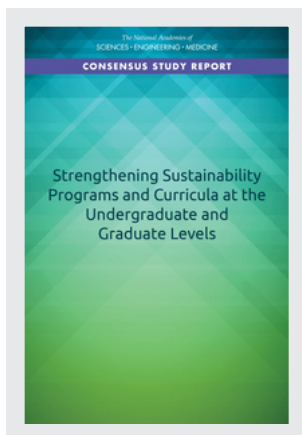


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Strengthening Sustainability Programs and Curricula at the Undergraduate and Graduate Levels

Committee on Strengthening Sustainability Programs and Curricula at
the Undergraduate and Graduate Levels

Science and Technology for Sustainability Program

Board on Higher Education and Workforce

Policy and Global Affairs

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The National Academies of
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**COMMITTEE ON STRENGTHENING SUSTAINABILITY
PROGRAMS AND CURRICULA AT THE
UNDERGRADUATE AND GRADUATE LEVELS**

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Preface

We can be the first generation to succeed in ending poverty; just as we may be the last to have a chance of saving the planet. The world will be a better place in 2030 if we succeed in our objectives.

—United Nations Resolution adopted September 25, 2015
Transforming our World: The 2030 Agenda for
Sustainable Development

Societies that prioritize and intentionally connect healthy natural environments and social justice are likely to sustain their institutions, people, and ecosystems in the face of large changes that challenge their status quo. The coronavirus 2019, or COVID-19, pandemic, which was rapidly enveloping the world as I wrote this preface, offers a harsh reminder that societies with these priorities best prepare their leaders and citizens to exercise the mutual aid, flexibility, and ingenuity needed to reduce harm from catastrophic shocks. Societies with these priorities improve their resilience to change and capacity to pursue new opportunities for all to prosper. These insights, drawn from many fields of research, underlie the urgent drive by people and organizations around the world to achieve the United Nations Sustainable Development Goals by 2030.

We are at a hinge moment of urgency. Now is the time to turn around unsustainable environmental, economic, and social trends that already harm nature and billions of people. Left unchecked, these trends will profoundly diminish opportunities for future generations and environmental conditions on which life depends. But this need not lead us to despair. Urgency can focus and elevate individual and collective agency to navigate paths forward within an environmentally safe and socially just operating space for humanity. Countless youth, workers, elders, and leaders are founding and implementing relevant initiatives in their communities, nations, and international networks to recover healthy ecosystems and human communities and to achieve diversity, equity, and inclusion in these efforts.

Higher education plays a crucial role in meeting this grand challenge. Indeed, the number of U.S. undergraduate and graduate degree programs, research institutes, and centers focused on sustainability has markedly increased in the

past decade—an exciting and hopeful sign. This has generated a vibrant debate on what should be the key elements of and structural support for interdisciplinary sustainability education programs. The National Academies of Sciences, Engineering, and Medicine Board on Higher Education and Workforce and the Science and Technology for Sustainability Program therefore formed the Committee on Strengthening Sustainability Programs and Curricula at the Undergraduate and Graduate Levels.

Our committee was tasked to consider current practices and major advances, key competencies, partnerships with enhanced recognition of the Sustainable Development Goals and other frameworks, and other issues. We convened three workshops to solicit input on the current state of play and opportunities to strengthen sustainability curricula and programs. We received input from a wide range of interested parties, particularly educators, students, and graduates of sustainability programs; members of bridging organizations that address sustainability; and employers of graduates who received sustainability education. We also considered literature from a wide range of fields. This report presents our recommendations on strengthening sustainability curricula and programs in higher education in terms of core competencies, contents, and broader contexts; building the academic environment to incentivize these programs; and developing a sustainability workforce. The report also emphasizes the need for inclusion of faculty and students who collectively span diversity across the social spectrum.

It has been a great honor and pleasure to chair our six-member committee in designing three different workshops across the nation and collaborating on this report. Our deliberations revealed a willingness to simultaneously embrace hard truths about structural obstacles and rising opportunities for achieving a more sustainable and just future. We learned so much from each other, and I look forward to ongoing friendships. We benefited tremendously from the vision and advice of National Academies' staff leadership, including Vaughan Turekian, executive director of Policy and Global Affairs, who initially conceived this study; Thomas Rudin, senior director of the Board on Higher Education and Workforce; and Franklin Carrero-Martínez, senior director of the Science and Technology for Sustainability Program. Special thanks go to our outstanding study director, Lida Beninson, for her guidance, knowledge, and professionalism; to Emi Kameyama for sophisticated corralling of information and other assistance; and to Austen Applegate for coordinating complex workshops and committee meetings. We are enormously grateful to Paula Whitacre, who served as consulting writer for this report. We also thank the Cynthia and George Mitchell Foundation for supporting this project.

Anne R. Kapuscinski, *Chair*
Committee on Strengthening
Sustainability Programs and Curricula
at the Undergraduate and Graduate Levels

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We would also like to thank the more than 75 educators, employers, and others who participated in the interactive sessions held at the first two workshops. Their active engagement provided critical input to the committee.

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This Consensus Study Report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by PAMELA MATSON, Stanford University and HELEN QUINN, Stanford University (retired). They were responsible for making certain that an independent examination of this report was carried out in accordance with the standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the authoring committee and the National Academies.

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Summary

The urgency to address environmental, economic, and societal challenges continues to increase worldwide. Ensuring that humans have sufficient food, clean water, energy, housing, education, and health must not be at the expense of clean air, rich biodiversity, natural resources, and thriving ecosystems. Meeting human needs of today should not encumber future generations from meeting those same needs; thus, people need to operate socially, economically, and politically in sustainable ways. Central to achieving sustainability is education at all levels, from as early as preschool and throughout all levels of the workforce.¹ Noticeably, there is documented growing interest in sustainability education in colleges and universities across the United States. The number of undergraduate and graduate degree programs, research institutes, and centers focused on sustainability has markedly increased in the past decade.

Connected to this growth in higher education sustainability programs is a rich debate related to defining key competencies for these programs. Several organizations have examined this issue, including the U.S. Council of Environmental Deans and Directors of the National Council for Science and the Environment and the United Nations Educational, Scientific and Cultural Organization, or UNESCO, and they have noted that the lack of core competencies for sustainability remains a key limitation to fully characterizing the effectiveness of sustainability education (Halinen, 2017). Evidence-based core competencies

¹ *Sustainability* is commonly defined in the United States as follows: “to create and maintain conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations” (National Environmental Protection Act of 1969, as amended through December 31, 2000 [NEPA 2000], Executive Order 13514 [White House, 2009]).

for interdisciplinary sustainability programs can provide suitable guidance for curricular and program development, research, policy, communication, and pedagogical approaches at academic institutions. They can also serve as a guide for students to select academic programs and potential career options, a reference for employers to understand qualifications of graduates, and the foundation for a potential specialized accreditation for interdisciplinary sustainability programs. The growing demand for well-qualified sustainability professionals within the public, private, and nonprofit sectors also points to the value of developing core competencies.

A variety of pedagogical approaches for achieving core competencies can further strengthen sustainability programs in higher education. Project-based learning, experiential learning, and longer-term projects that immerse students in practitioner organizations will allow students to address complex sustainability challenges in real-world, authentic, and often messy problem settings. Another approach is to present students with wicked problems, in simulated real-world settings, elaborated either as carefully developed qualitative cases or more quantitatively structured applied problems that represent sustainability challenges. Learning in such real-world and simulated contexts can help develop greater familiarity among learners with systems where interactions are complex, uncertain, and difficult to model and where solutions may create unforeseen, inequitable, and negative consequences. The point is not to discourage solutions-based thinking but to educate students on the complexities of sustainability issues so that solutions are not oversimplified.

Sustainability is emerging as a field that is revolutionizing how humans work and live. Industries, institutions, and organizations across all domains and sectors now intersect with sustainability challenges and opportunities, affecting the knowledge and skills required for the future workforce. Thus, the National Academies of Sciences, Engineering, and Medicine were asked to provide expert insights for strengthening the emerging discipline of sustainability in higher education in the United States. Since the field of sustainability education is relatively new, the committee gathered information at three workshops, complemented by further research into available literature. The committee engaged business leaders, program directors, faculty, and students at three workshops held across the United States, including Austin, Texas, Washington, D.C., and Santa Cruz, California.² Each workshop was designed to examine different approaches and drivers for a coherent curriculum in the growing number of higher education sustainability programs, and to identify how sustainability education could address enduring and emerging issues identified in frameworks as the

² See Appendix D for the final workshop agendas. A short summary of each of these workshops is available on the National Academies Press website at www.nas.edu.

United Nations Sustainable Development Goals (SDGs) and by employers and practitioners (or “end users”) in private, public, and nonprofit sectors.

LANDSCAPE FOR SUSTAINABILITY EDUCATION

The committee benefited substantially from research, analysis, and case studies to develop the agendas for its public workshops, consider themes and recommendations, and fulfill its statement of task (see Box 1-1). The report first describes the local, national, and global landscape related to sustainability education (see Chapter 2) by highlighting key frameworks through which to understand, research, and teach the field of sustainability, including the SDGs, but also other relevant frameworks from the private sector. The committee examines the history and current status of sustainability education programs in the United States and globally, including those that have publicly embraced the SDGs as a framework for organizing core sustainability issues. The report finally also discusses employment prospects for sustainability graduates in terms of the opportunities and the skills that employers seek, in addition to efforts to address diversity, equity, and inclusion in sustainability-related education and employment.

CONCLUSIONS AND RECOMMENDATIONS

Based on the information gathered during the course of the study, the committee offers a set of recommendations, grouped by report chapter and organized by three principal themes: (1) strengthening sustainability educational programs at undergraduate and graduate levels, (2) building the academic environment for sustainability in higher education institutions, and (3) developing a sustainability workforce to understand and address current and future sustainability challenges. These three themes are the focus of Chapters 3, 4, and 5, and the recommendations below are discussed in greater detail in each of the respective chapters. The report also includes a recommendation for additional research on sustainability education in areas where gaps in evaluation, definitions, and trends remain. The committee’s recommendations and the choices of educational programs given as models are based primarily on input from practitioners attending the three workshops or members of the committee, as described in the committee’s statement of task. However, the committee examined relevant literature and research where available.

Strengthening Sustainability Programs

With interest high among current and incoming students and the ever-increasing need to improve human well-being while remaining within planetary boundaries, many higher education institutions are creating or expanding sustainability education programs. The committee highlights necessary competencies,

content areas, and capacity building that students should gain through classroom and experiential learning across different contexts.

Competencies and Capacities for Sustainability Education

The growth in sustainability programs at colleges and universities and the demand for graduates of these programs has led to concerted efforts to define the key competencies that sustainability graduates should acquire. Wiek et al. (2011) define competencies as “a functionally linked complex of knowledge, skills and attitudes that enable successful task performance and problem solving,” and use competencies and capacities interchangeably. Defining core competencies can help guide efforts of sustainability educators to identify learning outcomes and assessments, prepare students for careers in sustainability by enabling them to be change agents (see Chapter 5), and match sustainability curricula with existing and emerging needs of employers of university graduates.

Recommendation 3.1: Academic institutions of higher education should embrace sustainability education as a vital field that requires specifically tailored educational experiences and the development of core sustainability-focused competencies and capacities delivered through courses, majors, minors, certifications, research, and graduate degrees in sustainability.

Content Areas in Sustainability Education

Beyond learning competencies, the committee recommends the incorporation of key sustainability content knowledge that students need at the undergraduate and graduate levels. The range of topics should address current and future sustainability challenges using problem-based and solutions-oriented learning. While some students will prefer to gain knowledge about a broad number of topics in sustainability, others will prefer to specialize in more targeted areas. Necessary content and depth and breadth of understanding will depend in part on the nature of the sustainability programs. Degrees in sustainability will typically focus on the integration of broad sets of content areas (breadth as strength), while degrees that incorporate sustainability into existing disciplines, such as sustainable engineering, will require a strong emphasis on core content (depth as strength) viewed through a sustainability lens. At the graduate level, sustainability programs, which may engage students from a variety of undergraduate disciplines, have to provide a foundational understanding of sustainability principles, competencies, and capacities, but the expectation is for students to develop depth in specific content, methods, or approaches (including depth in specific competencies and capacities). For graduate programs where sustainability is an adjective to a defined discipline (e.g., sustainable architecture), depth in

that discipline is expected, while sustainability can serve as a framing concept to suitably qualify the core elements of the discipline. In both cases, sustainability students and graduates will need to collaborate with others for a common baseline understanding of content areas that include the history of sustainability, ethics and social justice, data analytics, business administration, sustainability science, diversity and justice, and Indigenous knowledge and culture. The committee recognizes 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.

Recommendation 3.2: Sustainability curricula and programs in higher education should encompass key and emerging sustainability content areas to prepare students to address complex sustainability challenges in a real-world setting while incorporating problem-based and solution-oriented approaches to sustainability.

Contexts and Applications of Sustainability Education

Sustainability higher education needs to help students understand the intersections and interdependencies in their social and organizational contexts and identify the leverage points that can enable transitions toward sustainability. Through sustainability education, students should understand how built, social, and organizational environments are shaped by the requirement of goods, services, and infrastructures that meet human needs and wants, and that these requirements affect and are affected by the natural environment and ecosystem. Students then need to act in ways that balance human and social development in relation to environmental goals. Incorporating capacities in sustainability education will enable translation of competencies into effective practice (Clark and Harley, 2020).

Experiential learning enables consolidation of learner capacity to translate knowledge into practice. Student learning in higher education sustainability programs should include experiential learning opportunities with business, government, nongovernmental, or other civil society organizations. It should also include other community engagement opportunities via internships, student research, and professional development programs to foster specialized knowledge, technical expertise, and interpersonal skills for collaboration to address sustainability challenges from local to global scales (Eyler, 2009). Benefits of experiential knowledge include a deeper understanding of subject matter, the capacity for critical thinking and application of knowledge in complex or ambiguous situations, and a recognition of the value of lifelong learning, including learning in the workplace.

Sustainability higher education programs should also provide students a conceptual understanding of how organizations learn and change (March and Olsen,

1975; Nelson and Winter, 1982; Chadwick and Raver, 2015; Lozano, 2014; Schulz, 2017). This should complement opportunities for practical experience (e.g., internships, apprenticeships) in the organizational contexts in which many of them will seek careers.

Recommendation 3.3: Sustainability curricula and programs in higher education should train students to understand the highly interdependent, varied, and complex contexts of sustainability (including organizational contexts); to develop their ability to discern and address the historical and contemporary trajectories and consequences of sustainability processes; and to apply their learning in experiential learning settings (community, organizational, service) so that learners can be more effective implementers of effective transitions toward sustainability.

Strengthening a Supportive Academic Environment

The increase in sustainability education programs constitutes evidence that many campuses are taking steps to engage students, faculty, and staff on the topic. The committee focuses on how academic institutions can build sustainability education programs, including bridging disciplinary silos; promoting diversity, equity, and inclusion; and strengthening federal support for sustainability programs in higher education, and where research on the future evolution of these programs and their impacts is needed.

Bridging Disciplinary Silos

Sustainability is an interdisciplinary field overlapping with nearly every major and degree program in higher education. Clark and Wallace (2015) noted that while “interdisciplinarity” and “integration” enjoy strong positive support in theory, making them a reality is more challenging. The reality is that most academic institutions are not set up to foster this interdisciplinarity. Despite the challenges, strategies to foster interdisciplinarity in sustainability education include (1) exploring team teaching with faculty from different departments, (2) developing an incentive system for collaboration in teaching and research, (3) training the educators about the value of interdisciplinarity, and (4) working across a diverse range of departments, among others.

Recommendation 4.1: Academic leaders should encourage the development of, implementation of, and participation in interdisciplinary sustainability programs that bridge disciplinary silos by fostering effective strategies such as team teaching, curriculum planning, interdisciplinary advising and preparation of graduate students,

SUMMARY

and educator trainings across departments about competencies and content areas of sustainability. Sustainability programs can be launched and evolve under a variety of institutional arrangements, but a commitment to and value of inclusivity and interdisciplinarity is of fundamental importance, particularly from top leaders of higher education institutions.

Diversity, Equity, and Inclusion

It is critically important to incorporate the principles of diversity, equity, and inclusion in sustainability education programs. Infusing diversity, equity, and inclusion principles into sustainability education is crucial to achieve the SDGs and other sustainability goals, because graduates of sustainability education programs engage a diversity of community, government, and industry stakeholders with a diversity of perspectives, backgrounds, and expertise. Environmental and sustainability-related diversity pathway programs, as well as several transuniversity programs, are possible avenues to help diverse students enter the field. Promoting strategies to improve diversity, equity, and inclusion in sustainability education is also critical to address underrepresentation in academic programs and the workforce.

Recommendation 4.2: Sustainability education programs should prioritize attracting and supporting students with varied backgrounds and lived experiences, supporting them for success in a variety of sustainability careers. This also requires attracting and retaining faculty from diverse backgrounds in sustainability education programs, with additional attention to equity, inclusion, and local and Indigenous knowledge in the content of the curriculum and the institutional setting.

Federal Support of Sustainability Programs in Higher Education

Policy makers have recognized the role that campus sustainability programs have in achieving societal goals. In 2008, Congress passed the Higher Education Sustainability Act of 2007 as part of the Higher Education Opportunity Act, which established a competitive grant program through the U.S. Department of Education, in consultation with the U.S. Environmental Protection Agency for universities and places of higher education to develop and implement sustainability curriculums, practices on campus, and academic programs.³ Although the

³ Higher Education Sustainability Act (HESA) of 2007, S. 2444, 110th Congress (2007–2008); Higher Education Opportunity Act, H.R. 4137, 110th Congress (2007–2008), Public Law No: 110-315; available at <https://www.congress.gov/110/plaws/publ315/PLAW-110publ315.pdf>, accessed on March 11, 2020.

Higher Education Opportunity Act was passed, the Higher Education Sustainability Act itself was only appropriated funding for one year, and no assessment or evaluation of the program is available. In November 2019, legislation was introduced in the U.S. Senate to reauthorize the program through what the bill sponsors titled the Higher Education Sustainability Act of 2019.⁴ The committee noted that since 2008, the federal agencies that support sustainability research and initiatives have broadened beyond the Environmental Protection Agency, the only agency designated in the legislation as a collaborating entity with the Department of Education, the grant administrator. Given the range of federal programs that currently support sustainability-related activities, other agencies would also be suitable to support grant programs for sustainability education and research. Additionally, making provisions for minority-serving institutions to qualify for those federal sustainability education grants will attract and support diverse students in sustainability education.

Recommendation 4.3: Federal agencies should increase their support for sustainability education programs, and they should include provisions for minority-serving institutions to apply for and receive grants to establish or revise sustainability education programs.

Sustainability Education Research Agendas

Limited available data and analyses on the effectiveness of sustainability higher education programs and their curricular offerings on different metrics, employment trajectories and labor outcomes of graduates, and ongoing programmatic and curricular innovations suggest some important directions for future research in sustainability education. Throughout the workshops, participants highlighted the need for criteria by which to evaluate programs as well as their influence on the institution, on student career paths, on sustainability as a field, and on measures of success relative to the SDGs and other frameworks. The centering of sustainability as part of corporate strategy and value creation and growth in green jobs related to energy-efficient design and production are among the workforce trends that have increased demand for sustainability education, but definitions and data collection remain fluid (Novello and Carlock, 2019). This diversification calls into question how sustainability curricula may also change, and how the decade of action toward the SDGs may shape the landscape and partnerships that will define a global, shared, post-2030 agenda. Research is also needed on how core competencies and content areas across sustainability programs are converging, diverging, or evolving; on effectiveness of the different student-centered, interactive pedagogies used across programs; and on

⁴ Higher Education Sustainability Act of 2019, S. 2928, 116th Congress (2019–2020), available at <https://www.congress.gov/116/bills/s2928/BILLS-116s2928is.pdf>, accessed on September 23, 2020.

SUMMARY

how institutional policies, structures, and curricula affect the development and flourishing of these programs.

Recommendation 4.4: To strengthen and support sustainability education programs, research should be conducted on (i) the effectiveness of sustainability curricula for achieving program-level goals and contributing positively to communities of practice, along with impacts on activities within higher education institutions overall; (ii) the marketplace for sustainability jobs and pathways for students to secure those opportunities; (iii) how core competencies and content areas in sustainability programs may be converging, diverging, or otherwise evolving; and (iv) how these programs will prepare students for a post-2030 agenda for sustainable development.

