worldviews. The definition needed to serve SELC’s mission of identifying the multiple ways sustainability is represented at OSU, including the disciplinary and interdisciplinary scholarship and teaching programs of the University, and avoid turning SELC into a gatekeeper of a narrow vision. What definition of sustainability could apply across the university and – because the ultimate goal is to educate students for work in the wider world – beyond?

With this in mind, SELC members were asked to survey the literature across their respective fields (e.g. urban planning, geography, economics, history, natural resources) to identify key definitions that they and their colleagues operate from as they address sustainability. SELC leadership also provided paraphrased versions of well-known definitions such as Brundtland (1987) and ones published by other universities such as Arizona State University. Not surprisingly, this process generated dozens of different definitions for consideration. Members were surveyed to provide feedback on the

possibilities and a meeting to discuss the options quickly made clear that no single definition was going to be adequate. The committee considered trying to write a definition themselves, or to identify one overarching definition with more specific sub-definitions under its umbrella. But these, too, felt like imposing too narrow or hierarchical vision. In the end, submitted definitions were provided via PowerPoint and the committee discussed *multiple* definitions *without* prioritizing them (see [Box 1](#) for a sample of the dozens of reviewed definitions). Starting from multiple definitions from diverse disciplines is one of the key strengths of the SELC approach. There is neither competition among the definitions nor an assumption that they are all compatible. The point is not to agree with all of them but to understand multiple perspectives, appreciate their differences, and place oneself (and their unit) within the spectrum of perspectives. As SELC reviewed the definitions alongside each other, it became easier to see common dimensions of sustainability across fields as well as aspects of sustainability that were more specific to particular disciplines. SELC then analyzed the language of the definitions through group discourse and consensus building, including examinations of which concepts were distinct, overlapping, or equivalent; distinct and common elements include considerations of human and natural systems, balance, integration, limits, equity, economy, environment, justice, and planetary boundaries.

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Box 1. Sample sustainability definitions suggested by SELC members reviewed to guide a new approach

Sustainability is a condition that allows humans and other species to flourish and thrive in perpetuity within Earth's carrying capacity, and not unjustly burdened by the actions of others ([Bullock and Hitzhusen, 2015](#); Natural Resources).

Sustainability involves a triple bottom line that balances environmental impacts, economic gains and social well-being ([Elkington, 2004](#); Economics).

Sustainability means staying within critical ecosystem and environmental boundaries, including planetary boundaries that define a "safe operating space" for humanity; it also depends on the resilience of natural and human systems, such as those providing energy and food, and the ability of communities to recover, adapt and flourish in the face of changing environmental, economic and social conditions. ([Rockström et al., 2009](#); Ecology).

Sustainability refers to nondeclining human welfare or well-being over time; using resources in a way that maintains or improves the well-being of communities and global society ([Irwin et al., 2016](#); Economics).

Sustainability is inherently complex and political, often contested, shaped by real-world processes influenced by relations of power, and is normative because it is value-laden ([Mansfield, 2009](#); Geography).

Sustainability is improving human well-being and ensuring social equity for present and future generations while safeguarding the planet's life-supporting ecosystems ([Boone, 2024](#); Arizona State University).

Sustainability implies meeting the needs of the present without compromising the ability of future generations to meet their own needs ([Brundtland, 1987](#); Popular).