Developing a Sustainability Workforce

For a strong sustainability workforce, it is important to support students beyond their academic needs in terms of the financial, emotional, and other pressures they may face outside the classroom. Collaboration opportunities among sustainability students and professionals is also crucial for them to develop into effective change agents. In this context, professional societies can play an important role to support such professionalization and collaboration as they do in many disciplines.

Developing Change Agents

Change agents play crucial roles in “initiating, managing, or implementing change” (Caldwell, 2003). To address the complexity of sustainability challenges, sustainability education programs must prepare their students also to become change agents—while they are in school and in their careers (Kremers et al., 2019). Achieving the SDGs will require change agents from multiple disciplines beyond the small percentage who study sustainability in depth (i.e., undergraduate majors or minors and/or as graduate students). Students are entering sustainability programs with the desire to change the world for the better. Academic programs can harness this motivation with the necessary competencies, knowledge, and skills described in this report.

Recommendation 5.1: Completion of a sustainability program in higher education should improve students’ ability to design, implement, and lead proactive change toward a sustainable world. Thus, sustainability education programs should provide training and mentoring support to enhance capacities of their graduates to translate knowledge to effective action to meet emerging local, regional, national, and global needs.

Enhancing Collaboration among Sustainability Professional Societies and the Role of Accreditation

As sustainability education programs emerge and evolve, students, faculty, staff, and program directors would benefit from opportunities to share best practices, obtain guidance on career paths for students, and join a network or community with which to share ideas and develop shared principles and values. Professional societies play a role in facilitating community building and resource sharing through convening groups. They also present an entity that can set standards and determine parameters for program evaluations and potential accreditation, as well as lead efforts for standardized data collection about students, employees, and employers. Such capabilities would be valuable to both sustainability education programs and the sustainability workforce.

One role played by professional societies in the United States is to serve as an accreditor. The committee's statement of task (see Box 1-1) requested that the committee consider the feasibility of accreditation of sustainability programs to strengthen them and to further engage with the SDGs. Our internal deliberations and consultations across the three workshops did not lead to a clear consensus. In consideration of possible accreditation in the future, several participants suggested strategies that are more voluntary and less rigorous than a full-bore accreditation program yet still useful to students and other stakeholders.

Recommendation 5.2: Professional societies focusing on sustainability education should pursue collaborative opportunities to (i) provide a forum for convening sustainability students, researchers, and professionals; (ii) build partnerships with the public and the private sectors; (iii) offer formalized training and mentorship; (iv) promote information sharing; (v) develop shared principles and values; (vi) establish a model for assessing sustainability education programs; and (vii) establish and lead a cross-sectoral effort to track and analyze employment in sustainability-focused jobs.

To clarify the obligations of various stakeholders to strengthen sustainability programs in higher education, the final chapter compiles and organizes the committee's recommendations by stakeholder to strengthen sustainability programs in higher education, in addition to research agendas, given the urgency of our global sustainability challenges. While the committee assigns recommendations to a particular stakeholder, their implementation will often require collaborative efforts by several or all stakeholders. The tremendous growth and evolution of sustainability curricula, research, and practicum programs at undergraduate and graduate levels provide an opportunity to address the urgent environmental, economic, and societal challenges of communities. The analysis and recommendations offered in this report are intended to assist governments, higher education institutions, private and nonprofit organizations, students, professional

associations, and the philanthropic community with identifying future priorities for activities on strengthening sustainability education across the United States and globally.

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1

Introduction and Overview

Twenty years ago, the Board on Sustainable Development of the National Research Council conducted the study *Our Common Journey: A Transition Toward Sustainability* (NRC, 1999). The goal of this landmark report was to “reinvigorate the essential strategic connections between scientific research, technological development, and societies’ efforts to achieve environmentally sustainable improvements in human well-being” (NRC, 1999, 2). The title paid tribute to *Our Common Future*, the 1987 World Commission on Environment and Development report that laid the groundwork for sustainable development (WCED, 1987). *Our Common Journey* also deliberately introduced the concept of a “journey,” adopted to “reflect the board’s view that any successful quest for sustainability will be a collective, uncertain, and adaptive endeavor in which society’s discovering of where it wants to go is intertwined with how it might try to get there” (NRC, 1999, 2).

AN URGENT JOURNEY

The journey continues. The urgency to address environmental, economic, and societal challenges has increased worldwide as social and environmental processes intersect to exacerbate climate change, deforestation, ecosystem degradation, poverty, inequality, and conflict. When *Our Common Journey* was published in 1999, its authors envisioned a time horizon of two generations to make serious progress in the transition toward sustainability. To many observers, that two-generation window now seems like a luxury that human civilization does not have. As a result, there is a pressing need to dramatically increase design and implementation of solutions to sustainability challenges.

Against this backdrop, individuals and groups around the world are taking steps to achieve sustainable development despite, or because of, the challenges. In 2015, the global community, through a resolution of the United Nations General Assembly, adopted the Sustainable Development Goals (SDGs), a comprehensive set of 17 interconnected goals that “recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth—all while tackling climate change and working to preserve our oceans and forests.”¹ Communities, businesses, governments, and other formal and informal institutions are seeking ways to become more sustainable, whether explicitly tying their efforts to the SDG goals, other frameworks, or embarking on their own, complementary paths.

In 1999, *Our Common Journey* called for a research agenda for the interdisciplinary field of sustainability science and greater use of knowledge-action collaboratives to solve critical sustainability problems. This call aligned with the action plan developed at the 1992 Earth Summit held in Rio de Janeiro, Brazil, which had outlined a foundation for the field of education for sustainable development (UNCED, 1993), or the more common term in the United States, sustainability education. As defined by the United Nations Educational, Scientific and Cultural Organization, or UNESCO, education for sustainable development “empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability, and a just society, for present and future generations, while respecting cultural diversity.”² At the UN Conference on Sustainable Development, or Rio+20, in 2012, the international community agreed to “promote education for sustainable development, and to integrate sustainable development more actively into education beyond the UN Decade of Education for Sustainable Development” (UNESCO, 2014a, 2014b).

Higher education institutions play a vital role in sustainability education in terms of educational curricula, research, collaborative action, and workforce development. Different definitions of sustainability education (Tilbury, 1995), hold in common a concern with applying learning to address real-world sustainability challenges (Figueiró and Raufflet, 2015; Sterling, 2010; Wals and Jickling, 2002). Thus, Wiek et al. (2011, 204) defines it as “education that should enable students to analyze and solve sustainability problems, to anticipate and prepare for future sustainability challenges, as well as to create and seize opportunities for sustainability.” The Green Education Foundation (2018) defines it as “education that utilizes applied learning models that connect real-world circumstances with the broader human concerns of environmental, economic, and social systems.” At the same time, because sustainability is a relatively new and still-evolving

¹ See United Nations Sustainability Development Goals, available at <https://sustainabledevelopment.un.org/sdgs>, accessed on March 11, 2020.

² For the definition of “education for sustainable development,” see <https://en.unesco.org/themes/education-sustainable-development/what-is-esd>, accessed on March 11, 2020.

synthetic concept in academia, definitions and programs of sustainability education continue to be refined in light of diverse needs of students and institutions.

Analogously, meanings of terms used in sustainability education are still evolving. Terms are often used interchangeably even if they may mean different things to different people (Shephard et al., 2018). Therefore, for the sake of clarity, we define some of the key terms used throughout this report in Appendix A: these include sustainable development, sustainability, sustainability education, sustainability education programs/sustainability programs in higher education, sustainability curricula, environmental education, sustainability science research, and sustainability education research.

One of the central goals of higher education in sustainability is to equip learners with the knowledge, skills, competencies, and capacities that would enable them to work effectively in societal and environmental sustainability careers. Many institutions of higher education already have robust programs to prepare students to enter the workforce, cognizant of the SDGs and related sustainability challenges; others are in the process of creating such programs within existing offerings. From an employer perspective, public- and private-sector organizations need workers who are well versed in the principles of sustainability: people with a variety of skills, from entry level to top leadership, representing all segments of society, and able to apply their knowledge in sectors of the economy that range from agriculture, health care, financial services, transportation, and much more. Students are also creating demand. Many students may enter sustainability education programs with a passion to create change and develop the skills to channel that passion into action. Students may also look to incorporate sustainability concepts into the academic or career options they have already chosen, such as developing more sustainable supply chains in business or fewer carbon-emitting transportation options. Regardless of their motivations, current and future undergraduate and graduate students will likely enter a broad range of sustainability-related fields.

The importance of these questions has led some relevant grantmaking foundations, such as the Rockefeller Brothers Fund, V. Kann Rasmussen Foundation, the Nathan Cummings Foundation, and the Cynthia and George Mitchell Foundation to fund attempts to answer them. In 2013, the Foundation Center released a report indicating that U.S. foundations awarded \$1.2 billion in grants that were focused on the “right to a clean, healthy, and sustainable environment” (Foundation Center, 2013). By 2017, support from foundations for work on sustainability had more than doubled to \$2.7 billion (Foundation Center, 2017).

The top issues receiving funding from foundations are biodiversity and species preservation, energy, fresh water and inland water ecosystems, terrestrial ecosystems and land use, climate and atmosphere, coastal marine ecosystems, and sustainable agriculture and food systems. The most frequently funded strategies are advocacy, stewardship, and research. In 2015, these strategic approaches received 35 percent, 24 percent, and 15 percent of the funding, respectively (EGA and Foundation Center, 2017).

WORK OF THE COMMITTEE

In 2018, the Science and Technology for Sustainability Program and the Board on Higher Education and Workforce convened the Committee on Strengthening Sustainability Programs and Curricula at the Undergraduate and Graduate Levels. This six-person committee was requested to share findings and recommendations for strengthening sustainability programs and curricula at the undergraduate and graduate levels that relate to the SDGs and other relevant sustainability frameworks. (See Box 1-1 for the Statement of Task.)

BOX 1-1 Committee Statement of Task

An ad hoc committee under the Science and Technology for Sustainability (STS) Program, in collaboration with the Board on Higher Education and Workforce (BHEW), will plan and conduct a series of three public workshops focused on strengthening sustainability programs and curricula at the undergraduate and graduate levels in the United States. Each workshop will examine different approaches and drivers for a coherent competency- and skill-based curriculum in the growing number of higher education sustainability programs, in order to connect them to the issues addressed through such frameworks as the United Nations Sustainable Development Goals (SDGs) and the priorities of end users, including the private and public sectors. Specific issues to be addressed in the workshops may include:

- Providing an overview of current practices and major advances in sustainability education at the undergraduate and graduate levels, both domestically and internationally, including trends in expansion across programs and disciplines and promising new approaches;
- Examining a comprehensive set of key competencies critical for sustainability education, and identifying knowledge gaps and critical barriers related to the effective development of common core competencies for interdisciplinary sustainability programs;
- Identifying strengths, gaps, priorities, and opportunities for university engagement with the SDGs, including accreditation of programs or national-level organizations to support and guide sustainability programs;
- Fostering partnerships between schools, universities, sectors, regions, and nations in sustainability higher education with enhanced recognition of the SDGs; and
- Discussing research agendas related to sustainability and the SDGs and the role of academic institutions to inform post-2030 processes.

Based on the content of the three workshops, the committee will produce a report that provides findings and recommendations for strengthening sustainability programs and curricula at the undergraduate and graduate levels that relate to the SDGs and other relevant sustainability frameworks.

To gather input, the committee convened three public, participatory workshops to gather perspectives from a diverse group of trainers and end users in sustainability education. The trainers included educators at public and private institutions, including research-intensive universities, private colleges, and 2- and 4-year minority-serving institutions. End users included professionals in engineering, administrative, and other roles in local and federal agencies, nonprofits, consulting firms, and corporations. Many of the participants are directly involved in hiring interns or entry-level employees.

The committee designed two workshops, held in Austin, Texas, in December 2018, and Washington, D.C., in February 2019, around a series of open-ended questions for group discussion by educators and employers. Breakout sessions first divided “training” and “end-user” stakeholders into separate groups, then merged them. They used the questions to stimulate discussion about current sustainability education practices and gaps, trends in sustainability education and workplace needs, and critical barriers to access. The first workshop included discussions on a systems thinking approach to sustainability; the diversity of necessary competencies, including such skills as communications and negotiations; and the importance of engaging with new technologies and big data and ethical dimensions in sustainability education. Participants in the second workshop emphasized the need for a mix of crosscutting skills both interpersonal and cognitive, as well as diversity, equity, and inclusion space, not just among students but also within faculty and across the board.

A third workshop in Santa Cruz, California, in January 2020, diverged from the breakout-session format of the first two gatherings by convening three panels: the first included students and recent alumni to reflect on their educational experiences and preparation for employment in the field, followed by sessions of end users (employers) and educators that focused on the sustainability skills and competencies valued by hiring organizations and in the research and academic community, as well as ideas for strengthening sustainability programs. The workshop also included the discussion on how higher education can engage with their local communities in preparing students for careers in sustainability. The final workshop agendas are in Appendix D, and key themes that emerged from these workshops are highlighted throughout the report. Brief summaries of each of these workshops is available on the National Academies Press website at www.nas.edu.

In addition, the committee conducted a review of the literature and of existing curriculum reform and competency definition efforts, which were discussed at the workshops and during committee deliberations. The committee’s recommendations and the choices of educational programs given as models are based primarily on input from practitioners attending the three workshops or members of the committee, as described in the committee’s statement of task. However, the committee examined relevant literature and research where available.

How the world predicts, responds to, and reconciles the challenges of the 21st century and beyond will require transformations on many levels and in all sectors.

The committee offers the findings and recommendations in this report, focused on higher education, to form a part of this vital endeavor. Much of the literature informing the findings and recommendations in the report analyzed practices in degree programs, but the committee encourages sustainability program directors to apply the recommendations to nondegree sustainability programs where appropriate. In addition, the committee encourages using the evaluations of those efforts to inform subsequent research on strengthening sustainability programs in higher education.

SCOPE OF THE STUDY AND ORGANIZATION OF THIS REPORT

Sustainability education around the world includes all levels from the primary grades to adult training and continuing education courses. This report focuses on undergraduate and graduate education in the United States, recognizing that all areas of sustainability education, including K–12, workforce development, and citizen education, are critical to sustainability efforts.

Indeed, sustainability is emerging as a revolutionary field of actionable knowledge to change how humans work and live. Analogously, sustainability education carries an enormous societal responsibility to identify both system- and component-level insights to enable sustainable societal transitions. The study consciously builds on global and national efforts already under way to strengthen sustainability education.

After a consideration of the local, national, and global landscape related to sustainability education in Chapter 2, the report hones in on its three principal themes related to the substance of sustainability programs (i.e., competencies, content, and context), their institutional organization and support, and the relationship with a strong sustainability workforce. Chapter 3 highlights the competencies, content areas, and capacities students need through classroom and experiential learning. Chapter 4 focuses on how academic institutions can build sustainability programs and where research may support their success. Chapter 5 examines the importance of developing a strong sustainability workforce. Each chapter includes specific recommendations that the concluding Chapter 6 compiles and organizes by actor.

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2

Landscape for Sustainability Education

A large body of enduring and emerging research on sustainability showcases theoretical and goal-oriented frameworks that have informed sustainability education. This chapter briefly introduces four key frameworks that have emerged from sustainability research and influenced the subject matter of sustainability education programs. It also briefly describes the history and current status of sustainability education programs in the United States and globally. It then highlights the importance of sustainability-related employment and the need to address diversity, equity, and inclusion in sustainability-related education and employment, and it provides a summary of organizations engaged in sustainability in higher education.

FRAMEWORKS FOR SUSTAINABILITY

Frameworks help organize knowledge and practice (Ostrom, 2008). They offer a structure that can guide classroom, laboratory, and experiential learning, and orient policy, research, and practice. Sustainability frameworks fall broadly into two groups. The first set has sought to construct theoretical foundations for sustainability analyses and to represent the dynamic human and natural processes related to sustainability, highlighting at the same time the relationships among the constituent elements of the framework. Work on coupled natural and human systems and social-ecological systems (Ferraro et al., 2019; Liu et al., 2007; Ostrom, 2009) falls into this first set. Many other frameworks—and the list does not exhaust by any means the different fields—such as ecological economics (Costanza, 1991; Daly, 1996; Röpke, 2005), political ecology (Bryant and Bailey, 1997; Robbins, 2011), sustainability transitions (Johnstone and Newell, 2018; Markard

et al., 2012), resilience (Folke et al., 2010; Holling, 1996), environmental justice (Banzhaf et al., 2019; Mohai et al., 2009; Taylor, 2000), and earth systems governance (Biermann et al., 2012; Dryzek and Stevenson, 2011) also seek to achieve analogous theoretical and explanatory understanding. A second set of frameworks concerns social and environmental sustainability goals and outcomes, seeking to identify how such goals can be achieved. Work on the Sustainable Development Goals (SDGs) and on the Doughnut model falls into this second group, as do efforts in corporate social responsibility (Doh and Tashman, 2014; Montiel, 2008) and circular economy (Kirchherr et al., 2017; Pieroni et al., 2019). The private sector's reporting initiatives apply metrics and tools to similarly focus on businesses pursuing sustainability goals, even if in more specific fields.

Members of the committee and participants in its public workshops discussed a range of these frameworks in the context of how they apply to sustainability practice and research. The ensuing discussion does not aim at a comprehensive introduction to different sustainability frameworks. Rather, it emphasizes, when developing and implementing sustainability higher education programs, the value of explicitly considering conceptual underpinnings and how existing frameworks highlight different sustainability-related processes and outcomes. A unifying framework that encompasses and informs different aspects of sustainability education by connecting social and environmental factors, interactions, processes, and outcomes remains a work in progress, a goal toward which researchers and educators in sustainability education will be likely to continue to strive.

Theoretical Frameworks in Sustainability Education

As sustainability education has grown in importance and research on sustainability has informed sustainability education, the range, diversity, and integrative ambitions of sustainability frameworks that offer interdisciplinary theoretical foundations for sustainability education has also witnessed commensurate growth. Interdisciplinary frameworks in fields such as political ecology, common property, environmental feminism, and ecosystem-based management have combined disciplinary insights and methods from a range of social and ecological fields of study to address sustainability challenges associated with different patterns of human-environmental interactions and the social and environmental outcomes with which sustainability is typically concerned. In particular, two frameworks—coupled natural and human systems and social ecological systems—have advanced theoretical ambitions to connect social and environmental interactions to inform systematic understanding of relationships and outcomes away from or toward sustainability.

Coupled Human and Natural Systems Framework

Research and curricular innovations relying on the coupled human and natural systems (CHANS) framework emphasize as their starting point the “pat-

terns and processes that link human and natural systems” (Liu et al., 2008, 639). Interactions between human and natural processes, and coupling at the system level are thus important features of the CHANS framework (NSF, 2018) (see Figure 2-1). Coupled systems frameworks additionally draw upon complexity science to highlight the nonlinearity of human-environment relationships, the importance of reciprocal interactions and feedback, the limits to rationality of agent decision-making, cross-scale interactions, the nested nature of both natural and social systems, and spatial and temporal causal coupling of systems (An, 2012; Pickett et al., 2005).

The coupled systems approach has concrete frameworks for causal and descriptive analyses. The approach is encompassing in that it can accommodate a wide range of empirical phenomena with which sustainability educators, students, and professionals are concerned. The CHANS framework supports the elaboration of methods and education for sustainability because it highlights analytical approaches for systems analysis that explicitly connect behavior of agents with system outcomes and stresses the importance of feedback and emergent phenomena. Its emphasis on cross-scale interactions allows educators and practitioners to capture important dimensions of real-world sustainability processes. Over the past two decades, with substantial support from the U.S. National Science Foundation, CHANS research and educational innovations have expanded rapidly

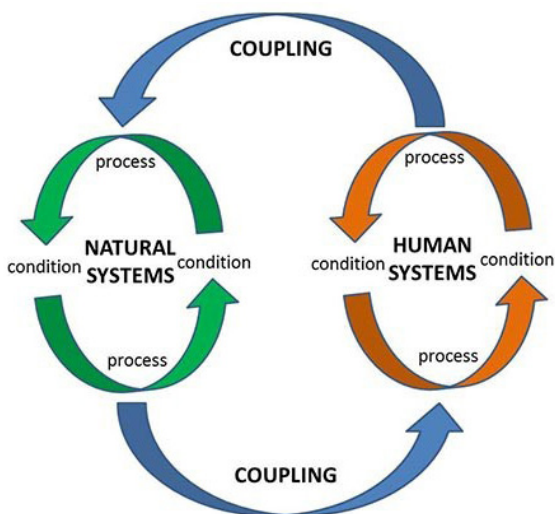


FIGURE 2-1 Four requisite components of a successful Dynamics of Coupled Natural and Human Systems project.

SOURCE: National Science Foundation. 2018. Dynamics of Coupled Natural and Human Systems Program Solicitation. NSF 18-503. Available at <https://www.nsf.gov/pubs/2018/nsf18503/nsf18503.htm>, accessed on September 4, 2020.

and provided important foundations for both curricular and scientific advances relevant to sustainability education (Kramer et al., 2017).

Social-Ecological Systems Framework

The social-ecological systems (SES) framework has been described as “arguably the most comprehensive conceptual framework for diagnosing interactions and outcomes in social-ecological systems” (Partelow, 2018). Consistent with the coupled systems framework, the SES framework also emphasizes the social and ecological interactions and links in attempting to understand sustainability processes and outcomes—it is, however, more specific in two ways. It identifies a suite of concrete causal factors hypothesized to be responsible for observed social-ecological outcomes. It is also more specific in that its primary focus is on social-ecological interactions in the context of natural resources such as land, water, wildlife, pastures, fisheries, and forests.

With founding contributions from Elinor Ostrom and her colleagues (Agrawal, 2001; Anderies et al., 2004; Ostrom, 2007), the SES framework highlights the importance of four core subsystems of governance, users, resource systems, and resource units; their interactions; and the social, economic, and political settings in which resource systems are embedded—both contextually and through causal connections (see Figure 2-2). Understanding these linkages and the relationships among the factors characterizing the subsystems is critical to understand system outcomes.

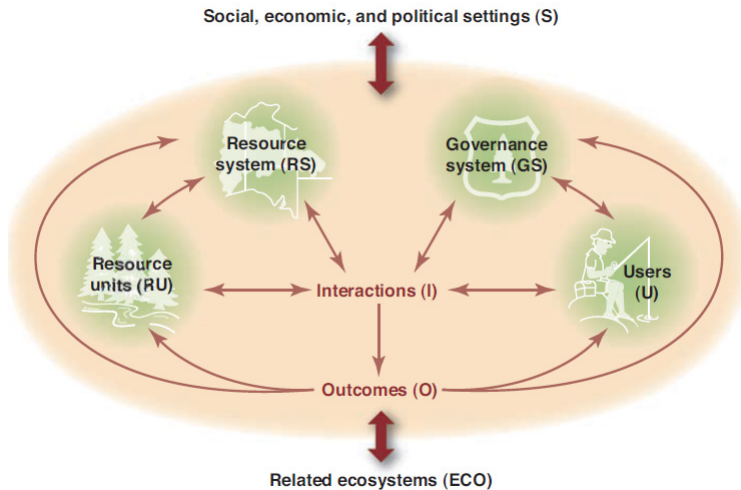


FIGURE 2-2 The core subsystem in analyzing the social-ecological systems framework. SOURCE: Ostrom, 2009. Available at <https://science.sciencemag.org/content/325/5939/419>, accessed on November 5, 2020.

Frameworks Emphasizing Sustainability Goals

Goal-focused frameworks aim to orient and guide action for achieving socio-environmental sustainability, in some contrast to theoretical frameworks providing ways to envision and understand relationships, interlinkages, and feedbacks among social and environmental processes that affect sustainability. It is important, however, to not overstate this distinction. The two sets of frameworks, rather than working at cross-purposes, offer complementary emphases on sustainability processes and outcomes. One set seeks to provide integrative understandings of the processes, the other set analyzes and develops goals toward which sustainability efforts can direct attention and resources. Perhaps the most prominent of such goal-setting frameworks is the 17 SDGs, adopted by the United Nations and its agencies, more than 190 country governments, and many nongovernmental organizations striving for greater sustainability. Below, we also discuss the Doughnut model, which attempts to identify a safe and just operating space for humanity by taking into account aspirations for the well-being of people and the natural environment.

Sustainable Development Goals

Perhaps the most well-known framework articulated globally as a set of interlocking aspirational goals is the 17 SDGs. In 2015, 193 member countries of the UN came together to commit to meeting 17 wide-ranging goals (see Figure 2-3) that group together 169 more specific targets and more than 240 indicators for measuring progress. The SDGs use clear, direct language (e.g., No Poverty, Affordable and Clean Energy, Climate Action) and bold graphics to present high-level global aspirations to achieve economic prosperity, social inclusion, and environmental integrity by 2030. The near-universal adoption of the SDGs has provided an organizing principle, shared agenda, and common language for governments, the private sector, civil society members, academia, and philanthropic communities around the world to frame their activities, interactions, impact, and reporting.¹

SDG 4 addresses the issue of education directly, that is, “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all,” and Target 4.7 of that goal specifically addresses education for sustainable development (ESD) by stating “by 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development” (UN, 2020). The SDGs are

¹ See United Nations Sustainable Development Goals, available at <https://sustainabledevelopment.un.org/sdgs>, accessed on March 11, 2020.



FIGURE 2-3 United Nations Sustainable Development Goals.

SOURCE: United Nations, 2019. Communications materials. Available at <https://www.un.org/sustainabledevelopment/news/communications-material>, accessed on June 19, 2020.

intentionally interrelated: for example, education is needed to achieve other SDGs, while other SDGs affect whether quality education becomes a reality. In addition, several existing legal, policy, and organizational constructs have been mapped to the SDGs, including longstanding global norms on human rights² and nationally determined contributions to reduce greenhouse gas emissions.³ Such mapping can align agendas to the framework of the SDGs, but does not necessarily look at the tensions between the goals. Interactions across the 17 goals and their 169 targets generate multiple synergies (i.e., progress in one goal also supports progress in another goal) but also trade-offs (i.e., progress in one goal would hinder progress in another goal).

Understanding these linkages and externalities is essential to “leave no one behind,” the commitment made in UN Resolution 70/1 adopting the 2030 Agenda that has become the de facto slogan and organizing principle for implementation of the SDGs.⁴ Many experts contend that leaving no one behind requires locally adapted solutions. For example, Stafford Smith et al.

² See the Danish Institute for Human Rights, Sustainable Development Goals, available at <https://www.humanrights.dk/our-work/sustainable-development-goals-0>, accessed on March 11, 2020.

³ See the German Development Institute on connecting climate action to the SDGs, available at <https://klimalog.die-gdi.de/ndc-sdg/>, accessed on March 11, 2020.

⁴ See the United Nations Committee for Development Policy document “Leaving No One Behind,” available at https://sustainabledevelopment.un.org/content/documents/2754713_July_PM_2_Leaving_no_one_behind_Summary_from_UN_Committee_for_Development_Policy.pdf.

(2018, 1483) state that “deeply differentiated and context-specific actions” are required and “despite the need for global outcomes, most implementation will be local.” Moallemi et al. (2019) similarly argue for a local agenda on the SDGs and a means to codevelop this information with communities and stakeholders.

The global push to achieve the SDGs is driving the need for highly skilled, well-trained experts in sustainability who can translate global policy into a local or organizational context, source measures of impact, and build action-oriented coalitions. Higher education institutions are responding to the need for educational approaches to help students address the challenge of balancing the economic, social, and environmental dimensions of sustainable development.

A Framework for Safe and Just Sustainable Development

The development of the SDGs was preceded by other goal-oriented frameworks that focused attention on environmental and social boundaries. The Doughnut framework, originated by Kate Raworth in 2012, builds on the planetary boundaries model developed in 2009 that focused on planetary-scale environmental impacts. The Doughnut framework explicitly includes social boundaries to navigate pathways in a “safe and just operating space for humanity” (Raworth, 2012; Leach et al., 2013; Dearing et al., 2014). This framework adds a set of 11 social boundaries as *lower* bounds for human well-being to the *upper* environmental planetary boundaries (Raworth, 2012; see Figure 2-4). These social boundaries, including water, income, education, resilience, voice, jobs, energy, social equity, gender equality, health, and food, aim to raise all of humanity above minimums: for example, ensuring people have at least a certain level of nutrition, education, income, and other basic needs. This framework stresses that the challenge of sustainability is to navigate development within a socially just and environmentally safe space between these lower and upper boundaries: “combining the inner limits of social boundaries and the outer limits of physical boundaries in this way creates a doughnut-shaped space within which all humanity can thrive by pursuing a range of possible pathways that could deliver inclusive and sustainable development” (Leach et al., 2013, 85).

Other Frameworks

In recent years, a number of organizations have built frameworks based on the SDGs, the Doughnut models, and their own research and analysis. For example, *The World in 2050* presents a framework of “integrated pathways” that identifies six “exemplary transformations which allow achieving the SDGs and long-term

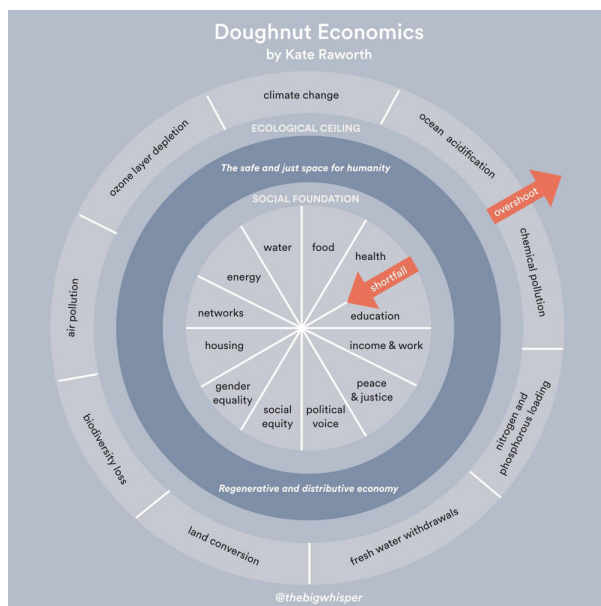


FIGURE 2-4 The “doughnut”-shaped space to provide possible pathways that could deliver inclusive and sustainable development based on social and planetary boundaries. SOURCE: The Big Whisper, 2020, based on Raworth, 2012. Available at <https://www.thebigwhisper.com/blog/2019/12/23/introduction-to-doughnut-economics-and-thoughts-for-how-to-apply-this-framework-to-your-endeavor>, accessed on November 5, 2020.

sustainability to 2050 and beyond.”⁵ In 2018, the World Bank released its own “Environmental and Social Framework” to guide its investment project financing.⁶

The private sector also incorporates sustainability principles into strategy and operations through metrics and tools to measure progress (Matson et al., 2016). According to a recent survey of more than 700 global companies conducted by PricewaterhouseCoopers, 72 percent of companies mention the SDGs in their annual corporate or sustainability reports, 50 percent identify SDGs as a priority, and 54 percent mention them in their business strategies (PwC, 2018). Findings from a McKinsey survey show that companies that address sustainability do so “to align with their business, goals, and values; build, maintain, or improve cor-

⁵ The six transformations relate to (1) human capacity and demography; (2) consumption and production; (3) decarbonization and energy; (4) food, biosphere, and water; (5) smart cities; and (6) digital revolution. For more information, see “Transformations to Achieve the Sustainable Development Goals,” available at http://pure.iiasa.ac.at/id/eprint/15347/1/TWI2050_Report081118-web-new.pdf, accessed on March 12, 2020.

⁶ See the World Bank’s “Environmental and Social Framework,” available at <http://pubdocs.worldbank.org/en/837721522762050108/Environmental-and-Social-Framework.pdf>, accessed on March 12, 2020.

porate reputation; and/or improve operational efficiency and lower costs.”⁷ The environmental, social, and governance, or ESG, framework has been increasingly used in recent years to evaluate the sustainability of companies and investments, as well as to better evaluate risk. Henisz et al. (2019) note that ESG-oriented global sustainability investment has increased 68 percent since 2014 and tenfold since 2004, currently reaching \$30 trillion. The UN launched its private-sector UN Global Compact in 2000, a voluntary, nonbinding pact among businesses based on 10 principles that include respecting the environment. With 10,453 member companies across 166 countries, the Global Compact has been a driving force for businesses to adopt and align their work to the SDGs.⁸ The Business and Sustainable Development Commission, a global group of business leaders, identifies 60 market opportunities that could be commercially lucrative while also helping achieve the SDGs (AlphaBeta, 2017). The commission also recognizes the impact on education and employment if the private sector were to build on these opportunities, including the creation of 380 million jobs by 2030 and creation of new business models by company innovators.⁹ Membership organizations, such as the World Business Council for Sustainable Development, and transparency and accountability tools, such as the World Benchmarking Alliance or the Global Reporting Initiative’s Sustainability Disclosure Database, seek to build platforms and forums for sharing information and best practices around sustainable business (see Box 2-1).

SUSTAINABILITY SCIENCE

The abundance of theoretical and action-oriented frameworks to guide sustainability education and to strengthen its connections with the world of sustainability goals and actions is a clear sign of the vigor of a growing field. Research in sustainability science provides key organizing principles for available and emerging knowledge and frameworks related to sustainability. Sustainability science emerged as a distinct field in the early 2000s with key contributions that sought to better delineate the relationship between human well-being and the environment. Sustainability science has an explicit commitment to interdisciplinarity and use-inspired basic and applied research that advances fundamental knowledge and also influences sustainability outcomes through active engagement. Both these features of the field aim to undermine the traditional separation between social, natural, and applied sciences, as also between science and practice (Clark, 2007;

⁷ See McKinsey & Company’s survey review “Sustainability’s Strategic Worth,” available at <https://www.mckinsey.com/business-functions/sustainability/our-insights/sustainabilitys-strategic-worth-mckinsey-global-survey-results#>, accessed on March 12, 2020.

⁸ See <http://unglobalcompact.org>, accessed on March 12, 2020.

⁹ See the Business and Sustainable Development Commission’s report *Better Business Better World*, available at https://d306pr3pise04h.cloudfront.net/docs/news_events%2F9.3%2Fbetter-business-better-world.pdf, accessed on March 12, 2020.

BOX 2-1

Sustainability Commitments in the Private Sector

With an increase in companies using the United Nations Sustainable Development Goals (SDGs) framework to develop new sustainable opportunities, universities can support corporate sustainability efforts by developing educational approaches that align with the SDGs and private-sector approaches. As noted later in this chapter, a trend with implications for sustainability education includes the growing demand for well-qualified sustainability professionals within the private sector.

Several recent, high-profile efforts have signaled the private sector's recognition that verifiable steps toward sustainability are important for their customers, with implications for their bottom line. For example, in August 2019, the Business Roundtable released a "Statement on the Purpose of a Corporation" signed by 181 chief executive officers representing more than 15 million employees and more than \$7 trillion in annual revenues. This statement recognized the need to benefit all stakeholders, rather than just shareholders, which revises more than 20 years of "shareholder primacy" as central to the Business Roundtable's Principles of Corporate Governance. The shift focuses on creating long-term value through practices that include investing in employees and communities, thus also orienting the corporations toward the breadth of stakeholders involved in the SDGs.

Some nonprofit groups have emerged to further promote sustainability in the private sector. Ceres is a sustainability nonprofit organization working with investors and companies to address key global sustainability challenges, including climate change, water scarcity and pollution, and inequitable workplaces while advancing sustainability in businesses (Ceres, 2020). The Carbon Disclosure Project is a nonprofit organization that administers the global system for reporting on environmental impacts by public and private entities, providing benchmarking and scoring to measure and manage those disclosures (CDP, 2020). B Lab is a global nonprofit organization that supports using business as a force for good, or in its words, "build a regenerative and inclusive economy that works for all." B Lab is perhaps most recognized as the certifying administrator for companies designated as Benefit, or B Corporations. In late January 2020, B Lab and the UN Global Compact announced a free tool, called the SDG Action Manager, which fuses B Lab's B Impact Assessment, the Ten Principles of the UN Global Compact, and the SDGs with expert feedback to enable companies to self-assess and benchmark their adherence to sustainable and equitable business practices.

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Clark and Dickson, 2003; Kates, 2011). In drawing upon theories and tools from multiple disciplines as they relate to social and environmental science, sustainability science also highlights the contextual and the dynamic nature of social and biophysical relationships (Bettencourt and Kaur, 2011; Spangenberg, 2011).

These key features of sustainability science make it an attractive field for integrative work in sustainability and for sustainability education. But for the field to support the achievement of the SDGs and other sustainability goals, its practitioners, educators, and researchers must act to highlight the critical importance of sustainability for present and future generations, address inequalities in sustainability education, and strengthen collaboration in sustainability education beyond the rich world (Messerli et al., 2019).

SUSTAINABLE DEVELOPMENT AND SUSTAINABILITY

Sustainability is implied in sustainable development, as noted in such significant work as *Our Common Future* (WCED, 1987), the *Human Development Reports* of the UN Development Programme, and the concept of the “triple bottom line” articulated by John Elkington (1994). However, the two terms are not interchangeable and can even be in conflict in some situations.

Wackernagel et al. (2017, 1) noted “sustainable development” as “the world’s official commitment to everyone’s wellbeing (development), while recognizing the need to operate within the planet’s ecological limits (sustainable).” Yet when countries’ rankings in the SDG Index were plotted against their development achievements (using the UN’s Human Development Index) and their resource use (based on Global Footprint Network’s Ecological Footprint), they found that “ranking high on the SDG Index strongly correlates with high per person demand on nature (‘footprint’), while low ranking correlates with low footprints.” They concluded, “the SDGs as expressed today vastly underperform on sustainability. Such underperformance is anti-poor because lowest income people exposed to resource insecurity will lack the financial means to shield themselves from the consequences.”

There is a need to consider sustainable development in the context of sustainability as measured by Earth’s “safe and just operating space” of the Doughnut model. The potential tensions among various sustainability frameworks and goals lend a note of caution in the design and evaluation of sustainability curricula in higher education. Ensuring contextual linkages between sustainability and sustainable development in education is critical so that students, teachers, and communities remain engaged partners in achieving truly sustainable development in service to the SDGs, and reflect the intent to balance “people, planet, and prosperity.”¹⁰

¹⁰ United Nations A/RES/70/1 – Transforming our world: the 2030 Agenda for Sustainable Development, Preamble. Available at <https://sustainabledevelopment.un.org/post2015/transformingourworld>, accessed on March 12, 2020.

BRIEF HISTORY OF SUSTAINABILITY EDUCATION AT THE UNDERGRADUATE AND GRADUATE LEVELS

Sustainability education began earlier than development of the planetary boundaries, SDGs, or other frameworks described above, and it has expanded and adapted to changing environmental and social priorities. Moreover, sustainability higher education programs have roots in earlier environment- and development-focused programs. Sterling (2004) traced the historical evolution of environmental education from Sir Patrick Geddes (1854–1932) in the United Kingdom, through environmental science and the rise of Western environmentalism in the 1960s with Rachel Carson’s *Silent Spring* (1962), and then, in the 1970s, the International Union for Conservation of Nature (in 1970) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) (in 1977) formulating the first definitions of environmental education. The International Union for Conservation of Nature defined *environmental education* as “the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among man, his culture and his biophysical surroundings.” UNESCO defined the goal of environmental education as, “To foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas; to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment; to create patterns of behaviour of individuals, groups and society as whole towards the environment” (Chauvet de Andrade, 1997). These early definitions of environmental education are centered on the environment but carry the seeds of the social and economic dimensions that would later sprout in sustainability education.

Development education emerged during the 1970s among nongovernmental organizations and some Western education systems, and it both overlapped and was in tension with the high-level international attention to environmental education (Sterling, 2004). These two trends then merged in the focus on Education for Sustainability (EfS) in *Our Common Future* in 1987 and in Education for Sustainable Development (ESD) at the Earth Summit in Rio de Janeiro, Brazil, in 1992. EfS, Sterling thus argued, marks the evolution of environmental education from a narrow focus on the natural environment to the environment and human development in ESD, then to the balance between environmental, economic, and social development in EfS.

In 1990, the president of Tufts University in Massachusetts convened 22 university presidents and chancellors from 15 countries in Talloires, France. Many years before “sustainability” became a normal part of the lexicon, these forward-looking leaders called for higher education to “increase the awareness, knowledge, technologies, and tools to create an environmentally sustainable future.” Their 10-point Talloires Declaration recognizes the role of universities as role models, providers of education and training, and incubators of research and policy.¹¹

¹¹ For more information, see Talloires Declaration, available at <https://sustainabledevelopment.un.org/post2015/transformingourworld>, accessed on March 12, 2020.