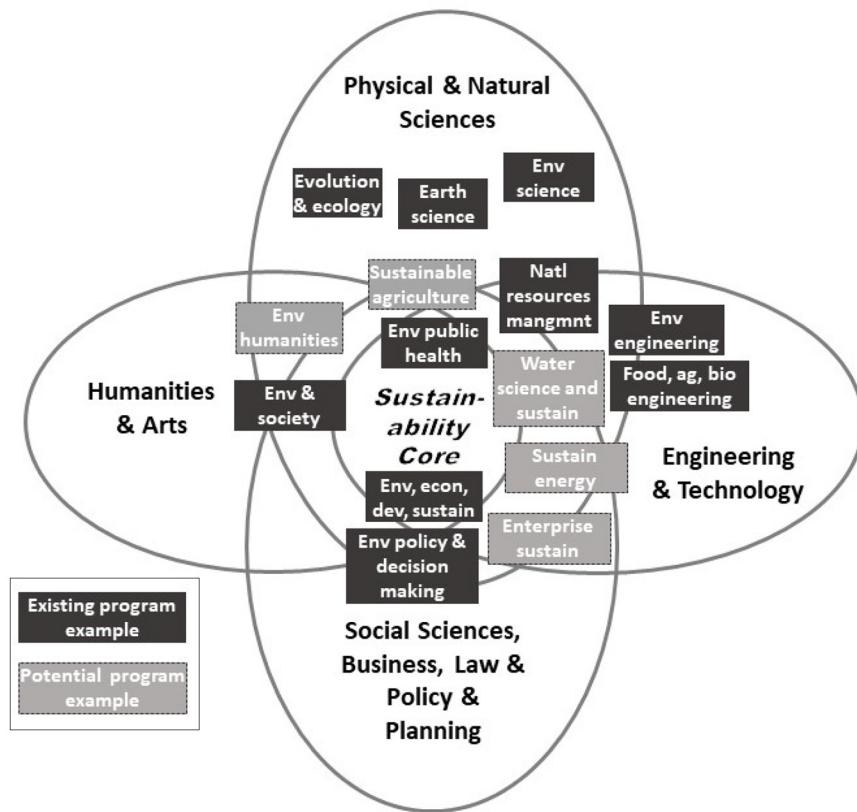
3.2.2 Word clouds, a Venn diagram, and the six dimensions. The next step expanded on the definition discussion to examine the language that existing courses and programs at the University were using to attribute meaning to sustainability. To identify sustainability courses and programs, SELC used a 2015 review of OSU's full course catalog prepared for

the STARS reporting to the Association for the Advancement of Sustainability in Higher Education (AASHE); the reporting involved some of the SELC members. The review identified sustainability courses and programs based on the learning outcomes that explicitly highlighted sustainability. For example, any program that had at least two sustainability learning outcomes and that spanned two of the three basic areas of sustainability (social, economic, environmental) reflective of the integrated nature of the concept was deemed a sustainability program. Any course with at least one learning objective related to sustainability was deemed a sustainability course.

SELC members generated a series of word lists and clouds created from sustainability course titles, course descriptions, and learning outcomes and compared these with the language found in the different sustainability definitions. This process helped to better visualize similarities and differences in emphasis between approaches to sustainability across OSU units and beyond, helping to make explicit the range of sustainability meanings and contexts. It also provided a firmer sense of where OSU sustainability programs were similar and where they were distinct.

In a parallel effort, the committee mapped key sustainability programs as determined by the 2015 AASHE report onto a four-lobed Venn diagram that situates four general types of academic programs (Figure 2). Dubbed the “four leaf clover,” this conceptual model includes lobes for Physical and Natural Sciences; Engineering and Planning; Social Sciences, Business, Law, and Policy; and Humanities and Arts, centered around a Sustainability Core. Conceptualizing sustainability in terms of overlaps of traditional divisions within academia and placing programs within various lobe(s) at varying distances from the core was useful for visualizing sustainability as an inherently transdisciplinary field and for mapping programs in terms of how they cross these traditional divides. This exercise also helped to reveal gaps in the existing curriculum content, e.g. sustainability curricula in the humanities and arts was revealed as a clear gap, which paved the way to a new minor in environmental humanities. However, there were also significant limitations to framing sustainability in terms of a Venn diagram. It pinned each program at one spot on the diagram, rather than recognizing that a program could be in multiple places in different ways. It also was not specific to the content of sustainability education, whether framed in terms of goals, theories, or competencies. Additionally, it risked an interpretation in which programs with more overlaps (at the core) are more relevant to sustainability than those further out.

The four-leaf clover image coupled with the varied sustainability definitions gave rise to a preliminary list of knowledge areas that could be used as criteria to comprehensively characterize programs and courses at OSU in terms of their relevance to sustainability. This list was the first draft of the six dimensions in terms of both categories and the associated substantive considerations that developed from the definitions. SELC vetted it across disciplinary units through a series of discussions between May and November 2018 to determine whether all units felt their approach to sustainability was fairly included and honored in its particularity. Each meeting began with a review of the current list and descriptors, followed by a facilitated discussion with members of SELC representing a range of disciplinary and interdisciplinary perspectives. Updated definitions and discussion notes were shared following each meeting and members had the opportunity to add edits or further thoughts to online documents. Criteria evolved in response to this feedback. For example, the initial list included “environmental challenge areas,” e.g. climate, energy, food systems, water, air, soil, etc. as a criterion, but was later revised to “earth and environmental systems” as a knowledge area. This allowed the framework to be agnostic in terms of topic and applicable to diverse sustainability



Notes: Boxes are intended to be illustrative, not comprehensive

Source: Figure courtesy SELC

Figure 2.
"Four leaf clover" diagram of existing and potential sustainability programs at Ohio State

challenge areas. From this iterative process emerged the final set of six dimensions and their interpretations (Figure 1).