Education was also an important component of the UN Rio Declaration on Environment and Development. In 1992, the Rio Declaration called for “reorienting education towards sustainable development,”¹² and subsequent UN efforts have built on the goals in that document. Senator John Kerry and his wife Teresa Heinz jumpstarted the effort to link sustainability with education more deliberately in 1993 when they collaborated with Anthony Cortese to launch Second Nature. The organization focused its attention on getting college and university presidents to spearhead sustainability initiatives on their campuses (Peterson, 2013). In 2006, 12 college and university presidents, working in collaboration with Second Nature, ecoAmerica, and the Association for the Advancement of Sustainability in Higher Education (AASHE), met to charter the American College and University Presidents Climate Commitment (ACUPCC).¹³ The founding signatories invited their peers to sign on to the commitment and achieved 336 charter signatories by September 2007. ACUPCC was rebranded and expanded to form the Presidents’ Climate Leadership Commitments in 2015.¹⁴ The Carbon Commitment and the Resilience Commitment were also launched in 2015 as part of this rebranding (Second Nature, n.d.). To date, approximately 700 U.S. universities enrolling about 6 million students have signed the ACUPCC. The institutions share information publicly about their greenhouse gas inventories, climate action plans, and progress reports on sustainability initiatives. In summarizing the impact, Dyer and Dyer (2017) argued that “while there had been significant growth in higher education sustainability initiatives over the preceding decade, the ACUPCC helped shift these from a collection of distinct programs to a strategic imperative for colleges and universities. The initiative promotes cross-disciplinary education, research, and practice needed for society to achieve sustainability.”

Globally, colleges have made commitments to achieving sustainability goals by signing international agreements such as the Talloires Declaration (Adams et al., 2017). Currently, more than 6,000 higher education institutions on all continents have declared a climate emergency and are supporting a three-point plan to mitigate the crisis (Second Nature, 2019).

In 2005, the UN launched the Decade of ESD initiative, with periodic conferences and agreements to both track and inspire progress. These efforts aimed to infuse sustainability across curricula as well as set up more focused ESD programs. The UNESCO Global Action Programme, first established to advance the ESD agenda, focuses on five priority areas: (1) advancing policy, (2) transforming learning and training environments, (3) building capacities of educators and trainers, (4) empowering and mobilizing youth, and (5) accelerating sustainable

¹² See Agenda 21, Chapter 36, “Promoting Education, Public Awareness and Training,” available at <http://www.un-documents.net/a21-36.htm>, accessed on March 12, 2020.

¹³ See <https://secondnature.org>; <https://ecoamerica.org>; and <https://www.aashe.org>, all accessed on March 12, 2020.

¹⁴ See <https://secondnature.org/signatory-handbook/the-commitments>, accessed on March 12, 2020.

solutions at the local level.¹⁵ While ESD is recognized as a key element of the SDGs, Kioupi and Voulvoulis (2019) developed a systemic framework for connecting the SDGs to educational learning outcomes to facilitate the transition to sustainability. The authors' analysis highlights the need for identifying competencies and aims that can be core to educational programs in sustainability and thus better aligning educational programs to the goals of sustainability frameworks and the public and private sectors.

CURRENT STATUS OF HIGHER EDUCATION PROGRAMS IN SUSTAINABILITY

Covering a spectrum of issues from the global and local scales, and with a range of goals, current sustainability education programs provide a diversity of approaches in their offerings. Throughout this report, we highlight a variety of educational programs to illustrate the breadth and range of these programs and to underscore that no one-size-fits-all program is advisable or even possible.

U.S. Programs

Many interdisciplinary environmental programs in the United States were established at higher educational institutions over the last 40 years (Vincent and Focht, 2009). Some interdisciplinary programs focused on systems-based approaches that have existed for several decades, typically without “sustainability” in their names.

A large survey of U.S. interdisciplinary environmental programs found consensus in defining the field as “an applied, interdisciplinary focus on the interface of coupled human-natural systems with a normative commitment to sustainability” (Vincent and Focht, 2011). The survey also found a positive relationship between enrollment and program inclusion of sustainability (in core principles, coursework, and research and service learning opportunities), preparing students to be change agents and providing community service, which parallel major features of sustainability education addressed in Chapters 3 and 4 of this report. Vincent et al. (2013) surveyed 231 interdisciplinary environmental and sustainability (IES) program administrators, who rated the importance of 41 knowledge areas and 38 skill areas in what they view as the “ideal” curriculum for each IES degree that they administer. The study included data on 363 IES programs, which were representative of 1,859 IES programs nationally. Their statistical analysis found that undergraduate IES programs clustered around three frameworks, involving a natural science, social science, or sustainability solutions emphasis; and graduate IES programs

¹⁵ See UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development, available at <https://unesdoc.unesco.org/ark:/48223/pf0000230514>, accessed on March 11, 2020.

clustered around two frameworks, having either a natural systems or sustainability solutions emphasis. They also found that sustainability degree programs statistically fit within these IES frameworks. Importantly, “problem-solving for sustainability” was core to the curriculum across all the IES frameworks. These findings suggest that it is not possible to make a categorical distinction between interdisciplinary environmental higher education programs and sustainability education programs.

Sustainability undergraduate and graduate degree programs have developed against a backdrop of high interest by university leadership (as noted above) but also, and just as significantly, with substantial investments by both students and faculty. To illustrate the growth, the Sustainable Endowments Institute in Cambridge, Massachusetts, released a College Sustainability Report Card (or Green Report Card) from 2006 through 2011 (SEI, 2012). The reports examined sustainability education and efforts on 322 U.S. and Canadian college campuses that enroll about 4.2 million students. Over the span of 5 years, the reports revealed increasing commitments to sustainability on those campuses. For instance, the commitment to reduce carbon emissions increased from 23 percent in 2006 to 64 percent in 2011, campuses having a farm or garden went from 9 percent in 2006 to 70 percent in 2011, and those with green buildings went from 22 percent in 2006 to 79 percent in 2011. In addition, by 2011, 95 percent of the campuses had a sustainability committee, compared with only 40 percent in 2006.

In addition, college students express support of sustainability efforts on their campuses. Using indicators from the College Sustainability Report Card, Emanuel and Adams (2011) surveyed 148 undergraduates in Hawaii and 258 undergraduates in Alabama. They found that 69 percent of the students in Hawaii and 57 percent of those in Alabama believed that their college should make sustainability a priority in campus planning, development, and day-to-day operations. They also found that 68 percent of the students in Hawaii and 56 percent of those in Alabama felt that “everyone in my school’s community should support sustainable solutions to environmental problems.”

Campus sustainability projects have also been used for educational demonstrations and curriculum development for many universities. Cai and Shafiee-Jood (2017) examined campus sustainability programs at six universities (Harvard University, University of Washington, Ohio State University, University of Minnesota, University of California, Berkeley, and Cornell University) and found that these universities have successfully integrated research and education into their campus sustainability programs and initiatives.

These campus commitments to sustainability are linked to the proliferation of sustainability and related degree programs nationwide. Arizona State University launched its School of Sustainability in 2006 as the first school in the United States to explicitly explore the principles of sustainability (see Box 2-2). The growth in sustainability programs has been documented by the National Council

BOX 2-2

Sustainability Education at Arizona State University

The School of Sustainability at Arizona State University (ASU) was established in 2006 with a mission to “educate a new generation of scholars and practitioners and create innovative modes of scholarship by bringing together leaders, stakeholders, and people from multiple disciplines to develop practical solutions to the most pressing sustainability challenges” (ASU, 2019a, 2019b). The school offers multiple undergraduate and graduate programs and minors, doctoral and professional leadership programs, as well as others through ASU Online. A 4+1 Accelerated Bachelor’s+Master’s program allows students to earn both a bachelor’s degree and a master of sustainability solutions degree in 5 years. The School of Sustainability curricula are built around five core competencies (as identified in Wiek et al., 2011) and emphasize experiential learning, corporate and K–12 work, research with faculty, leadership development, and community service (Boone, 2015). The school promotes a transdisciplinary approach in its curriculum and creates synergies between multiple disciplines by addressing a broad range of global sustainability challenges, including energy, materials, and technology; water quality and scarcity; international development; ecosystems; social transformations; food and food systems; and policy and governance (ASU, 2019b).

All School of Sustainability undergraduates are required to complete a Capstone Internship prior to graduation. The Sustainability Undergraduate Research Experience provides need-based stipends to support undergraduates to work on faculty-led research projects. The ASU Study Abroad Office administers more than 250 study abroad programs in more than 65 countries across the globe, with the opportunity to apply classroom learning in a global context. The school also provides mentorship opportunities to support career development experience for students and alumni, such as Sustainabilitybuddies (an undergraduate peer-to-peer mentor program), Job Shadow Program, Frasier Global Mentorship Program, and ASU Mentor Network.

As of May 2020, 1,684 degrees have been awarded by ASU’s School of Sustainability, including 1,156 bachelor’s degrees, 458 master’s degrees, and 70 doctoral degrees. Regarding employment, 95 percent of B.A./B.S. graduates are currently employed or pursuing a graduate degree, with 72 percent of those employed working in a sustainability-related role. One hundred percent of both M.A./M.S. and Ph.D. graduates are currently employed, with 86 percent and 94 percent of those employed working in a sustainability-related role, respectively (ASU, 2020).

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for Science and the Environment (NCSE), which conducted three censuses of interdisciplinary environmental, sustainability, and energy (IESE) degrees in 2008, 2012, and 2016 (Vincent, 2010; Vincent et al., 2012, 2017). This periodic lens provides a useful tool to observe the growth in the number of programs and the various ways the programs are offered.

The 2016 NCSE survey (reported in Vincent et al., 2017) compiled data from 1,690 institutions listed in the 2015 Carnegie Classifications, including 315 doctoral universities, 683 master's colleges and universities, and 657 baccalaureate colleges.¹⁶ Within this total are 82 historically Black colleges and universities, 112 Hispanic-serving institutions, 309 minority-serving institutions, 40 women's colleges, and 35 tribal colleges.

According to NCSE, the number of IESE degrees offered grew by 15 percent in the 4 years between 2012 and 2016, to a total of 2,361 degrees offered by 872 higher education institutions. Within this total, sustainability programs may be offered as degrees in sustainability, sustainable management, sustainability studies, environmental sustainability, and more than a dozen other names. A degree program in “environmental and sustainability design” also emerged between 2012 and 2016.

In addition, the NCSE survey identified other degrees with strong sustainability elements. The top five IESE degrees in 2016 were environmental sciences (33 percent), environmental studies (20 percent), natural resources (18 percent), sustainability (11 percent), and policy and management (7 percent). The survey also revealed that 2,222 degree programs offer IESE specializations while conferring a degree in other fields. As an example, Columbia University offers multiple sustainability degree pathways, at both the undergraduate and the graduate levels (see Box 2-3).

IESE graduate programs are expanding as well. Between 2012 and 2016, the number of doctoral degrees increased 50 percent and master's degrees by 38 percent. This growth suggests that the number of sustainability faculty with advanced degrees in sustainability science—rather than environmental science, biology, or related fields—will increase, leading to a further maturation of the discipline.

Another finding of note from the NCSE survey is that 50 percent of the IESE degree programs are in their own departments, schools, or colleges, an increase of 9 percent since 2012. According to the report authors (Vincent et al., 2017, 7), “this is significant because IESE degree programs administered by their own IESE units typically have more resources and autonomy than IESE degree programs that span or are located within traditional disciplinary units.”

¹⁶ See Carnegie Classification of Institutions of Higher Education, 2015 Data File, available at <http://carnegieclassifications.iu.edu/downloads/CCIHE2015-PublicDataFile.xlsx>, accessed on September 23, 2020.

BOX 2-3
**Columbia University Undergraduate and
Graduate Programs in Sustainability**

Columbia University offers a variety of environmental-related degrees, including an undergraduate program in sustainable development and sustainability master's programs. Established in 1995, the Earth Institute is "the largest university-wide research organization in the world dedicated to sustainability research, practice, and education" (Columbia University, 2019). As an undergraduate program, the Earth Institute offers a major and concentration in sustainable development, in collaboration with the other schools and departments on campus (Columbia University, 2018). Students are required to complete a capstone workshop course in their senior year, with the opportunity to work with real-world clients such as the Nature Conservancy, the U.S. Military Academy West Point, and the New York City Department of Environmental Protection. The Summer Ecosystem Experiences for Undergraduates Program, or SEE-U, provides undergraduate students with the opportunity to engage in environmental fieldwork as well as classroom lectures and lab work (Columbia University UGE, 2019). An accelerated program allows students to earn both a B.A. in sustainable development and an M.S. in sustainability management in 5 years.

A growing part of the educational process in Columbia's graduate programs is through experiential learning (Cohen, 2019). For example, the M.S. in Sustainability Management Program, in partnership with the Earth Institute's Center for Sustainable Urban Development, developed an interdisciplinary course in 2017 titled "Access, Innovation, and the Urban Transportation Transition" that includes a series of lectures, a case study approach, and experiential learning in New York City (Ladue, 2017). To prepare a new generation of engineering professionals, the School of Engineering and Applied Science offers an M.S. in earth resources engineering with concentrations in sustainable energy or sustainable waste management (Columbia University EEE, 2019a, 2019b).

Global Programs

While there is no known survey comparable to the NCSE census that provides a global review of sustainability education programs, the committee identified many networks and programs that indicate the breadth and scope of efforts outside the United States. The committee could not assess their strengths and gaps, but the range of international programs indicate a global interest in information exchange and networking to meet the needs of institutions and students in sustainability education.

Some of these global education programs have UN connections. United Nations University's Institute for the Advanced Study of Sustainability, located in Japan, offers master and doctoral degree programs focused on sustainability

Columbia University also offers certifications in sustainability analytics, sustainable finance, and sustainability water management to train professionals in quantitative and technical skills through applied sustainability curriculum (Columbia University, 2019), as well as a doctoral program in sustainable development (Columbia University SIPA, 2019). The M.S. in sustainability management recently graduated its 800th student, with approximately 75 percent holding sustainability positions in the private sector and the remaining 25 percent in government and nonprofit organizations in the United States and abroad (Columbia University, 2020).

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to students from around the world.¹⁷ The Global RCE Network, with regional centers of expertise on ESD encompasses more than 175 institutions as of April 2020, linking UN agencies, formal education institutions, and informal educators.¹⁸ The Global Universities Partnership on Environment for Sustainability serves to increase the mainstreaming of environment and sustainability practices and curricula into universities around the world.¹⁹

¹⁷ See Institute for the Advanced Study of Sustainability, available at <https://ias.unu.edu/en/>, accessed on September 23, 2020.

¹⁸ See Global RCE Network on Education for Sustainable Development, available at <https://www.rcenetwork.org/portal/>, accessed on March 11, 2020.

¹⁹ See Global Universities Partnership on Environment for Sustainability, available at <https://www.unenvironment.org/es/node/10655>, accessed on March 11, 2020.

Sustainability education networks in Asia and the Pacific include the UN Environment Programme Regional Office for Asia and the Pacific's Asia-Pacific Regional University Consortium, the Pacific Regional Environmental Programme, and the Pacific Islands Forum.²⁰ In Latin America, networks of universities offering sustainability programs include the Mexican Consortium of University Environmental Programmes for Sustainable Development, Environmental Committee of the Association of Universities Group Montevideo, and the Alliance of Iberoamerican University Networks for Sustainability and the Environment.²¹ The European Network on Higher Education for Sustainable Development, also called the COPERNICUS Alliance, includes 12 institutions.²² The Mainstreaming Environment and Sustainability in African Universities Partnership Programme, an initiative of UNESCO, the Association of African Universities, and the United Nations University, has 85 universities across Africa as members.²³

Looking more closely at the responses of countries to the UN's Decade of Education for Sustainable Development, the Swedish government established the Swedish International Centre of Education for Sustainable Development in 2006 at the former Gotland University. Housed at Uppsala University today, the center promotes integrated collaborative research and development projects in Sweden and abroad, while offering training courses for teachers, professors, teacher educators, policy makers, and project leaders.²⁴ Several higher education institutions also provide courses related to interdisciplinary sustainability science, including a master's program in social-ecological resilience for sustainable development at the Stockholm Resilience Centre (UNECE, 2012).

The Danish Ministry of Education published a national strategy for education for sustainable development in 2009, and the Danish Regional Centre of Expertise on Education for Sustainable Development has focused on creating a national network for practical research and development of ESDs, including all disciplines and levels of education (Danish Ministry of Education, 2009).²⁵ In May 2014, the Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability was established under the auspices of UNESCO to focus on a unique com-

²⁰ See Global University Network for Innovation on Sustainability and Higher Education in Asia and the Pacific, available at <http://www.guninetwork.org/articles/sustainability-and-higher-education-asia-and-pacific>, accessed on March 11, 2020.

²¹ See Global University Network for Innovation on Sustainability and Higher Education in Latin America and the Caribbean, available at <http://www.guninetwork.org/articles/higher-education-environment-and-sustainability-latin-america-and-caribbean>, accessed on March 11, 2020.

²² See COPERNICUS Alliance, available at <https://www.copernicus-alliance.org>, accessed on March 12, 2020.

²³ See Mainstreaming Environment and Sustainability in African Universities Partnership Programme, available at <https://www.unenvironment.org/fr/node/10690>, accessed on March 12, 2020.

²⁴ See Swedish International Centre of Education for Sustainable Development, available at <http://www.swedesd.uu.se/about>, accessed on March 12, 2020.

²⁵ See also United Nations Global Universities Partnership on Environment for Sustainability, available at <https://www.unenvironment.org/es/node/10655>, accessed on March 12, 2020.

bination of problem- and project-based learning, engineering education research, and education for sustainable development (Holgaard et al., 2016).

In 2015, Australia developed consensus standards for the interdisciplinary environmental and sustainability field, titled “Learning and Teaching Academic Standards Statement for Environment and Sustainability,” based on a participatory process with nearly 1,000 stakeholders, including academics, students, practitioners, and representatives of Indigenous interests (Phelan et al., 2015). The statement includes minimum or threshold learning outcomes required of environment and sustainability graduates. These learning outcomes are endorsed by the Australian Council of Environmental Deans and Directors as a curriculum reference point for program design, development, and delivery in this field.

The Education for Sustainable Development in Africa, launched by the United Nations University’s Institute for Sustainability and Peace in 2008, involves eight African partner universities in an interuniversity collaboration program of graduate training and research.²⁶ This work builds on courses developed by the Environic Foundation International that are structured around the SDGs to create a sustainable Africa (EFI, 2020). In 2016, the Kenya Green University Network was launched to include sustainability and environmental practices into the curricula, research projects, and campus designs at Kenyan universities (UNEP, 2016).

These examples demonstrate the enormous vitality of sustainability education programs in countries beyond the United States. They also underscore the substantial diversity in content, methods, structure, and reach of programs in other countries, including many lower- and middle-income countries. At the same time, the major resource gaps that hobble sustainability education offerings in lower-income countries suggest that substantial gains may result from more systematic collaboration between higher education institutions offering sustainability education programs in the United States and internationally. Improved and more equitable access to sustainability education; curricular design to adapt sustainability education to local needs; and greater integration between research, instruction, and the practice of sustainability are only some of the potential gains from more systematic international collaboration for sustainability higher education.

The Sustainable Development Goals in National and Global Higher Education Programs

Several U.S. and international higher education institutions have publicly embraced the SDGs as a framework for organizing core sustainability issues. For example, Yale University examines how teaching and research at the university aligns with the 17 SDGs (Goodall and Moore, 2018), and Case Western Reserve Univer-

²⁶ See Education for Sustainable Development in Africa, available at <https://unu.edu/projects/education-for-sustainable-development-in-africa-esda.html#outline>, accessed on March 12, 2020.

sity has launched the AIM2Flourish initiative, which claims to be the world's first higher education curriculum for the SDGs and "Business as an Agent of World Benefit" (AIM2Flourish, 2019). Internationally, the University of Groningen in the Netherlands has developed a 3-year bachelor degree program based on the SDGs, the University of Hong Kong offers Common Core courses tagged with the SDGs as a framework for transdisciplinary and holistic learning, and the University of Geneva and Tsinghua University of China have jointly launched a master of public policy for sustainable development goals (ISCN, 2017; Geneva Trialogue, 2019).

Many organizations are also examining strategies to map SDGs onto campus operations and course curricula. The Higher Education Sustainability Initiative, a partnership of UN agencies and initiatives, provides a platform for more than 300 higher education institutions from around the world to exchange best practices and educate future leaders on the SDGs (UN, 2019). Additionally, the UN Sustainable Development Solutions Network was set up in 2012 "to mobilize global scientific and technological expertise to promote practical solutions for sustainable development."²⁷ Originally hosted by Columbia University's Earth Institute, the network became an independent nonprofit in 2016, and launched its global University Partnership Program in 2017. The Association of Public and Land-grant Universities and the United Nations Institute for Training and Research issued a joint Declaration on University Global Engagement as an opportunity for higher education institutions to commit to cross-border and cross-sector research in pursuit of novel solutions to the SDGs (Evers, 2018; Declaration on University Global Engagement, 2019). Other initiatives to advance global engagement on SDGs include the United Nations Academic Impact, SDG Academy, and Geneva Trialogue on scaling education for the SDGs.²⁸ The Association for Advancement of Sustainability in Higher Education also provides conferences and webinars related to the SDGs and curricula.