3.3 Making meaning of the six dimensions framework

The six dimensions framework provides an inclusive approach to identifying the breadth of sustainability education at OSU. The aim is to help guide students seeking courses and programs that fit their interests, units (alone or in collaboration) designing new courses and programs that complement what already exists, and the university designing its general education curriculum and other cross-campus initiatives. Use of the framework starts by identifying whether and how each course or program addresses any of the six dimensions. Some courses and programs will address one dimension, more will address several in different combinations, and a very few will address all six. Courses and programs that address none are not considered part of the sustainability education curriculum.

It is important to recognize that the six dimensions are a heuristic device and are not meant to imply each as a discrete realm of the real world. Rather, as dimensions they convey a sense of scope and provide a way to organize and identify different sustainability

perspectives, approaches, and topics. Within any course or program, the dimensions might be organized or addressed differently than they are in this model, but that does not preclude locating them within it.

It is not necessarily the case that a course or program addressing many dimensions is more relevant to sustainability than a course addressing just one. More relevant than the number of dimensions a course or program covers is the *extent* to which it addresses any given dimension. The model recognizes that each course or program is unlikely to address all dimensions equally. Further, the connections within the framework highlight how the dimensions are not necessarily additive but instead an integrative gestalt.

The framework does not focus on specific challenges (e.g. energy, water) nor does it capture the specific perspectives (disciplinary or otherwise) within each dimension, which will vary. Instead, it maximizes synergy by demonstrating how courses and programs from different units and disciplinary perspectives do or could relate to each other. The point is not that each of the dimensions represents an existing silo; rather thinking of them as *dimensions* emphasizes interconnections and helps identify complementarity. For example, multiple perspectives regarding the conditions that enable a sustainable energy transition – including not just technological, but also social, economic, political, and environmental – are critical for developing the knowledge and skills needed to achieve this transition. This inclusivity was an essential goal in developing the six dimensions and yields many benefits. For instance, advisors might steer students to multiple courses rather than suggesting students choose one. It might lead to program innovations such as new interdisciplinary certificates or minors that build from existing courses. It could enhance a student's ability to choose a class or degree program that will focus on the dimensions of sustainability that match their interests. It prevents narrow "ownership" of sustainability by one program or college: sustainability through the framework becomes a university-wide endeavor with different academic units contributing to its different dimensions. Moreover, the framework makes visible and builds on even seemingly incompatible perspectives and approaches. It serves not just as a mechanism for thinking about sustainability but as a mechanism for collaboration and inclusivity across very real differences, which is among the greatest skills that the authors hope to impart to OSU students through sustainability education.

4. Results: applying the framework

The six dimensions framework has been used in practice at OSU in multiple contexts, including restructuring the general education curriculum, designing interdisciplinary majors and certificates, guiding new course development, and most recently developing a university-wide vision and corresponding visioning paper to advance sustainability education and workforce development. The framework has even been extended beyond education to support an interdisciplinary approach to sustainability research and community engagement at OSU. Here the authors describe an early application of the framework: undergraduate program and course categorization across the university. This example highlights the robustness of the framework to guide sustainability education decision making.

In 2019, SELC first applied the six dimensions framework to a comprehensive effort to collect data on all undergraduate curricular offerings. Both a course-level and a program-level survey (see <https://si.osu.edu/curriculumdata>), administered by SI, were distributed to curricular deans, department chairs, and undergraduate program faculty leaders.

Academic units were asked to identify all sustainability-related undergraduate programs and to assign a numerical score for each of the six dimensions to each program. Numbers ranged from 0 to 4 with 0 representing the absence of content in a specific dimension and 4 indicating a strong focus for that dimension. Any program with a 4 reported in at least one

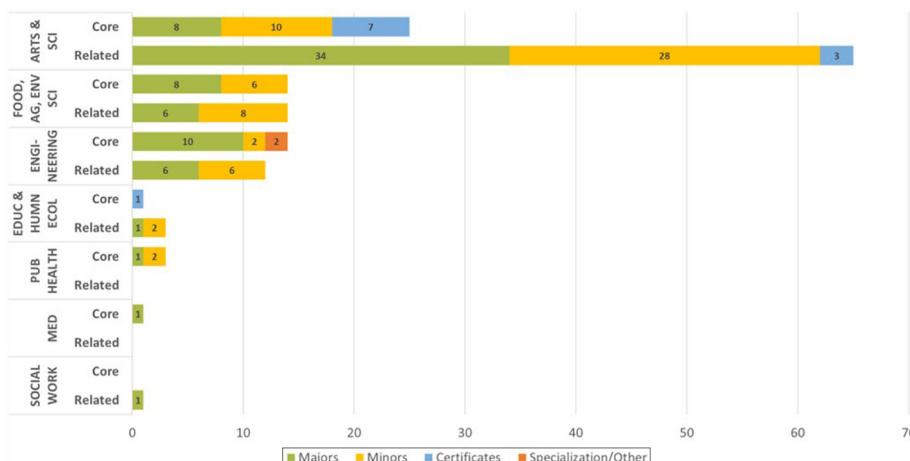
dimension of sustainability was identified as a “core” sustainability program. Programs reporting any level of sustainability content, but not a strong focus in any area, were then identified as a “related” sustainability program.

In addition, each unit was asked to assess the sustainability content of their individual courses by assigning a “P” for primary or “S” for secondary in each dimension that applied to each course. A primary rating was defined as at least one Expected Learning Outcome or half of the overall course content focused on a specific dimension of sustainability. A secondary rating was defined as at least one module (or multiple sessions) of the course, but less than half of the overall course content, focused on a particular dimension of sustainability. It is important to note that a course could be tagged with more than one primary or secondary rating, depending on how many dimensions met these criteria.

This comprehensive data collection uncovered a much greater number and diversity of sustainability courses and programs at OSU than had previously been reported. In total, the data revealed 151 undergraduate programs with sustainability content, including 26 core and 48 related majors, 64 minors, and 11 certificate offerings. The proportion of core sustainability programs is distributed roughly equally across the three largest colleges (Figure 3): Arts and Sciences (23%), Engineering (30%), and Food, Agricultural and Environmental Sciences (23%). This confirms that core knowledge areas of sustainability exist across the university in multiple colleges and academic programs.

The course survey yielded 711 undergraduate courses that include at least some sustainability content, i.e. at least one primary or secondary rating for one of the six dimensions. The distribution of courses across colleges is somewhat different than programs. The largest proportion of courses with sustainability content is in FAES (35%), followed by Arts and Sciences (29%) and Engineering (14%). This suggests that students from FAES are most likely to be exposed to sustainability content through one or more of their courses, even though they may or may not be enrolled in a major considered to be a core or even related sustainability major.

To further explore the relative distribution of core sustainability content, the authors summed the number of primary tags for each of the six dimensions across academic programs. Figure 4 illustrates these results for the academic programs that have the greatest number of primary tags associated with their course offerings. Based on these self-reported data, about half of these



Source: Figure courtesy SELC

Figure 3.
Proportion of core
sustainability
programs across
seven colleges at OSU