Voluntary National Reviews, typically a commitment by UN member states to "conduct regular and inclusive reviews of progress" toward the SDGs, have begun to take different perspectives, with subnational governments preparing Voluntary Local Reviews. In September 2019, Carnegie Mellon University in Pittsburgh, Pennsylvania, committed to delivering the first "Voluntary University Review" in 2020.²⁹ This commitment echoes efforts of other universities that have worked in partnership with local and regional governments to track and report progress, including the University of Bristol (Fox and Macleod, 2019) in partnership with the Bristol City Office, and a consortium of institutions supporting the City of Los Angeles, including Occidental College, the Thunderbird

²⁷ See UN Sustainable Development Solutions Network, available at <https://www.unsdsn.org>, accessed on July 7, 2020.

²⁸ See <http://www.sdgacademy.org> and <https://gt-initiative.org/events/geneva-trialogue>, both accessed on March 12, 2020.

²⁹ See <https://sdg.iisd.org/news/carnegie-mellon-university-to-present-voluntary-university-review-in-2020>, accessed September 23, 2020.

School of Global Management at Arizona State University, the University of Southern California, the University of California, Los Angeles, and Pomona College (Office of the Mayor, 2019).

Times Higher Education's Impact Rankings presents the impact higher education institutions have on society based on their success in delivering the SDGs by providing comparisons across three broad areas: research, outreach, and stewardship. The second edition of the ratings includes 766 universities from 85 countries (*Times Higher Education*, 2020). The SDGs provide an opportunity for higher education institutions to work across departments, majors, and community members, such as faculty, staff, and students, to fulfill missions to provide knowledge, build skills, and support the cultivation of global citizens (Mahalak, 2018). Universities can collaborate with governments, the private sector, and the public to help accelerate progress toward the SDGs through higher education initiatives.

SUSTAINABILITY-RELATED EMPLOYMENT

An important aspect of the committee's work was to understand the employment prospects for sustainability graduates in terms of the opportunities and the skills that employers seek, especially when hiring recent graduates.

The number of people who are employed in sustainability-related jobs cannot be comprehensively ascertained because the field encompasses occupational categories that range from engineering to policy to community organizing and more, in the public, private, and nonprofit sectors. Moreover, especially over the past few years, many organizations have integrated sustainability across their activities, beyond setting up a separate sustainability office or job category.

The committee examined several sources of employment data, including data collected by the U.S. Bureau of Labor Statistics (BLS) and the private firm Burning Glass Technologies, recognizing that they do not show the complete picture of current or projected employment.³⁰ Professionals from hiring organizations who participated in the committee's workshops also provided anecdotal but valuable evidence about demand within their organizations and the skills they seek, especially in the entry-level positions that would attract new graduates.

While there is not a single BLS code that identifies individuals whose primary job is to advance sustainability, the committee analyzed BLS data in 36 occupations that encompass sustainability in some way, from agricultural technicians to zoologists and wildlife biologists. These data project a 3.9 percent growth rate between 2018 and 2028: with a net increase of 108,200 jobs during the period. Growth is expected in all but five of the segments (BLS, 2019). However, the data show jobs formally related to the environment while including many jobs

³⁰ For more information on Burning Glass Technologies, see <https://www.burning-glass.com>, accessed on March 12, 2020.

that are likely not related to sustainability; therefore, they only provide a limited picture of the range of jobs related to sustainability.

In 2010, the BLS used three surveys to collect data on the numbers of workers in what it termed “green jobs”; however, federal budget cutbacks in 2013 ceased the effort.³¹ It is useful to know how the BLS defined green jobs in designing the surveys: “(A) jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources; (B) jobs in which workers’ duties involve making their establishment’s production processes more environmentally friendly or use fewer natural resources.” The BLS also recognized sustainability-related jobs within many other categories that it regularly surveys, including management, science, engineering, accountants and auditors, business operations specialists, and compliance officers (Hamilton, 2012).

The committee conducted several searches of employment over the past decade using data compiled by Burning Glass Technologies, a firm that provides analytics about labor market patterns across the workforce. To do so, the committee drew from workshop input from employers, BLS data, and their own expertise to brainstorm keywords (e.g., sustainable development, natural resources, climate change) to launch the searches. Including the term “sustainability,” the number of jobs posted grew from about 100,000 in 2010 to 600,000 in 2020. In searches through the Burning Glass database that did not use the term, the number of jobs grew from about 50,000 in 2010 to 200,000 in 2020. Variability in how sustainability is defined and the limitations of the existing data sources indicate a clear need to better articulate what constitutes the sustainability workforce and for more detailed data about this workforce.

In addition to the data from BLS and Burning Glass, another indication about sustainability employment trends in the private sector emerges from *State of the Profession 2018 Report*, conducted by GreenBiz (2020). GreenBiz has conducted a “state-of-the-profession” survey every 2 years and has seen changes over time in how sustainability is increasingly embedded across companies.

In large companies (revenues over \$1 billion), the numbers with “one or more dedicated sustainability resources” remained roughly constant in corporate social responsibility and environmental health and safety departments, both at about 40 percent of companies (GreenBiz, 2020). However, the numbers tripled in facilities and supply chain departments—in facilities, from 7 percent of companies to 30 percent; in supply chain operations, from 10 to 49 percent. In addition, the 2018 GreenBiz survey revealed that companies’ hiring practices of sustainability professionals have recognized the value of sustainability education (GreenBiz, 2018, 22):

Ten to 15 years ago, companies exploring the opportunity to leverage sustainability as a strategic business initiative typically placed someone from inside

³¹ See Bureau of Labor Statistics Green Careers, available at <https://www.bls.gov/green/green-careers.htm>, accessed on March 12, 2020.

the organization, preferably an individual with connections and respect across the firm. Since then, we have witnessed the mainstreaming or “professionalization” of the sustainability role. Nowhere is that more apparent than in the dramatic increase in hiring from outside the company.

We also lack data on the career pathways of graduates from sustainability and environmental programs. Although some universities such as Arizona State University and Columbia University (see Boxes 2-1 and 2-2) track career trajectories of their own alumni, it is unknown how graduates from sustainability-related programs move into the workforce and whether sustainability education provides graduates a competitive advantage in hiring and career progression. To obtain more reliable information about the career pathways of sustainability graduates, future efforts by labor analysts, economists, statisticians, or other relevant experts could develop comprehensive data collection and tracking approaches similar to the National Survey of Recent College Graduates conducted by the National Center for Science and Engineering Statistics.³²

DIVERSITY, EQUITY, AND INCLUSION IN SUSTAINABILITY EDUCATION AND EMPLOYMENT

The employment figures above, combined with the changing demographics of the United States, have led to the need to strengthen diversity, equity, and inclusion in sustainability education and employment.³³ The current faculty and student populations in most interdisciplinary environmental, sustainability, and energy programs do not reflect the demographic changes under way in the country, nor do the staff and boards of employing organizations.

The committee examined research related to diversity, equity, and inclusion in sustainability education and employment to better understand the demographic gaps. As background, the U.S. Census Bureau reported that in 2020, 50.2 percent of all children under age 18 in the country identify with racial and ethnic groups that are traditionally underrepresented in science and engineering,³⁴ but in 2060,

³² See National Survey of College Graduates, available at <https://www.nsf.gov/statistics/srvygrads>, accessed on June 23, 2020.

³³ According to the D5 Coalition (www.d5coalition.org/tools/dei), *diversity* is defined “broadly to encompass the demographic mix of a specific collection of people, taking into account elements of human difference, but focusing particularly on racial and ethnic groups, LGBT populations, people with disabilities, and women.” Improving *equity* is “to promote justice, impartiality, and fairness within the procedures, processes and distribution of resources by institutions or systems.” *Inclusion* “refers to the degree to which diverse individuals are able to participate fully in the decisionmaking processes with an organization or group.”

³⁴ The National Science Foundation defines *underrepresented minorities* as comprising three racial or ethnic minority groups (Blacks, Hispanics, and American Indians or Alaska Natives) whose representation in science and engineering education or employment is smaller than their representation in the U.S. population. See NSF. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017*, Special Report NSF 17-310, available at <https://www.nsf.gov/statistics/2017/nsf17310/digest/glossary-and-key-to-acronyms>, accessed on February 7, 2020.

that same group is projected to constitute 64.4 percent of the population (Colby and Ortman, 2015). Educational institutions must be prepared to offer nurturing and inclusive learning environments for all students.

Diversity, Equity, and Inclusion Considerations in Higher Education

At this time, there has not been a survey of the racial and ethnic demographics of sustainability undergraduate and graduate students as robust as those that look more broadly at science and engineering fields. Although the interdisciplinary nature of a sustainability degree does not make the field neatly fall within a science and engineering discipline, the available data can provide some useful guideposts for sustainability given the partial overlap of disciplines.

The numbers of underrepresented minority students obtaining degrees in science and engineering fields have risen, although their percentage, as a reflection of population, remains low. By 2016, 13.7 percent of the science and engineering bachelor's degrees were obtained by Latinx students and 8.7 percent by African Americans, while less than 1 percent were earned by Native Americans or Pacific Islanders (NSF, 2019). The 2019 *Women, Minorities, and Persons with Disabilities in Science and Engineering* report from the National Science Foundation noted that the increase in science and engineering bachelor's and doctoral degrees earned by underrepresented minorities is due, in part, to the important role that minority-serving institutions, which includes historically Black colleges and universities and high-Hispanic-enrollment colleges and universities, have played in training students for bachelor's degrees. The report states that many of these students go on to earn graduate degrees in science and engineering (NSF, 2019).

Data compiled by the Higher Education Research Institute at the University of California, Los Angeles, and the National Science Foundation show that substantial percentages of students of color enter colleges and universities with the intent of majoring in science and engineering fields (HERI, 2014). For instance, in 2014, 54.2 percent of Asian, 45.1 percent of Latinx, 40.4 percent of Black, and 30.0 percent of Native American incoming freshman said they intended to major in science and engineering disciplines. These figures indicate diverse students enter these fields, but are diverted from pursuing the degrees.

While these data do not precisely mirror sustainability degree programs, they offer key insights for efforts to recruit and retain underrepresented minority students at all levels in sustainability higher education programs.

Diversity, Equity, and Inclusion Considerations in Employment

The Pew Research Center reports that increases in science, technology, engineering, and mathematics (STEM) occupations are outpacing overall job growth. Since 1990, STEM employment has increased by 79 percent, growing from 9.7 million to 17.3 million in 2017 (Funk and Parker, 2018). Women constitute

50 percent of all U.S. workers in STEM occupations, but fewer women than men occupy leadership positions in these fields. Black and Latinx employees are underrepresented in the STEM workforce. Blacks comprise 11 percent of the U.S. workforce overall but only 9 percent of STEM workers. Similarly, Latinx workers make up 16 percent of the U.S. labor force but comprise 7 percent of all STEM workers.

A sector that employs sustainability graduates is environmental nonprofit organizations. Here, research (Taylor, 2015) highlights the underrepresentation of female and minorities, especially in leadership positions. To illustrate, in 2014 women comprised 63.5 percent of the interns at environmental nonprofit organizations, but 49.7 percent of senior staff and 28.3 percent of presidents. Underrepresented minorities comprised 20.9 percent of the internships, 7.1 percent of senior staff positions, and 3.4 percent of presidents. However, a Green 2.0 survey of organizations addressing environmental and conservation issues reveals a positive trend in the representation of people of color in full-time positions and senior staff at those organizations. Data from the report revealed a slight increase in women (65 percent) and people of color (30 percent) on senior staff at environmental nonprofit organizations, suggesting some improvement in their representation over a 5-year span (Green 2.0, 2019). Continued research and analysis on the diversity of employees at organizations addressing sustainability is key to informing inclusive and equitable practices.

Within the federal workforce, according to 2018 data from the Partnership for Public Service, 57.9 percent of the 159,967 workers in sustainability-related agencies and bureaus in 2018 were males and 42.1 percent were females (see Table 2-1) (Partnership for Public Service, 2019). Between 2006 and 2018 the percentage of females and underrepresented minorities working in these agencies increased slightly.

Disparities in Sustainability Education and Employment

A large body of research has examined the issues of gender, racial, and ethnic disparities across STEM fields, including the following National Academies reports: *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads* (NAS-NAE-IOM, 2011), *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce* (NASEM, 2019), *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering* (NAS-NAE-IOM, 2007), and *To Recruit and Advance: Women Students and Faculty in Science and Engineering* (NRC, 2006). Complementing this body of knowledge, additional research provides insights into why sustainability programs may have difficulty in recruiting underrepresented minority students, with a focus on how the programs are framed and potential misperceptions about race, ethnicity, and class related to the natural world. For example, perceived interest and comfort in the natural world can influ-

TABLE 2-1 Demographic Characteristics of the Workforce of Federal Environmental Agencies: 2018

Federal Environmental Agencies	Gender						Race									
	Workforce Size in 2018		Male		Female		White		Black		Hispanic or Latinx		Asian		Native American	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Department of Agriculture (USDA)	70,310	38952	55.4	31356	44.6	50764	72.2	9070	12.9	5625	8.0	2250	3.2	1266	1.8	
Department of Commerce -- National Oceanic and Atmospheric Admin.	11,043	7410	67.1	3633	32.9	8923	80.8	928	8.4	375	3.4	568	5.4	55	0.5	
Department of Energy	13,809	8824	63.9	4985	36.1	10108	73.2	1560	11.3	984	7.2	718	5.2	166	1.2	
Department of Interior	46,476	25095	60.0	19390	40.0	35339	72.9	2812	5.8	3199	6.8	1183	2.4	4557	9.4	
Environmental Protection Agency	13,415	6453	48.4	6922	51.6	8600	65.6	2308	17.8	979	7.3	805	6.6	94	0.7	
Nuclear Regulatory Commission	2,914	1801	61.8	1113	38.2	1874	64.3	463	15.9	210	7.2	300	10.3	15	0.5	
Total	159,987	82,565	57.9	87,402	42.1	115,808	72.4	17,221	10.8	11,383	7.1	5,913	3.7	6,152	3.8	
Land and Resource Management Units																
Bureau of Land Management (Interior)	7,749	4727	61.0	3030	39.1	6292	81.2	294	3.6	690	8.9	132	1.7	147	1.9	
Bureau of Reclamation (Interior)	5,201	3552	68.3	1649	31.7	3689	76.7	172	3.3	536	10.3	182	3.5	125	2.4	
Farm Service Agency (USDA)	3,605	1417	39.3	2188	60.7	2891	80.2	382	10.6	151	4.2	65	1.8	50	1.4	
Forest Service (USDA)	23,346	14381	61.6	8965	38.4	18467	79.1	1097	4.7	2195	9.4	420	1.8	700	3.0	
National Park Service (Interior)	15,515	9668	62.3	5848	37.7	12195	78.8	1272	8.2	915	5.9	279	1.8	326	2.1	
Natural Resource Conservation Service (USDA)	9,508	5953	62.6	3566	37.5	7588	79.8	769	8.4	590	6.2	114	1.2	190	2.0	
Office of Surface Mining, Reclamation and Enforcement (Interior)	378	227	60.1	151	40.0	267	70.6	58	15.3	23	6.1	10	2.7	8	2.1	
U.S. Fish and Wildlife Service (Interior)	7,314	4381	59.9	2933	40.1	6005	82.1	329	4.5	475	6.5	168	2.3	161	2.2	
U.S. Geological Survey (Interior)	6,281	4001	63.9	2280	36.1	5397	86.2	244	3.9	263	4.2	207	3.3	50	0.8	
Total	76,878	48,305	61.2	30,591	38.8	63,091	80.0	4,548	5.9	5,638	7.4	1,577	2.0	1,758	2.2	

SOURCE: Compiled from Partnership for Public Service, 2019. *Best Places to Work in the Federal Government*. Available at <https://bestplacestowork.org>.

ence sustainability engagement, since affinity for nature is a comparable baseline from which sustainability educators can build support for campus sustainability activities, although it is necessary to acknowledge that interest in natural and environmental issues is only one of many components covered in sustainability science. It is a common practice to depict underrepresented minority students, especially Black students, as disinterested in the outdoors (Taylor, 2018a, 2019). This portrayal may occur even in programs intended to encourage participation from students who are historically underrepresented in STEM and sustainability-related fields. To illustrate, O’Connell and Holmes (2011) described what they observed as perceptions by underrepresented minority students about geosciences, interactions with the outdoors, and career aspirations. They argued that those students were less likely than White students to express interest in working on science projects in outdoor settings, and that the families of underrepresented minority students tend to be unsupportive if the student decides to major in the geosciences. In contrast, Huntoon et al. (2015) found that helping underrepresented minority students feel like they belong in geosciences programs enhances retention—especially at the doctoral level.

Several scholars have researched how college students relate to the natural world and reached varying conclusions. Virden and Walker (1999) studied 323 students at a public university and found that White and Latinx students were more likely to prefer more remote and less developed settings than Black students. Manning (2012) studied students at Southern Utah University and found that male students scored higher on a connectedness-to-nature scale than females, and urban students had higher scores on the same scale than suburban and rural students. Lakenau (2018) conducted a survey of university students and observed that an introductory ecology course enhanced students’ connectedness to nature.

Other studies of college and university students show that—regardless of race and ethnicity—many students have an affinity for nature and the outdoors (Taylor, 2018a). A recent study of 157 STEM college students found that approximately 91 percent of underrepresented minority students reported that they felt somewhat or very connected to nature. Almost all underrepresented minority students surveyed (95.4 percent of Black students, 98.6 percent of other minority students) indicated that they were either curious or very curious about nature. Another study highlighted that many students across the academy (arts, humanities, and science) are already enrolled in a range of sustainability and science courses, but with a gap by race/ethnicity. However, while 41.3 percent of White respondents indicated that they had taken at least one sustainability course, only 16.3 percent of Black students and 21.2 percent of other underrepresented minority students had taken courses of this nature (Taylor, 2018b).

Another line of research revealed that underrepresented minority students express a strong interest in working in the sustainability/environmental workforce. As shown in Table 2-2, in a study analyzing data from 157 students, more than three-quarters of Black and other minority students surveyed expressed a

TABLE 2-2 Interest in Working in the Environmental Field Upon Graduation

Area of the Environmental Workforce	Percent who are Somewhat or Very Interested in Working in Organizations					Mean Score (Range = 1-5)				
	Total Sample	White	Black	Minorities	Other	Total Sample	White	Black	Minorities	Other
	Federal government environmental agency, e.g., U.S. Fish and Wildlife Service	81.7	86.7	76.2	81.8	4.18	4.24	4.10	4.20	4.20
State departments of natural resources	78.6	86.9	76.2	74.2	4.06	4.17	4.05	4.00	4.00	
Environmental think tank, e.g., Rocky Mountain Institute, Env. Policy Institute	77.9	76.1	73.9	81.8	4.07	4.04	4.05	4.11	4.11	
Academic institution as research scientist, etc.	77.3	76.1	76.2	78.8	4.05	4.07	4.07	4.02	4.02	
Environmental nonprofit, e.g., Audubon Society, National Wildlife Federation	74.5	82.6	68.3	72.8	3.97	4.17	3.83	3.92	3.92	
Professional conservation association, e.g., Ecological Society of America	73.4	80.4	54.7	80.3	3.94	4.13	3.62	4.02	4.02	
Environmental justice organization, e.g., We Act	65.6	54.3	71.4	69.7	3.87	3.72	4.00	3.89	3.89	
Environmental education center	64.5	69.2	63.4	63.1	3.64	3.64	3.68	3.62	3.62	
Nature center	63.7	74.1	57.1	60.6	3.75	3.91	3.62	3.71	3.71	
Environmental grantmaking foundation, e.g., Alaska Conservation Foundation	61.0	67.4	59.5	57.5	3.64	3.80	3.64	3.53	3.53	
Parks	55.2	65.2	50.0	51.6	3.49	3.65	3.33	3.47	3.47	
Botanical garden or arboretum	53.3	54.3	47.6	56.1	3.5	3.54	3.36	3.56	3.56	
Museum focusing on conservation or natural history	53.2	60.9	42.9	54.6	3.22	3.35	3.02	3.26	3.26	
Zoo or Aquarium	50.7	58.7	38.0	53.0	3.24	3.54	2.83	3.29	3.29	

SOURCE: Taylor, 2018b

desire to work in federal environmental agencies upon graduation; similar high percentages reported interest in working in state departments of natural resources; and 73.9 percent of Black students and 81.8 percent of other students of color expressed interest in working for environmental think tanks. Additionally, more than two-thirds of underrepresented minority students indicated a desire to work in environmental nonprofits, while roughly 60 percent said they would like to work in nature centers (Taylor, 2018b).

Despite this interest, the data from government and nonprofit organizations discussed above show a small percentage of underrepresented minority employees, and the numbers decrease with the level of seniority (Taylor, 2018b). Reasons for this disconnect as identified by underrepresented minority students include what they see in that workforce (Taylor, 2018b, 165): “The potential for upward mobility in an organization and the diversity-related institutional infrastructure are key factors that minority students in this study are looking for in environmental organizations when it comes time to decide where they will work.” Improving diversity in sustainability-related employment will remain a challenge if these misgivings about career progression are not addressed systematically.

ORGANIZATIONS ENGAGED IN SUSTAINABILITY EDUCATION

In gathering input for this report, the committee heard remarks from representatives of sustainability councils, associations, alliances, and other organizations. As recognized by Dyer and Dyer (2017) when reviewing the efforts of the American College and University Presidents Climate Commitment related to climate change, higher education administration and faculty are recognizing the value in collaborating with external organizations to share visions and best practices for advising sustainability education. Several organizations that provided input or were discussed at the committee’s public workshops are highlighted below; however, the committee recognizes that this list may be representative of the number and range of organizations engaged in sustainability education.

Founded in 2005 as a group of higher education associations to advance sustainability, the Association for the Advancement of Sustainability in Higher Education includes administrators, faculty, staff, and students. AASHE offers continuing education and a self-reporting metric for colleges and universities to measure their sustainability performance, known as the Sustainability Tracking, Assessment, and Rating System. AASHE also supports member efforts to integrate sustainability into teaching, operations, and research.

The National Council for Science and the Environment, as noted earlier in this chapter, conducts a census of programs that includes sustainability, and it is developing a consensus statement of core competencies. Within NCSE, the Alliance of Sustainability and Environmental Academic Leaders provides input and perspectives to the larger council.

The purpose of the Sustainability Curriculum Consortium is to build “collective capacity as educators and change agents, along with the administrators and stakeholders who can support them, to improve the ways sustainability is perceived, modeled, and taught.”³⁵ It aligns its activities, especially through its webinars, around three key themes in sustainability education: pedagogy, substantive content, and leadership.

The U.S. Partnership for Education for Sustainable Development takes a broad look at sustainability education, from K–12 to higher education to communities of faith and other organizations outside the academy. Along with AASHE, it coordinates the Disciplinary Associations Network for Sustainability, which aims to advance sustainability within other fields of study (physics, business, and history, to name but a few).

The Alliance for Sustainability Leadership in Education has more than 300 institutional members in the United Kingdom and Ireland. The Association of University Leaders for a Sustainable Future serves as the secretariat for signatories of the Talloires Declaration.

These organizations represent a broad collection of efforts to engage higher education programs to advance sustainability goals, often doing so by convening their members through conferences and webinars. By providing frameworks for sustainability performance, resources for education and community engagement, and professional development and networking opportunities, these organizations are valuable partners for initiatives to strengthen sustainability programs in higher education.

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³⁵ For more information, see <https://curriculumforsustainability.org/about-us>, accessed on March 12, 2020.

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3

Strengthening Sustainability Programs

Academic institutions play a critical role in meeting Earth’s sustainability challenges, with the potential—and imperative—to have a larger impact in the years to come. As described in Chapter 2, U.S. colleges and universities currently offer a variety of sustainability programs within a range of institutional arrangements. Workshop participants reflected this variety: they represented faculty, administrators, and undergraduate/graduate students from private colleges and state universities who were connected with discrete schools of sustainability or those within larger science, engineering, or social science units. Many noted the need to introduce sustainability concepts to students majoring/minoring in the field and also to those in other disciplines. Some students matriculate with plans to major or minor in the field, while others discover it when they get to campus. With interest high among current and incoming students and the ever-increasing need to balance societal trajectories between the *lower* bounds for human well-being and the *upper* environmental planetary boundaries, many higher education institutions are looking to create or expand their sustainability education programs and offerings.

INSTITUTION-WIDE CONSIDERATIONS

A symposium convened through the American Association for the Advancement of Science in 2015 took an institution-wide view of the successful design and implementation of sustainability programs (Hart et al., 2016). Five broad parameters, echoed in different ways by the symposium participants, provide a starting point from which to consider the specifics of what a sustainability pro-

gram could offer. These parameters articulated by symposium participants are summarized as follows:

1. Universities must realize that emphasizing solutions is essential when studying sustainability problems.
2. Building effective interdisciplinary collaborations in sustainability programs is challenging but must start early.
3. Academic efforts will be misaligned, misallocated, and mistaken in the absence of productive stakeholder partnerships.
4. The path to solutions requires innovation, risk tolerance, and persistence.
5. Universities must apply their research strengths to examine institutional initiatives and develop evidence-based principles to guide institutional transformation.

A common theme across these parameters is that leadership and support from the top is key—by university presidents, chancellors, deans, directors, and boards. Leadership commitment to sustainability can facilitate the interdisciplinary collaboration so vital to the field; provide resources, including support for underrepresented minority groups; and encourage innovation (Gordon et al., 2019; Boone et al., 2020).

Although many higher education institutions are looking to create or expand their sustainability programs, they often lack a clearly articulated statement about how they will deliver on that goal. The importance of support from top leadership and the growing interest in sustainability-related curricular offerings in higher education institutions leads the committee to three key areas of focus for sustainability education: competencies, content, and contextual application. The remainder of this chapter covers these aspects in greater detail.

COMPETENCIES AND CAPACITIES FOR SUSTAINABILITY EDUCATION

The growth in sustainability programs at colleges and universities and the demand for graduates of these programs has led to concerted efforts to define the key competencies that sustainability graduates should acquire. The effort aligns with broader work to define competencies for 21st century learning. Recent work has also begun to highlight the importance of collective capacities that may enable sustainability transitions. It is imperative for learners to acquire both individually focused competencies through higher education coursework and curricula, and work toward the organizational and societal capacities necessary for sustainability pathways.

Wiek et al. (2011, 204) define *competencies* as “a functionally linked complex of knowledge, skills and attitudes that enable successful task performance and problem solving.” Within this definition, different fields have defined core competencies or program-learning outcomes that students should have after com-

pleting their programs of studies. Different researchers and organizations have identified at least eight key competencies as critical to advance sustainability: systems thinking competency, anticipatory competency, normative competency, strategic competency, collaboration competency, critical thinking competency, self-awareness competency, and integrated problem-solving competency (de Haan, 2010; Rieckmann, 2012; UNESCO, 2017; Wiek et al., 2011).

As competencies for sustainability reference the forms of awareness, knowledge, and learning necessary for students to acquire and act, a related review by Clark and Harley (2020) highlights collective and organizational capacities necessary for transitions toward greater sustainability. *Capacity* here refers to the intention, ability, and competence to act effectively (Franks, 1999; van Kerkhoff and Lebel, 2015; Clark et al., 2016), and in this sense is complementary to sustainability competencies, which focus more on needs for individual learners. Together, they can prepare learners to achieve transitions toward greater sustainability more effectively.

Clark and Harley (2020) identify seven critical capacities. They view them as collectively being likely necessary, but not sufficient, for more sustainable social-ecological trajectories of change. The seven organizational capacities are (1) the capacity to integrate research across disciplines, (2) the capacity to measure sustainable development, (3) the capacity to promote equity, (4) the capacity to adapt to shocks and surprises, (5) the capacity to transform the system onto more sustainable development pathways, (6) the capacity to link knowledge with action, and (7) the capacity to devise governance arrangements that allow people to work together in exercising the other capacities.

The authors identify the key characteristic of the contemporary global system as the intertwining of nature and society and focus on heterogeneity, nonlinearity, accumulation of power, and inequality. Based on this diagnosis, they suggest that pathways toward sustainable development are difficult to predict and require iterative strategies that combine thinking and doing. Such iterative strategies need to be dynamic, adaptive, and reflexive.

Explicitly defining competencies and capacities for sustainability higher education programs can strengthen their design, implementation, and outcomes. Helping learners strengthen their competencies for societal transitions can enable more effective societal sustainability outcomes. We accordingly discuss several frameworks that developers and leaders of sustainability education programs can draw upon as their institutional needs and strengths allow so as to incorporate the competencies and capacities needed for stronger sustainability education.

A number of studies describe the competencies needed for 21st century learners. The competency framework known as the Partnership for 21st Century Learning, or P21, highlights problem-based, cooperative, and experiential learning, with a special focus on information and communication technologies.¹ The

¹ See Partnership for 21st Century Learning (P21), available at <http://www.battelleforkids.org/networks/p21>, accessed on March 11, 2020.

Association of American Colleges and Universities has organized its framework around a set of “essential learning outcomes” in four broad areas: (1) knowledge of human cultures and the physical and natural world, (2) intellectual and practical skills, (3) personal and social responsibility, and (4) integrative and applied learning.² The National Research Council (NRC, 2012) defined cognitive, interpersonal, and intrapersonal competencies: *Cognitive* competencies include the knowledge base of a given field, as well as critical thinking, analysis and problem-solving, spatial skills, and creativity. *Interpersonal* competencies include leadership, collaboration, communication, and teamwork. *Intrapersonal* competencies include intellectual openness (e.g., adaptability, cultural awareness, curiosity, responsibility), work ethic/conscientiousness, and self-regulation and stability.

In 2018, the National Academies of Sciences, Engineering, and Medicine developed a science, technology, engineering, and mathematics, or STEM, education framework for K–16. It does not explicitly mention sustainability, but it characterizes service or community-based learning, a hallmark of sustainability education, as a “high-impact practice” (NASEM, 2018). Sustainability education includes the arts, humanities, business, policy, and other knowledge domains in addition to STEM subjects.

A substantive effort to describe competencies for sustainability education was conducted by the United Nations Economic Commission for Europe Steering Committee on Education for Sustainable Development (UNECE, 2012). In their report, the Steering Committee described the type of learning inherent in education for sustainable development and tied these principles to five broad competencies: (1) learning to know (a way of thinking), (2) learning to be (a way of being), (3) learning to live together (a way of co-existing), (4) learning to do (a way of acting), and (5) learning to transform oneself and society. Education for sustainable development connects each of these competencies (learning to know, be, live together, do, and transform) with more specific outcomes for educators related to a holistic approach, envisioning change, and achieving transformation. The resulting framework lists these outcomes as “Competencies for Educators in Education for Sustainable Development,” which can serve as a useful reference for pedagogy (UNECE, 2012, 13).

Focusing more specifically on the field of sustainability, Evans (2019) suggests a set of five competencies: (1) systems competency, (2) critical and normative competency, (3) interpersonal and communication competency, (4) creative and strategic competency, and (5) transdisciplinary competency. In a different study, Eizaguirre et al. (2019) determines key sustainability core competencies by considering three different geographical regions (Europe, Latin America, and Central Asia) and the perspective of four different stakeholder groups (graduates,

² See Association of American Colleges and Universities, “Essential Learning Outcomes,” available at <https://www.aacu.org/leap/essential-learning-outcomes>, accessed on March 11, 2020.

employers, students, and academics). Their assessment of stakeholder responses relies on exploratory factor analysis. They suggest factors related to sustainability include competencies such as commitment to the preservation of the environment, ability to act with social responsibility, and appreciation of and respect for diversity and multiculturalism, among others.

During the committee's workshop in February 2019, Rod Parnell of Northern Arizona University and the National Council for Science and the Environment described Wiek et al. (2011) as most widely read, best synthesized, and most cited framework for sustainability competencies (Parnell and Brundiers, 2019). In the research and problem-solving framework illustrated below (see Figure 3-1), Wiek et al. (2011) "embrace the convergence that sustainability education should enable students to analyze and solve sustainability problems, to anticipate and prepare for future sustainability challenges, as well as to create and seize opportunities for sustainability." Fundamental to this strategy is teaching students the skills to develop scenarios of desired, plausible futures; to explore strategies or interventions to get there; and to make sure those transitions are effective and equitable. The interventions must be created with sufficient knowledge of the complex socio-ecological-technical systems dynamics both past and present that can define the problem, constrain or open possible interventions, and shape the direction and magnitude of the interventions. Scenario development should also explore the implications of maintaining the status quo (counterfactual) not only to understand the relative merits, or demerits, of interventions, but also to define the urgency and consequences of the problem or issue (e.g., fossil fuel use and climate change) under study. All stages depend on the ability of students to effectively engage with stakeholders and seek collaborative strategies that allow for effective and equitable decisions.

Wiek et al. (2011) point to five core competencies in sustainability education that can be linked to the framework and to each other (see Figure 3-2):

- *Systems thinking competence*: the ability to collectively analyze complex systems across different domains and across different scales, thereby considering cascading effects, inertia, feedback loops, and other systemic features. Educators and employers at the committee's workshops repeatedly returned to the need for systems thinking as a key competency for sustainability students. Students need to understand that different disciplines that researchers integrate to address a given sustainability challenge use different research methods—each with different strengths and weaknesses. Identifying synergistic combinations of different methods from different disciplines is a major part of the "art" of sustainability research.
- *Anticipatory competence*: the ability to collectively analyze, evaluate, and craft rich "pictures" of the future related to sustainability issues and sustainability problem-solving frameworks. Decision science in the face of uncertainty is a key competency. These skills are tailored to address

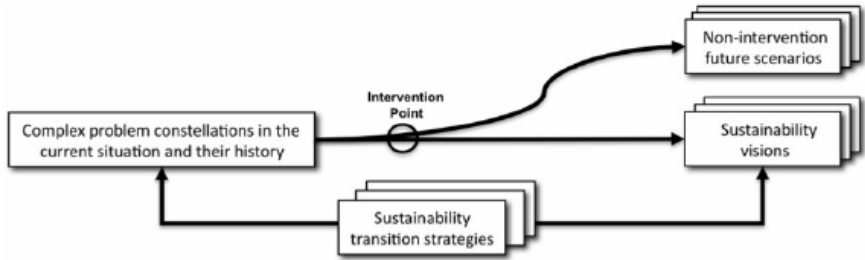


FIGURE 3-1 Integrated sustainability research and problem-solving framework. SOURCE: Wiek et al., 2011. Reprinted with permission from Springer Nature.

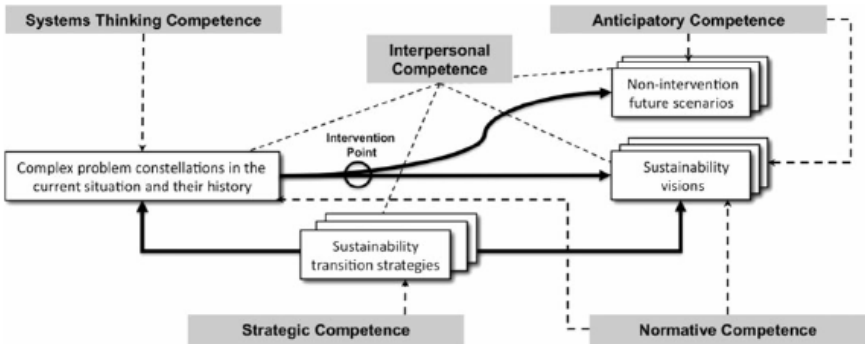


FIGURE 3-2 The five key competencies in sustainability (shaded in grey) as they are linked to a sustainability research and problem-solving framework described in Figure 3-1. SOURCE: Wiek et al., 2011. Reprinted with permission from Springer Nature.

key issues of sustainability, including unintended harmful consequences and intergenerational equity.

- *Normative competence*: the ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets. This involves applying ethical principles to available alternatives and embracing the value that sustainability is an inclusive goal involving individual, societal, and environmental well-being. It also recognizes that values guide behavior, which must be incorporated into developing effective sustainability strategies.
- *Strategic competence*: the ability to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability. Students need to understand theory of change approaches

that focus on implementing solutions that have a high potential to scale up, as well as community-led design.

- *Interpersonal competence*: the ability to motivate, engage, and facilitate collaborative and participatory sustainable research and problem-solving. Workshop participants considered this a critical competence, and several objected to ascribing this competency with the descriptor of “soft skill.” Many discussed the need for conflict management, leadership, teamwork, and inclusiveness.

While critical to sustainability, the competencies are also deliberately general because of the inherent breadth of foci across different sustainability programs. Thus, developing learning activities to impart the competencies becomes the task of specific programs.

An iterative Delphi study engaging 14 international experts in sustainability education have extended the original Wiek et al. (2011) framework to include an implementation competency and an intrapersonal competency or mindset as additional key sustainability competencies (Brundiens et al., 2020). Given the solutions-orientation of sustainability higher education, the expert panel argued that knowing how to successfully implement interventions is a fundamental skill. The addition of an implementation competency begins to highlight the importance of collective and organizational capacities to sustainability higher education, and makes the complementarity between competencies and capacities more visible.

The intrapersonal competency or self-awareness competency is the ability to “be aware of one’s own emotions, desires, thoughts, behaviors, and personality, as well as to regulate, motivate, and continually improve oneself drawing on competencies related to emotional intelligence” (Brundiens et al., 2020). The intrapersonal competency allows students to be self-aware and position themselves in relation to others, which is critical for effective and empathetic stakeholder engagement.

Sustainability competencies identified in the different sustainability education research efforts align well with each other. Given the range of key competencies relevant to sustainability education, no single learner can expect to become an expert across the suite of competencies. This basic fact highlights the importance of both specialization and collaboration in sustainability education and practice. Future research on sustainability education needs to assess the pattern of evolution and degree of convergence among different sustainability educators about core competencies and their relationship with capacities as the field matures.

Without referring explicitly to different competency frameworks (e.g., Evans, 2019), many participants at the workshops conducted by the committee reflected similar themes. For example, one student participant considered the collaboration required across her courses as a valuable aspect of her sustainability education, while a faculty participant described designing projects that, among other things,

require students to master the strategic competence described above. End users, or employers, echoed the need for mastery of these competencies. For example, one employer said he hired staff members who can “connect the dots,” while another participant said she needed staff members who understand how to work with people with different values and points of view, so that they “check their righteousness at the door to come up with solutions.” As part of the interpersonal competence described above, change management and leadership skills are increasingly important for sustainability professionals (see Chapter 5).

Identifying core competencies for sustainability education can serve students, institutions, and the community, including employers. Wiek et al. (2011, 204) note that key competencies “provide the reference scheme for transparently evaluating student learning and teaching effectiveness,” as well as serve as a “critical reference point for developing the ambitious knowledge and skill profile of students expected to be future ‘problem solvers,’ ‘change agents,’ and ‘transition managers.’” Specifically, defining core competencies in sustainability education can serve the following purposes:

- To describe how activities in sustainability programs relate to larger frameworks, including the university as a whole in its goals for general education and to the United Nations Sustainable Development Goals (SDGs) and other sustainability frameworks.
- To guide efforts of sustainability educators in identifying learning outcomes and foci of assessments.
- To differentiate sustainability graduates from other interdisciplinary and transdisciplinary programs.
- To prepare students for careers in sustainability and to be change agents for sustainability.
- To reflect the demands of industry for university graduates.
- To conduct sustainability research as graduate students.

Higher education sustainability programs that infuse their curricula with clear competency and capacity goals facilitate a shared understanding among educators, students, potential employers, and program evaluators of the intended outcomes by making these goals explicit. Thus, the committee makes the following recommendation to strengthen sustainability programs:

Recommendation 3.1: Academic institutions of higher education should embrace sustainability education as a vital field that requires specifically tailored educational experiences and the development of core sustainability-focused competencies and capacities delivered through courses, majors, minors, certifications, research, and graduate degrees in sustainability.

Implementation of this recommendation does not imply a specific curriculum or course sequence. Rather, students should engage in inclusive curricula that enable acquisition of knowledge and fluency in key core competencies, develop areas of content knowledge to the appropriate levels of breadth and depth, and have the opportunities to gain experience that helps them apply knowledge from courses in social and organizational contexts for practical insights.