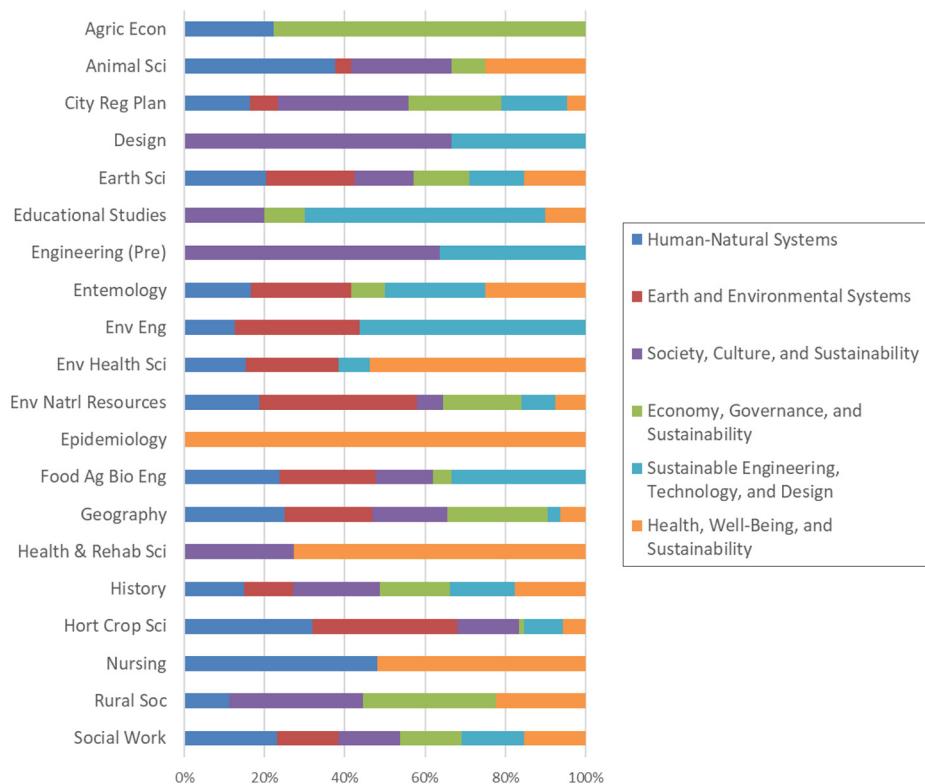


Figure 4.
Distribution of undergraduate course content across the six dimensions of sustainability by selected academic programs

Notes: Based on the self-ratings of academic units

Source: Figure courtesy SELC

programs have at least one course with a primary tag for each of the six dimensions, suggesting that these are likely to be highly interdisciplinary in nature, whereas other programs have a clear focus on one or two dimensions. This analysis also reveals the potential biases that are introduced through this self-assessment. For example, Earth Sciences and Social Work reported almost equal numbers of primary tags distributed across the six dimensions, despite the likelihood that their programs have greater focus on one or two of the dimensions.

5. Discussion

In developing the six dimensions framework, the team operationalized a big tent approach to sustainability by embracing the inclusion of multiple perspectives as a core tenet of sustainability and essential knowledge for enacting change. In this section, the approach is related back to the literature and then insights of advantages and challenges are presented followed by concluding remarks future directions.

5.1 Relating to literature

Returning to Weiss *et al.* (2021), the pattern of implementation adopted at the Ohio State University has been one of collaborative paradigm change that is neither entirely bottom-up

nor top-down, but instead has elements of both. The process that SELC members followed in arriving at the six dimensions framework was bottom-up and faculty-driven. The framework emerged organically from intentional conversations: an iterative process of listening to each other. Each person presented their perspective in a way that others could understand, with the aim being to work out how each is similar to and different from the others. In the middle of the siloed university, they created a collaborative space to listen.

The outcome of these bottom-up deliberations, the six dimensions framework, was legitimized by not only this inclusive, faculty-driven process, but also by SELC's university-wide role. While SELC does not have curricular authority, it is endorsed by university leadership as an important advisory group. The initial formation and representation of SELC across academic units was coordinated centrally. SELC is facilitated and supported through OSU's Sustainability Institute, including a dedicated staff member whose job includes managing the work of SELC and being a liaison with other academic partners. This support has been essential to ensuring the consistency, reliability, and effectiveness in SELC's collaborations with academic partners. In addition, SELC manages portions of a curricular endowment created through a unique public-private partnership between OSU and ENGIE, a global energy services company. In entering into a 50-year agreement to procure and manage OSU's energy needs for its main campus, ENGIE provided additional funds to create several endowments to support the academic enterprise at OSU, including one that provides an annual disbursement of funds to support new curriculum development. SELC members themselves have served in key positions throughout the university, including as chair and members of the GE sustainability theme committee, which has been essential to ensuring the relevance and alignment of SELC with the broader university teaching and learning mission. Altogether, these top-down processes and university resources have helped to establish SELC's legitimacy and central role in advancing sustainability education at OSU while SELC itself has maintained more of a bottom-up, faculty-driven structure.