CONTENT AREAS IN SUSTAINABILITY EDUCATION

In addition to learning competencies, the committee sought to understand the content knowledge sustainability students need to learn at the undergraduate and graduate levels. Workshop participants, a review of existing programs, and committee members' own experience suggested a range of topics that are needed to understand and address 21st century sustainability challenges. The 17 UN SDGs, which address multiple dimensions of human well-being and environmental integrity, make clear that a broad range of knowledge and skills is required to solve urgent, complex problems and develop enduring solutions at global scales. As an indication of the relevant range of expertise, sustainability programs grant bachelor's degrees of arts, science, engineering, design, business administration, and other fields at the undergraduate level, with a similar diversity at the master's and doctorate levels. The range of expertise and content areas of sustainability higher education programs will also likely change over time given the ongoing rapid evolution of the sustainability field.

Similar to other interdisciplinary offerings in higher education, sustainability programs have to grapple with the question of how to balance content depth versus breadth (Pennington et al., 2020). Typically, depth in college and university programs is associated with demonstrated expertise in specific kinds of knowledge, often defined by longstanding academic disciplines (e.g., economics, biology, history). Depth can also be defined and demonstrated by mastery of specific methods (e.g., econometrics, systems modeling, spatial analysis), or forms of professional practice (e.g., architecture, accounting, surveying). Breadth is usually supported in colleges and universities by having students take courses beyond a disciplinary major that are linked thematically, often defined by general education requirements (e.g., critical thinking, literary, numeracy), to offer alternate epistemologies, viewpoints, and perspectives and to make students more "well rounded." Breadth is also the demonstrated ability to link and synthesize different content knowledge and build a coherent framework to better comprehend the world. Students who have breadth strengths should be able to bridge disciplines and act as translators between experts with deep content knowledge in a specific field (Ashby and Exter, 2019). Broad interdisciplinary training is effective when learning is problem based or solutions oriented and relies on collaboration (Brassler and Dettmers, 2017).

Necessary content and depth and breadth of understanding depend in part

on the nature of sustainability programs. Degrees in sustainability typically focus on the integration of broad sets of content areas (breadth as strength), while degrees that incorporate sustainability into existing disciplines, such as sustainable engineering, require a strong emphasis on core content (depth as strength) but learned through a sustainability lens. At the graduate level, sustainability programs, which may engage students from a variety of undergraduate disciplines, have to provide a foundational understanding of sustainability principles, competencies, and capacities, but the expectation is for students to develop depth in specific content, methods, or approaches (including depth in specific competencies and capacities). For graduate programs where sustainability is an adjective to a defined discipline (e.g., sustainable architecture), depth in that discipline is expected, while sustainability can serve as a research problem framework. Figure 3-3 describes possible and approximate distribution of depth and breadth requirements for sustainability offerings based on program design (sustainability as focal discipline or as additive to another discipline) and graduate versus undergraduate levels. All programs should provide a basic understanding of sustainability frameworks, key competencies, and capacities, and embrace interdisciplinary models of learning and inquiry. Figure 3-3 is a schema that can be used as a guide to developing sustainability curricula that reflect both breadth and depth, but there is no single approach or framework that is suitable for all programs and institutions.

SUSTAINABILITY BREADTH AND DEPTH

Interdisciplinarity, sustainability frameworks, key competencies and capacities

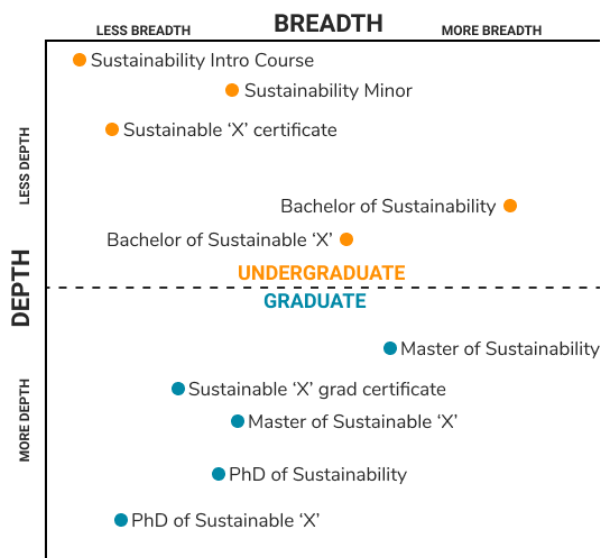


FIGURE 3-3 Schema for possible distribution of requirements for breadth and depth.
SOURCE: Committee generated.

Of necessity, students in sustainability programs must choose among many important sustainability concepts and skills with the limitations on time and resources. Indeed, even sustainability programs may need to specialize in specific knowledge areas because sustainability connects in important ways to a vast domain of knowledge and practice. One gap identified by workshop participants is the lack of assessment about which specific knowledge areas lead to the greatest success for the graduates, their employers, and ultimately for larger society-wide sustainability goals such as the SDGs. A suggestion from several workshop participants would be to conduct a survey along the lines of the National Science Foundation's survey of Ph.D.s or a survey of graduates 5 years out of school to understand which content areas are serving them best in their research and practice. The need for this kind of data is also discussed in Chapter 4 as part of an agenda for research on sustainability education programs.

Educators and end users at the workshops shared key perspectives on valued skills in sustainability. For example, an employer at the Austin, Texas, workshop valued systems thinking and analytical skills, but also urged students to learn the history and context of sustainability while in school. This topic is rarely taught in the workplace, she noted, "in the rush to find solutions."

Considering the many advances in technology, several workshop participants noted that sustainability learners need to know data analytics, including working with big data and artificial intelligence. They do not need to be experts, one workshop participant pointed out, but they need to understand the capabilities and have the language to interact with experts. Another participant suggested that students should become familiar with data analysis tools and their application to diagnosing problems and developing effective solutions for sustainability goals. At the same time, workshop participants noted that students should understand the need for transparency and the ethical dimensions of artificial intelligence and other technologies, so that "major social and cultural problems are not reinforced."

A recurring workshop theme was the need to embed ethics and social justice in all courses, for determining course content and for determining which voices are at the table, who is setting up and teaching a program, and whose needs are being addressed. As discussed elsewhere in this report, identifying and understanding structural racism and discrimination, as well as the impact of varying socioeconomic backgrounds and differential access to essential human services, is essential to developing effective sustainability strategies and solutions. Several workshop participants agreed sustainability actions should authentically prioritize and integrate Indigenous and intergenerational knowledge and culture for sustained impact.

Another workshop participant recommended the teaching of sustainability principles as a core institutional requirement, no matter a student's area of specialization, since "every student will have to deal with sustainability in his or her lifetime." Examples of universities that have recently added a core requirement, typically from a wide range of course options (e.g., Sustainability Science, En-

vironmental Sociology, Environmental Engineering Capstone Design), include the following:

- Dickinson College, Pennsylvania: requires students to take one course coded either as sustainability connections or sustainability investigation.³
- Pacific University, Oregon: requires students to complete a course from an approved list or conduct a project approved by its Center for a Sustainable Society.⁴
- University of California, Merced: requires students to fulfill a sustainability “intellectual experience badge” by completing one course or co-curricular from an approved list.⁵

When asked about gaps in their education, several student panelists at the Santa Cruz, California, workshop remarked on the potential trade-offs of breadth versus depth in content areas. One panelist reported that she was discouraged from taking science classes at her undergraduate institution because the introductory courses were, in her view, “set up to weed out students from pre-med.” Another panelist said she consciously avoided business classes, only to find after graduation that she wished she decided otherwise given the utility of various business skills for many positions in sustainability.

While beyond the scope of this report, some participants cited lifelong learning, continuing education, and executive education as strategies to provide sustainability concepts to those already in the workforce. When one workshop participant wondered whether an executive education degree would cannibalize longer, more traditional programs, an administrator whose sustainability program offers both types of programs said they appeal to different audiences and do not detract from either one.

Workshop participants discussed the need to adapt courses to focus on thematic issues, such as ecosystems and climate change, supply chain evaluation, and corporate social responsibility. As described in the proposed Higher Education Sustainability Act of 2019 (S. 2928), participants noted it would be useful for students to understand practical applications of sustainability, including “energy management, greenhouse gas emissions reductions, green building, waste management, transportation, resilience, green workforce, and other aspects of sustainability that integrate the local community with multidisciplinary academic

³ See Dickinson College’s requirements for degrees, available at https://www.dickinson.edu/info/20184/academic_offices_and_resources/2945/requirements_for_the_degree, accessed on March 11, 2020.

⁴ See Pacific University, Oregon, sustainability requirement, available at <https://www.pacificu.edu/academics/academic-resources/core-requirements/sustainability-requirement>, accessed on March 11, 2020.

⁵ See University of California, Merced, sustainability requirement, available at <https://ge.ucmerced.edu/requirements#Badges>, accessed on March 11, 2020.

programs and are applicable to the private and government sectors.”⁶ Additional information related to the legislation is described in Chapter 4.

The curricula in current sustainability programs encompass a wide range of content matter, and we cannot expect students to become experts in all areas. While some students will prefer to gain knowledge about a broad number of topics in sustainability, others will prefer to specialize in more targeted areas. In both cases, sustainability students and graduates will need to collaborate with others to address sustainability challenges, which can be more easily achieved if students have a baseline understanding of various content areas relevant to sustainability, including the history of sustainability, ethics and social justice, data analytics, business administration, sustainability science, and Indigenous knowledge and culture. Students would also benefit from an understanding of relevant sustainability frameworks, including the SDGs, through which their sustainability activities may support or inform. Therefore, the committee makes the following recommendation:

Recommendation 3.2: Sustainability curricula and programs in higher education should encompass key and emerging sustainability content areas to prepare students to address complex sustainability challenges in a real-world setting while incorporating problem-based and solution-oriented approaches to sustainability.

CONTEXTS AND APPLICATIONS OF SUSTAINABILITY EDUCATION

Competencies and capacities are essential elements in curriculum design. The curricula offered to students in sustainability education programs should explicitly develop relevant, clearly defined competencies and how they relate to the coursework included in the curriculum. Through scaffolding, students can learn basic concepts and skills in their early courses and then progress to more advanced concepts and applications (Lipscomb et al., 2010). Students should apply classroom learning to real-world problems to see links and build syntheses across subject matter, make inferences based on evidence and experience, envision solutions to sustainability challenges, and reflect on their role with collaborators in implementing these solutions.

Students need to understand and navigate trade-offs and conflicts and take advantage of synergies and co-benefits when attempting to achieve societal and organizational sustainability goals, whether in focusing explicitly on the SDGs, trying to achieve a “socially just and environmentally safe space” in the Doughnut framework, or implementing interventions to enhance other socioeconomic and environmental sustainability objectives.

⁶ Higher Education Sustainability Act of 2019, S.2928, 116th Congress (2019–2020), available at <https://www.congress.gov/116/bills/s2928/BILLS-116s2928is.xml>, accessed on June 8, 2020.

Sustainability Contexts

The 1990 Talloires Declaration (see Chapter 2) called for educational strategies that strengthened environmental literacy, collaboration for interdisciplinary approaches, and awareness of environmentally sustainable development. Over the last three decades, interdisciplinary environmental and sustainability education programs have continued to evolve and grow in the United States (see Chapter 2). The first higher education school of sustainability opened at Arizona State University in 2006 (see Box 2-2 in Chapter 2). In the past 15 years, sustainability programs have begun to offer courses, research, and other opportunities to help students understand the constructs of the natural environment and ecosphere, the human and social environment, the built environment, the intersections and interdependencies between these environments, and the implications for sustainable development.

Balancing competing needs and perspectives through well-grounded analysis is an essential component of sustainability education. Calling for change without understanding the trade-offs can compromise sustainability efforts. Students need to understand how institutions, policies, and programs drive the types and rates of resource utilization to satisfy human needs and wants. Additionally, they need to understand that capacity for effective partnerships between science and governance to address sustainability challenges is affected by “history, experience, and perceptions; quality of relationships (especially in suboptimal settings); disjunct across scales; power, interests, and legitimacy; and alternative pathways for environmental governance” (van Kerkhoff and Lebel, 2015). They should see that inequality in social structures affects access to services, political representation, and the distribution of benefits, costs, and risks and should understand that how these inequalities mandate deliberate steps to ensure diversity, equity, and inclusivity is central to successful sustainability solutions (Raworth, 2017).

Abson et al. (2017) sought to identify leverage points for influential sustainability efforts and noted that how knowledge is produced matters. They argue that an understanding of the following knowledge aspects is necessary for addressing sustainability challenges:

- How knowledge is compiled and integrated.
- Whose knowledge is legitimized and counts and to what extent.
- Who decides the criteria that are used to assess the available knowledge.
- Which formats of knowledge production at the science–society interface are most adequate for specific contexts and most promising to really fostering transformational change in practice.
- How knowledge produced in a specific context can be generalized or transferred to other contexts.
- How the kind of knowledge that is needed in any given situation is identified.

In sustainability programs, students need to understand and be able to judge and act critically to balance different approaches, particularly when prioritizing human and social development creates tension with environmental goals. For instance, students should understand how the built environment is shaped by the requirement of services and infrastructure to meet human needs and wants, and that these services affect the natural environment and ecosphere. Indeed, this is one example of the importance of knowing how to identify and work with the interactions between the SDGs (Nilsson et al., 2016; Pradhan et al., 2017).

The global policy context for sustainable development is an integral part of sustainability higher education programs, including the United Nations 2030 Agenda; the United Nations Framework Convention on Climate Change and Community of Practice structure; and reporting norms such as the Carbon Disclosure Project and the Environmental, Social, and Governance factors for evaluating sustainable finance.

The information gathered from workshop participants and the literature suggest that students need to understand the implications of global differences in national incomes, endowments of natural resources, current standards of living, and trade-offs between the economic North and South necessary to achieve and sustain progress on global sustainability.

EXPERIENTIAL LEARNING

Experiential education provides learners with the relevant experiences—internships, capstones, practicums, problem- or solutions-focused research, and other opportunities in a real-world setting—that strengthen and revise concepts and knowledge acquired in the classroom (Eyler, 2009). The benefits include a deeper understanding of subject matter, the capacity for critical thinking, application of knowledge in complex or ambiguous situations, and recognition of the value of lifelong learning, including learning in the workplace. Experiential education encourages students to apply their learning, and it should include an element of reflection on those experiences (Aktas, 2015; Domask, 2007).

Many sustainability education programs already offer experiential learning opportunities, such as the Coastal Science and Policy Program at the University of California, Santa Cruz (see Box 3-1). Workshop participants stressed the value of experiential education for their students, and students also identified “immersive experiential learning” as a valuable aspect of their education.

Experiential learning in sustainability takes place in U.S. communities (often near institutions) and other countries; in private, government, or nonprofit organizations; and on the university campus itself. Students may embed themselves in a local transportation agency, a global corporation, an organic farm, a school, a social justice nonprofit—the possibilities are nearly limitless. Several participants, including faculty, students, and alumni, said their students had even started or maintained sustainable businesses. Some innovation competitions and

BOX 3-1
Curricula That Emphasize Experiential Learning
Coastal Science and Policy Program (UCSC)

Experiential learning via a year-long capstone project is the heart of the graduate program in Coastal Science and Policy (CSP), begun in fall 2018 at the University of California, Santa Cruz.^a The interdisciplinary curriculum prepares students to become more effective leaders in solving coastal sustainability challenges, from watersheds to the open ocean.

The first year of a 2-year M.S. degree involves interdisciplinary coursework and a capstone planning seminar wherein students apply theory-of-change principles (Abson et al., 2017; Meadows, 1999) and methods (e.g., design for impact at scale^b) to plan a path to a scalable solution for each student's chosen challenge. Students write individual capstone plans that pursue early steps in their theory-of-change path and co-design the project with a partner organization from the non-profit, private, or governmental sector, guided by faculty advisors and peer review.

In the second year, each student conducts the capstone project immersed with the partner organization and advised by a partner mentor, faculty advisor, CSP program leadership, and (often) informal advisors. Students dial in from around the world into a weekly video-linked capstone seminar with their cohort and faculty instructor. This boundary-spanning system of mentoring and peer review facilitates real-time learning, ongoing reflection, and project adjustments. Students submit and present a final capstone report on deliverables to satisfy degree requirements. A new Ph.D.-designated emphasis in CSP allows Ph.D. students majoring in other fields to conduct capstone-like research immersed with a nonacademic partner for one dissertation chapter.

As of February 2020, the CSP program matriculated young leaders from 12 nations, pursuing capstone projects with start-up companies, governments, small to large conservation nongovernmental organizations, and consulting firms. The first cohort has conducted capstones on opportunities such as producing biodegradable plastic from food waste on the Google campus, building the coastal resilience capacity of Grenada by integrating coastal vulnerability assessment into the nation's coastal zone management plan,^c and strengthening community co-management of fish conservation zones in the Mekong River.^d

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^a See <https://csp.ucsc.edu>.

^b See <https://mulagofoundation.org/stuff/design-for-impact-at-scale>.

^c See <https://csp.ucsc.edu/people/current-students>.

^d See <https://fishbio.com/news/mekong-basin-dams-pose-danger-experts>.

accelerators for social enterprises encourage or specifically target higher education students with sustainability foci, such as the Ellen MacArthur Foundation's Circular Economy Programme and Pioneers, the Sustainable Ocean Alliance's Oceans Solution Accelerator, and the Bridge Spark Fund.⁷ Some workshop participants highlighted the excitement generated by the maker movement that lets students apply educational concepts through the creation and sale of products.

Many institutions offer experiential opportunities in the Global South for visiting and local students through study-abroad programs. For example, the International Sustainable Development Studies Institute in Thailand offers U.S. college students a "People, Ecology, and Development" semester to focus on "understanding the broader challenges of sustainable development through experiential studies of specific landscapes and cultures in the villages, mountains, coasts and islands throughout Thailand" (Ritchie, 2013). Africa Nazarene University in Kenya fosters student engagement with farmers in eastern Kenya to mitigate the impact of drought. Students exchange information about the needs and available resources, knowledge, and traditions of the community before suggesting solutions.⁸

Workshop participants also described capstone experiences that are offered at the end of a course of study, as well as experiences for students to learn and apply their knowledge over a semester, or follow a co-op schedule that alternates between work and study semesters. The idea of a "spiral of learning," in which a student may take a course, have a field experience, then return to the classroom, perhaps several times, was noted by workshop panelist Pamela Matson of Stanford University as a way to strengthen both classroom and real-world learning. Panelist Yuwei Shi from the Middlebury Institute of International Studies at Monterey noted his program transitioned from a capstone experience toward the end of a curriculum to one that takes place at the start of the program. The switch, he said, has enriched learning and allowed students to form a collaborative cohort earlier.

Several employers and end users at the workshops discussed how they designed programs or managed students participating in them and/or have hired students who had been through experiential education at their own or other organizations. Employers expressed the value of exposing students to the realities of working environments before they graduate. For example, as one participant noted, "Students need to take what they've learned and create something digestible for a chief financial officer."

⁷ See Ellen MacArthur Foundation Circular Economy Programme, available at <https://www.ellenmacarthurfoundation.org/our-work/activities/from-linear-to-circular/circular-economy-programme>; Sustainable Ocean Alliance, available at <https://www.soalliance.org>; and Bridge Collaborative's Bridge Spark Fund, available at <https://bridgecollaborativeglobal.org/what-we-do/fund>, all accessed on March 11, 2020.

⁸ For more information about Africa Nazarene University's Science and Technology Program, see <https://www.anu.ac.ke/school-department/school-science-technology>, accessed on March 12, 2020.

The quality of the experiential education program matters (Eyler, 2009). It should be more than checking off a box indicating that a student has had an internship in organization X or completed a research project in community Y. With this in mind, the committee sought to examine successful experiential learning programs in sustainability and consider how they are engaging to the student, educationally valuable, and useful to the relevant community or organization.

Community Learning

Many workshop participants warned about not just conducting research or seeking to “help” a community but also collaborating and co-learning with community members, whether in an adjacent neighborhood or an ocean away. Globally, Ritchie (2013) observed, “Working with marginalized communities in the Global South can present significant challenges—how to address inherent disparities in power and knowledge, and how, especially in a hierarchical society like Thailand, to ensure that local communities are not exploited for education, but rather are empowered through education.” Similar challenges can easily surface in a community adjacent to a college or university. Examples of community-led design of sustainability programs are highlighted in Box 3-2.