5.1.1 Lessons learned. There are a number of lessons learned in the development of the six dimension framework. First, the decision to remove the sticking point of a single definition was critical to the overall success of the endeavor. The resulting framework supports a collaborative approach that has begun to shift the sustainability paradigm at OSU in its multiple applications – from categorizing existing curricula, to guiding the goals and expected learning outcomes of new sustainability-themed General Education courses and other curricular programs, and, most recently, providing the foundation for a broad university-wide sustainability visioning process. As part of OSU's current effort to develop a transformational vision to advance sustainability across the academic enterprise, a sustainability education visioning paper lays out the "Ohio State Way of Sustainability" that is grounded in the six dimensions framework, including transdisciplinary approaches and a respect for differing, sometimes conflicting, perspectives on sustainability. As the University moves to considerations of educational assessment and operationalizing a vision of sustainability education integrated with research and engagement, the six dimensions framework has emerged as a cornerstone of these broader efforts. For example, a sustainability research visioning committee has used it to develop a matrix of challenge areas by the six dimensions to ensure that each area is addressed through transdisciplinary approaches that discover and integrate knowledge across the six dimensions.

Second, a collaborative approach to the framework still resulted in communication challenges. There remains a risk of oversimplifying by focusing on individual dimensions and losing the inherent integration element of the framework. In its application, for example, some have perceived the dimensions as independent entities. From that experience, the

authors added connecting arrows to the diagram (Figure 1) to emphasize the many interdependencies inherent in sustainability education.

Thirdly, there has been inconsistency in how courses and programs are categorized due to the reliance on self-assessments. There is clearly the need for greater uniformity in how the criteria are interpreted and applied, but there has not been the capacity to provide the needed training.

Fourth, the team missed the opportunity for a deeper incorporation of students' perspectives and ideas to inform and guide the work of SELC. SELC has engaged students in substantive ways, including working closely with a student capstone project team that synthesized over 3,900 responses from OSU undergraduates about their understandings and interests in sustainability topics and courses and programs at OSU. However, students did not have direct input into the framework. Continuity of student engagement is a challenge given SELC is a faculty-only committee.

Finally, the emergent process to develop the six dimension framework took five years from inception to the burgeoning integration into curricular and visioning decision making at the university. Ensuring that educators meet the sustainability challenges confronting the global community requires them to be more nimble and agile than they have been so far. If they are to fulfill a sustainability mission as a land grant institution, they will quickly need to leverage the inclusive foundation that has been built to deliver the transdisciplinary education and training that is urgently needed to empower sustainability leaders, practitioners, and change agents.

6. Conclusions

The six dimensions framework is an apt illustration of an emergent outcome that can result from a collaborative model of sustainability education that has both bottom-up and top-down aspects, highlighting a hybrid approach to curriculum change (Weiss *et al.*, 2021). Through considerable time and effort given by a group of highly dedicated people and enabled by university administration, resources and structures, this framework has catalyzed multiple interdisciplinary learning opportunities at OSU and is a cornerstone of the University's vision to advance sustainability as part of its academic mission. While the considerable time that it has taken to lay this critical groundwork is a limitation of the approach, the hope is that it will result in a broader and more durable platform for advancing sustainability, including the collaborative, interdisciplinary networks among faculty and academic units that are essential to fully achieving transdisciplinary sustainability education at OSU. Other institutions that seek to engage a similar approach may benefit from using the framework presented here as a starting point and from using an external facilitator to streamline the process.

In addition to providing the six dimensions of sustainability framework as a case study, this paper speaks to larger issues of interdisciplinarity across a university and holds lessons for other contentious topics. By making room for diverse perspectives, it is possible to identify a wide range of courses and programs that cover a broad topic (sustainability in this case) in some way. Without such a tool, universities run the risk of failing to identify or appreciate courses and programs that are contributing complementary understanding. Alternatively, they run the risk of prematurely regarding some courses and programs as overlapping. Against these risks, applying the model to individual courses and programs demonstrates how they are positioned within the space and the synergies and complementarities among them. By making explicit the multiple perspectives and approaches that different disciplinary domains bring to understanding this complex topic, the authors provide a model for how units within a university can work synergistically across and with differences.

References

Albareda-Tiana, S., Vidal-Raméntol, S. and Fernández-Morilla, M. (2018), "Implementing the sustainable development goals at university level", *International Journal of Sustainability in Higher Education*, Vol. 19 No. 3, pp. 473-497, doi: [10.1108/IJSHE-05-2017-0069](https://doi.org/10.1108/IJSHE-05-2017-0069).

Association of University Leaders for a Sustainable Future (ULSF) (2024), "Tallioires declaration", available at: <http://ulsf.org/talloires-declaration/> (accessed 9 August 2022).

Boone, C. (2024), "Arizona state university, school of sustainability", available at: <https://schooolofsustainability.asu.edu/> (accessed 12 March 2024).

Brundtland, G. (1987), "Report of the world commission on environment and development: our common future", available at: www.un-documents.net/our-common-future.pdf (accessed 9 August 2022).

Buckley, J.B. and Michel, J.O. (2020), "An examination of higher education institutional level learning outcomes related to sustainability", *Innovative Higher Education*, Vol. 45 No. 3, pp. 201-217, doi: [10.1007/s10755-019-09493-7](https://doi.org/10.1007/s10755-019-09493-7).

Bullock, C. and Hitzhusen, G.E. (2015), "Participatory development of key sustainability concepts for dialogue and curricula at the Ohio state university", *Sustainability*, Vol. 7 No. 10, pp. 14063-14091, doi: [10.3390/su71014063](https://doi.org/10.3390/su71014063).

Campbell, S.D. and Zellner, M. (2020), "Wicked problems, foolish decisions: promoting sustainability through urban governance in a complex world symposium: governing wicked problems", *Vanderbilt Law Review*, Vol. 73 No. 6, pp. 1643-1684.

Dmochowski, J.E., Garofalo, D., Fisher, S., Greene, A. and Gambogi, D. (2016), "Integrating sustainability across the university curriculum", *International Journal of Sustainability in Higher Education*, Vol. 17 No. 5, pp. 652-670, doi: [10.1108/IJSHE-10-2014-0154](https://doi.org/10.1108/IJSHE-10-2014-0154).

Elkington, J. (2004), "Enter the triple bottom line", in Henriques, A. and Richardson, J. (Eds), *The Triple Bottom Line: Does It All Add up?*, Earthscan, London, pp. 1-16.

Evans, T.L. (2015), "Transdisciplinary collaborations for sustainability education: institutional and intragroup challenges and opportunities", *Policy Futures in Education*, Vol. 13 No. 1, pp. 70-96, doi: [10.1177/1478210314566731](https://doi.org/10.1177/1478210314566731).

Franco, I., Saito, O., Vaughter, P., Whereat, J., Kanie, N. and Takemoto, K. (2019), "Higher education for sustainable development: Actioning the global goals in policy, curriculum and practice", *Sustainability Science*, Vol. 14 No. 6, pp. 1621-1642, doi: [10.1007/s11625-018-0628-4](https://doi.org/10.1007/s11625-018-0628-4).

Hill, L.M. and Wang, D. (2018), "Integrating sustainability learning outcomes into a university curriculum: a case study of institutional dynamics", *International Journal of Sustainability in Higher Education*, Vol. 19 No. 4, pp. 699-720, doi: [10.1108/IJSHE-06-2017-0087](https://doi.org/10.1108/IJSHE-06-2017-0087).

Hooey, C., Mason, A. and Triplett, J. (2017), "Beyond greening: challenges to adopting sustainability in institutions of higher education", *The Midwest Quarterly*, Vol. 13, pp. 280-291, available at: www.researchgate.net/publication/317342100_Beyond_Greening_Challenges_to_Adopting_Sustainability_in_Institutions_of_Higher_Education

Irwin, E., Gopalakrishnan, G.S. and Randall, A. (2016), "Welfare, wealth and sustainability", *Annual Review of Resource Economics*, Vol. 8 No. 1, pp. 77-98, doi: [10.1146/annurev-resource-100815-095351](https://doi.org/10.1146/annurev-resource-100815-095351).

Kioupi, V. and Voulvouli, N. (2019), "Education for sustainable development: a systemic framework for connecting the SDGs to educational outcomes", *Sustainability*, Vol. 11 No. 21, doi: [10.3390/su11216104](https://doi.org/10.3390/su11216104).

Krytus, K., Heavey, S.C. and Homish, G.G. (2021), "Competency-based student assessment in online and in-person master of public health programs", in Souza, J.M. and Rose, T.A. (Eds), *Exemplars of Assessment in Higher Education*, Routledge, New York, NY, pp. 166-180.

Lesser, R., Kennedy, D., Cuellar, M., Lyle, E., Shah, S., Bamberger, S. and Missent, S.K. (2023), "Put talent at the top of the sustainability agenda", Boston Consulting Group (BCG), available at: <https://web-assets.bcg.com/ca/ac/942930d34c39a01dbf280a07728b/bcg-put-talent-at-the-top-of-the-sustainability-agenda-jan-2023.pdf>

Mansfield, B. (2009), "Sustainability", in Castree, N., Demeritt, D., Rhoads, B. and Liverman, D. (Eds), *The Companion to Environmental Geography*, Blackwell, London, pp. 37-49.

Menon, S. and Suresh, M. (2020), "Synergizing education, research, campus operations, and community engagements towards sustainability in higher education: a literature review", *International Journal of Sustainability in Higher Education*, Vol. 21 No. 5, pp. 1015-1051, doi: [10.1108/IJSHE-03-2020-0089](https://doi.org/10.1108/IJSHE-03-2020-0089).

Michel, J.O. (2020), "Mapping out students' opportunity to learn about sustainability across the higher education curriculum", *Innovative Higher Education*, Vol. 45 No. 5, pp. 355-371, doi: [10.1007/s10755-020-09509-7](https://doi.org/10.1007/s10755-020-09509-7).

National Academies of Sciences, Engineering, and Medicine (NASEM) (2020), *Strengthening Sustainability Programs and Curricula at the Undergraduate and Graduate Levels*, The National Academies Press, Washington, DC, doi: [10.17226/25821](https://doi.org/10.17226/25821).

Rajabifard, A., Kahalimoghadam, M., Lumantarna, E., Herath, N., Hui, F.K.P. and Assarkhaniki, Z. (2021), "Applying SDGs as a systemic approach for incorporating sustainability in higher education", *International Journal of Sustainability in Higher Education*, Vol. 22 No. 6, pp. 1266-1284, doi: [10.1108/IJSHE-10-2020-0418](https://doi.org/10.1108/IJSHE-10-2020-0418).

Readings, B. (1997), *The University in Ruins*; Harvard University Press, Cambridge, MA.

Redman, A., Wiek, A. and Barth, M. (2021), "Current practice of assessing students' competencies: a review of tools", *Sustainability Science*, Vol. 16 No. 1, pp. 117-135, doi: [10.1007/s11625-020-00855-1](https://doi.org/10.1007/s11625-020-00855-1).

Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J. (2009), "Planetary boundaries: exploring the safe operating space for humanity", *Ecology and Society*, Vol. 14 No. 2, p. 32, available at: www.ecologyandsociety.org/vol14/iss2/art32 (accessed 9 August 2022).

Star, S.L. and Griesemer, J.R. (1989), "Institutional ecology, 'translations' and boundary objects", *Social Studies of Science*, Vol. 19 No. 3, pp. 1907-1939.

Sustainability Education and Learning Committee (SELC) (2019), "Recommendations for undergraduate sustainability education at Ohio state", available at: https://si.osu.edu/sites/default/files/Report%20to%20OAA%20on%20Undergraduate%20Sustainability%20Education%20at%20Ohio%20State_Final.pdf (accessed 12 August 2022).

United Nations (2024), "SDGs: history", available at: <https://sdgs.un.org/goals> (accessed 12 August 2022).

Weiss, M., Barth, M. and von Wehrden, H. (2021), "The patterns of curriculum change processes that embed sustainability in higher education institutions", *Sustainability Science*, Vol. 16 No. 5, pp. 1579-1593, doi: [10.1007/s11625-021-00984-1](https://doi.org/10.1007/s11625-021-00984-1).

Wiek, A., Withycombe, L. and Redman, C.L. (2011), "Key competencies in sustainability: a reference framework for academic program development", *Sustainability Science*, Vol. 6 No. 2, pp. 203-218, doi: [10.1007/s11625-011-0132-6](https://doi.org/10.1007/s11625-011-0132-6).

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