BOX 3-2 Community-Led Design of Solutions to Sustainability Challenges

Workshop participants emphasized the need for students to be exposed to efforts that are community designed and led as an important aspect of sustainability education. Virtually every community, large and small, has some such group that could involve energetic and open-to-learn students. Two examples participants mentioned in the workshops are as follows:

- The Fair Food Network connects households with healthy food to improve health, ignite local economies, and open opportunities. In Michigan, the network has established a fund that provides critical investment and business assistance to local food-related businesses. University of Michigan students have been involved in all aspects of the network.
- The Transformative Climate Communities Program in California awards grants to develop and implement neighborhood-level sustainability programs, with the investments to take place within disadvantaged communities (as defined by the California Environmental Protection Agency’s CalEnviroScreen tool). One such funded plan is called the Watts Rising Collaborative.^a

^a For more information about the Watts Rising Collaborative, see <https://www.wattsrising.org>, accessed on April 27, 2020.

To avoid disparities in power and resources, it is important to engage with local communities sincerely and authentically in designing and teaching relevant sustainability courses, so that they are “not exploited *for* education, but rather are empowered *through* education” (Ritchie, 2013).

Another issue raised by participants at the workshops and of concern to the committee relates to accessing experiential learning opportunities. Internships are valuable learning and résumé-building experiences, but there are very real barriers to participation, especially for students from low-income families and those who have responsibilities for other family members: the interns can be unpaid or underpaid, require one’s own transportation, or necessitate additional expenses to live in another location. These realities hamper students who need to earn income and reduce expenses. Several solutions were suggested, but this is a central challenge for improving diversity, equity, and inclusion in sustainability education (see also Chapter 4). One employer located in a remote area said her organization sought more centrally located projects where students could intern outside their office location. Several educators described efforts to find external funding to supplement compensation, especially for lower-income students who want experience in nonprofits and community-based organizations but have limited finances. One example could include the National Science Foundation’s Research Experiences for Undergraduates program that provides indirect funding for undergraduate students to participate in research (NSF, 2020).

Service Learning

While experiential education is increasingly understood as an effective pedagogy combined with classroom learning, service learning also provides rich educational opportunities in sustainability. Service learning is “a form of education in which students work with community partners to identify and address community needs in an academic setting, together with structured reflections designed to achieve desired learning outcomes” (Jacoby, 2015; Coleman et al., 2017). Coleman et al. (2017) conducted one of the few experiments about service-learning projects focused on climate change as a tool to teach sustainability concepts. Based on a joint effort between four college courses in different disciplines, they found that students in these classes improved their understanding of climate change, how it affects their respective disciplines, and personal responsibility for addressing climate change. Because sustainability is a complex and interdisciplinary field, service-learning projects that focus on the intersection of climate change and a given discipline can serve as a rich opportunity for students to learn about and engage with relevant sustainability issues in their field and outside the classroom. Accordingly, the Association for the Advancement of Sustainability in Higher Education provides credit for the Sustainability Tracking, Assessment and Rating System, or STARS, report for service-learning projects with a focus on sustainability.

Organizational Learning

In addition to applying their learning in diverse experiential contexts that include community and service learning, it is crucial for students to have a systematic understanding of how organizations learn and change, and of the organizational contexts in which many of them will pursue their career goals. A vast literature on the subject distinguishes how organizations learn. This literature contrasts organizational learning in relation to theories of agents and choice, conflict and bargaining, and competitive selection (Fiol and Lyles, 1985; Levitt and March, 1988; Miller, 1996). Theorists of organizations suggest that organizational learning relies on routines and is path dependent and goal oriented (March and Olsen, 1975; Nelson and Winter, 1982). Organizational learning denotes both accumulation of organizational memory and changes in organizational knowledge, whatever the source of knowledge (Chadwick and Raver, 2015; Lozano, 2014; Schulz, 2017). Recent research has highlighted the role of leadership in particular in organizational learning (Berson et al., 2015).

Because actions and strategies of business and civil society organizations are so critical for pathways toward sustainability, sustainability curricula should include both critical conceptual grounding for their students and opportunities for practical application of such learning in organizational settings. On the one hand, students of sustainability need a theoretically informed and conceptual understanding of organizational change to comprehend and appreciate the pressures and opportunities that their organizations confront when pursuing sustainability strategies. These organizational contexts likely constrain or provoke the choices that strengthen sustainability. On the other hand, students also need familiarity with how organizations work, learn, and change through practical experience in organizational contexts—whether through apprenticeship, internships, or other opportunities to engage decision makers and leaders of diverse organizations.

At the Santa Cruz workshop, student participants discussed what they had learned about organizational change theory. At least one student had taken an undergraduate course, although she said that the education she gained in that regard was through her role in organizing for fossil fuel divestment. All of the student panelists agreed that understanding how to intervene in organizations to fundamentally change structures was essential to their sustainability efforts.

Rich and diverse experiential opportunities for students' organizational learning will require educational institutions to collaborate more closely with business, government, and civil society organizations. Many already do, enabling productive interactions for their students, from local to global levels. Common to the success of programs that exist is the leveraging of at least one of the sustainability core competencies, such as systems thinking, and involvement of at least one sustainability content area, such as data use and analysis. These opportunities provide students with valuable first-hand experiences in sustainability in the need to find the synergies and consider the trade-offs that continually occur in

the real world. Given these benefits but mindful of the equity-related obstacles to overcome, the committee makes the following recommendation:

Recommendation 3.3: Sustainability curricula and programs in higher education should train students to understand the highly interdependent, varied, and complex contexts of sustainability (including organizational contexts); to develop their ability to discern and address the historical and contemporary trajectories and consequences of sustainability processes; and to apply their learning in experiential learning settings (community, organizational, service) so that learners can be more effective implementers of effective transitions toward sustainability.

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4

Building the Academic Environment

The United States has an extensive network of 2- and 4-year colleges as well as universities that create rich learning environments for sustainability education programs to thrive. The proliferation of sustainability education programs provides evidence that many campuses are taking steps to engage students, faculty, and staff on the topic. Learning takes place in the classroom and the lab, but also in the community—whether the community is local or global. Intentional efforts by developers of sustainability curricula are needed to impart the competencies, content areas, and capacities discussed in Chapter 3, against a backdrop of the context of trade-offs and potentially conflicting goals. Chapter 4 examines how the academic environment can foster (or sometimes impede) these connections; function as a “living lab”; overcome the reality of academic silos to strive for interdisciplinarity; embrace diversity, equity, and inclusion in sustainability; and interface with federal agencies to leverage resources.

COLLEGES AND UNIVERSITIES AS LIVING LABS

Higher education institutions can provide students with valuable experiential learning opportunities as accessible living labs. Chatham University in Pittsburgh and Syracuse University in upstate New York provide illustrative examples of living labs (see Box 4-1). Doctoral students at the University of Wisconsin–Madison have designed activities that use the campus as a living-learning laboratory for sustainability (University of Wisconsin–Madison, 2017).

Sustainability programs can take advantage of the higher education environment to provide students with opportunities for observation, co-creation, experimentation, and more. This can be especially useful for evaluating the potential

BOX 4-1**Living Labs at Chatham University and Syracuse University**

The Falk School of Sustainability and Environment at Chatham University in Pittsburgh offers one baccalaureate and four master's programs, each with an experiential learning component: bachelor of sustainability, master of arts in food studies, master of sustainability, and two dual degrees in which the latter two are connected with a master of business administration. The campus that houses the Falk School, the Eden Hall Campus, is billed as "the first campus in the world built from below the ground up on the principles of sustainability" (Chatham University, 2019a). Further, Eden Hall is "a vital, interdisciplinary laboratory designed to support collaboration between leaders and learners, academia and business, and the arts and sciences. Here we [Chatham] develop scalable tools and ideas that will drive data-based decision making across the social, economic, and environmental issues we will all face together, and implement them when applicable to not only exhibit their potential, but also serve as an inspiration for the community." Students learn about alternative energy, stormwater management, agricultural systems, air quality and climate, and natural and built systems in place. For example, the Sustainability Graduate Summer Intensive program in 2019 provided experiential learning resources at Eden Hall Campus for students prepared to study at the graduate level (Chatham University, 2019b). The Sustainability Leadership Academy is expected to provide high school students with an opportunity to explore various sustainability careers during its week-long experiential retreat at Eden Hall Campus (Chatham University, 2020).

In an innovative continual loop, Syracuse University in New York uses savings from energy efficiency and sustainability projects to fund new sustainability-related academic research, student projects, and course development. The Campus as a Lab for Sustainability program awards research/seed grants and education/pedagogy grants to faculty and students for projects that can advance the school's Climate Action Plan. The projects must have measurable outcomes in reaching the university's goal to become carbon neutral by 2040. Student examples include a project by an engineering student to use geophysical technologies and drones to identify locations that would benefit from green stormwater infrastructure or retrofits and another to develop an oral history of climate change activism at the university (Syracuse University, 2019).

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impact of sustainability activities before implementing them in the local or broader community. Oberlin College has been using this approach for more than a decade and is working with the town of Oberlin to provide its students with a real-world educational experience for sustainability (Carlson, 2011).

BRIDGING DISCIPLINARY SILOS

Part of the committee's task was to identify knowledge gaps and critical barriers related to the effective development of interdisciplinary sustainability programs. Sustainability is an interdisciplinary field overlapping with nearly every major and degree program in higher education. Interdisciplinarity facilitates "cognitive advancement in ways that would have been impossible or unlikely through single discipline means" (Spelt et al., 2009, 365). The National Research Council (NRC, 2014, p. 45) defined interdisciplinarity as an integration of

information, data, methods, tools, concepts, and/or theories from two or more disciplines focused on a complex question, problem, topic, or theme. The scope and goals of research programs range from incorporating borrowed tools and methods and integrating them into the practice of another discipline to generating a new conceptual framework or theoretical explanation and large-scale initiatives. The key defining concept of interdisciplinarity is integration, a blending of diverse inputs that differs from and is more than the simple sum of the parts. Individuals may work alone, but increasingly research is team-based. Collaboration introduces social integration into the process, requiring attention to project management and dynamics of communication.

This definition, though focused on research, applies also to integrating knowledge, information, data, and methods from different disciplines when developing a sustainability higher education program.

Interrelationships are inherent in the Sustainable Development Goals (SDGs), and integration across sectors, countries, and actors is vital to achieving them (Stafford-Smith et al., 2017). A natural follow-on is that sustainability education must be structured as the interdisciplinary field that it is, drawing on theories, bodies of knowledge, and practices across fields. Working across knowledge-based research programs, rather than institutional structures, should be central to interdisciplinary research (Khagram et al., 2010). The competencies and content areas outlined in Chapter 3 suggest a similar need to work across different knowledge bases for interdisciplinary sustainability education programs.

The Interdisciplinary Food Systems Teaching and Learning (IFSTAL) program, launched by a consortium of five universities in the United Kingdom, is one example of the power of bridging boundaries among academic disciplines and between academic and practitioner organizations to scale up training of a new generation of sustainability leaders (Ingram et al., 2020, 10). Since its start in 2015, IFSTAL has taught more than 1,500 students from 45 different univer-

sity departments; offered more than 100 graduate degree programs; and fostered collaborations with more than 100 public, private, and nonprofit organizations to “gain a better understanding of food-systems and how to address some of their complexities.” The program uses a flipped-classroom approach, and students’ participation is voluntary and not assessed. At least 350 students during the first 3 years of IFSTAL have transitioned into food systems–related jobs.

While interdisciplinary approaches are fundamental to sustainability programs, Clark and Wallace (2015) have noted that building interdisciplinarity and integration into curricula and learning remains a challenge. The reality is that most academic institutions are not set up to foster this interdisciplinarity (Boone et al., 2020). Despite the challenges, colleges and universities are attempting to foster interdisciplinarity in sustainability education using a variety of pedagogical and institutional strategies (described in further detail below). Sustainability is highly interdisciplinary in nature, therefore it is essential that sustainability programs overcome the separation of academic disciplines, despite the inertia of disciplinary structures. Sustainability programs can be launched and evolve under a variety of institutional arrangements, but a commitment to and value of interdisciplinary approaches is fundamental (Vincent and Mulkey, 2015), particularly from top leaders of higher education institutions (Hart et al., 2016; Boone et al., 2020).

Several scholars discuss how transdisciplinarity and sustainability research are closely related (Hadorn et al., 2006; Lang et al., 2012). In an NRC (2014) report related to health, transdisciplinarity is defined and described as transcending “disciplinary approaches through more comprehensive frameworks, including the synthetic paradigms of general systems theory and sustainability, as well as the shift from a disease model to a new paradigm of health and wellness.” The report goes on to say that by the late 20th century, “transdisciplinarity also became aligned with problem-oriented research that crosses the boundaries of both academic and public and private spheres. In this second connotation, mutual learning, joint work, and knowledge integration are key to solving ‘real-world’ problems. The construct goes beyond interdisciplinary combinations of existing approaches to foster new worldviews or domains.” In these senses, transdisciplinarity is similar to convergence research, defined by the National Science Foundation (NSF) as “a means of solving vexing research problems, in particular, complex problems focusing on societal needs. It entails integrating knowledge, methods, and expertise from different disciplines and forming novel frameworks to catalyze scientific discovery and innovation.”¹ With its focus on dynamics of integrated, complex social-ecological-technical systems, interdisciplinarity, and using problem-based and solutions-oriented approaches, sustainability education aligns with these concepts of transdisciplinarity and convergence.

¹ National Science Foundation, Convergence Research at NSF, available at <https://www.nsf.gov/od/oa/convergence/index.jsp>, accessed on November 5, 2020.

At the very least, students and practitioners in sustainability fields need to be open to working with researchers and practitioners with different disciplinary knowledge and training, complementary skills, and alternative perspectives (Haider et al., 2018). In many ways, as Haider et al. (2018) suggest, doctoral students in sustainability science are no longer just economists, sociologists, or ecologists working together in an interdisciplinary team. Rather, they need to engage with different disciplines, or others with interdisciplinary backgrounds, to address sustainability puzzles and challenges. Balancing methodological grounding and epistemological agility can form a basis for achieving rigorous inter- or transdisciplinary sustainability research.

Our workshop participants, even as they recognized the challenges of interdisciplinarity, identified several strategies to foster it in sustainability education:

- Train educators about the value of interdisciplinarity, recognizing that most have spent their careers in a disciplinary silo.
- Institute team teaching with faculty from different departments that jointly design and carry out a course (this is different from “tag teaching,” where one professor may be responsible for the first half of the semester and another professor for the second half).
- Develop an incentive system for collaboration in teaching (e.g., team-taught courses count as one course for both faculty) and research (e.g., seed funding for innovative, interdisciplinary explorations).
- Reward and recognize faculty (e.g., faculty honors, travel or research funds, graduate student support) who successfully engage in interdisciplinary collaborations.
- Manage sustainability curricula and education programs across departments to foster interdisciplinary approaches and encourage responsibility for programs across the college or university.
- Focus efforts on student goals and learning outcomes, with students engaged in the design of their sustainability education goals and working with faculty and staff to overcome challenges to meeting those goals.
- Look beyond an environmental lens when considering sustainability to include business, health, politics, and more, which by definition will require bringing in other disciplines.
- Understand the need for historical and foundational perspectives; systems thinking; applied knowledge crossing science, business, and policy; storytelling and communications across cultures and disciplines, including to those with little knowledge of sustainability; and practical engagement.
- Engage adjunct faculty or guest speakers who can speak about working across disciplines to succeed in their own professional lives.
- Work across a diverse range of departments, perhaps starting with co-sponsoring one-time events, such as a lecture or other special event, then maintaining more lasting connections.

- Utilize the connections forged through interuniversity groups, including many that are student led, such as the climate-focused 350.org or student arms of professional societies.²

Many colleges and universities have used teaching and curricular strategies to develop sustainability programs. Hoffman and Axson (2017) reported that another approach to foster interdisciplinarity is through sustainability institutes, and there are about 20 in the 63 institutions that make up the Association of American Universities. The institutes are consciously designed to be cross-disciplinary and include such areas as business, architecture, public policy, public health, engineering, and law, in addition to connections with environmental sciences or studies. Examples include the Earth Institute at Columbia University (see Box 2-3 in Chapter 2 for more detail), the Institute on the Environment at the University of Minnesota, and the Institute of the Environment and Sustainability at the University of California, Los Angeles. Key elements that enable such institutes to function effectively include a service mindset, an aim to “complement not compete” with existing organizations, broad participation, engagement, and relationship building, and careful communication with students and other institutional stakeholders.

Another approach to bridge disciplinary silos in sustainability education is to help faculty in other fields introduce sustainability concepts in their courses, even if they are not “sustainability professors” offering an explicit “sustainability course.” A pioneer is the Piedmont/Ponderosa Model of Faculty Development at Emory University and Northern Arizona University (NAU) (Barlett and Chase, 2012). The Ponderosa Project began at NAU in 1995 and trains faculty in a range of disciplines to revise their syllabi to integrate sustainability aspects. The Piedmont Project was launched at Emory in 2001 with help from the NAU organizers. Other institutions have since used the model, and the Association for the Advancement of Sustainability in Higher Education offers it to faculty who are interested but whose home institutions do not provide their own programs. Other examples include providing flexibility to students to build their own interdisciplinary major out of multiple minors or certificate programs for a highly specialized experience. For example, the University of Texas at Arlington offers an Interdisciplinary Studies program within the Honors College that includes an environmental and sustainability studies minor and sustainable engineering minor (University of Texas at Arlington, 2020).

Involving undergraduate students in interdisciplinary research is well suited to sustainability. Aktas (2015) highlights the value of interdisciplinary research in sustainability where “bringing different backgrounds and perspectives to a project enables a big picture view of problems at hand and leads to better solutions that are more in line with the three pillars of sustainability, while at the

² See 350.org, available at <https://350.org>, accessed on March 11, 2020.

same time providing valuable hands-on experience to undergraduate students.” Undertaking sustainability research may require different approaches from traditional disciplinary research. For instance, Aktas suggests that faculty should not refrain from working with students from different backgrounds and disciplines. Bolger et al. (2018) went further by organizing an entire study-abroad course for undergraduate students conducting community-based research on a sustainability challenge with the Gobabeb Research and Training Centre in the Namib Desert of Namibia and nearby settlements of the Topnaar Indigenous people. To accomplish this, they prepared students beforehand for collaborative research, encouraged student ownership of their learning, intentionally linked different areas of theory to the research, anticipated and navigated time constraints, and emphasized program-level and student-level engagement with the Indigenous community to prevent becoming “helicopter researchers.” These kinds of experiences underline the importance of sustainability research as more than knowledge generation: it should be problem based and solutions oriented, effectively engage stakeholders in authentic and supportive ways, and be undertaken with an explicit attention to diversity, equity, inclusion, and justice.

Peer-to-peer networks that bring together sustainability educators across institutions and across academic disciplines can also foster interdisciplinarity on their own campuses. The Alliance of Sustainability and Environmental Academic Leaders, National Council for Science and the Environment, and North American Association for Environmental Education are a few examples that offer national or global conferences, networking, and information sharing for researchers and practitioners from multiple disciplines.³ Another example is the Association for Environmental Studies and Sciences, established as an academic home for environmental studies, sciences, and sustainability faculty and students.

Given the highly interdisciplinary nature of sustainability, it is essential that sustainability programs overcome the artificial separation of academic disciplines, including curriculum planning, such as the definition of content, learning outcomes, assessments, and goals of the academic programs. Therefore, the committee makes the following recommendation:

Recommendation 4.1: Academic leaders should encourage the development of, implementation of, and participation in interdisciplinary sustainability programs that bridge disciplinary silos by fostering effective strategies such as team teaching, curriculum planning, interdisciplinary advising and preparation of graduate students, and educator trainings across departments about competencies and content areas of sustainability. Sustainability programs can be launched and evolve under a variety of institutional arrangements, but a commitment to and value of inclusivity and interdisciplinar-

³ See <http://ncseglobal.org> and <http://www.naaee.org>, both accessed on March 11, 2020.

ity is of fundamental importance, particularly from top leaders of higher education institutions.

DIVERSITY, EQUITY, AND INCLUSION

Key to promoting workforce diversity in sustainability careers is the integration of inclusiveness and equity in student educational experiences. To support sustainability actions across different communities and regions, identify and address global scientific or equity issues, and collaborate effectively with communities of all types requires a diverse workforce and network of professionals. Additionally, reducing inequality is embedded in the United Nations Sustainable Development Goals. Most directly, SDG 10 calls for reducing inequality within and among countries. Specifically, Target 10.2 aims by 2030 to “empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status” (UN, 2020a). Additionally, Goal 8 calls to “promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all,” while Goal 16 focuses on promoting “peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels” (UN, 2020a). The importance of sustainability and social justice has been emphasized in several documents, including the United Nations Declaration on the Rights of Indigenous Peoples adopted by the United Nations General Assembly on September 13, 2007 (UN, 2020b), as well as the Principles of Environmental Justice (NRDC, 2016).

Extensive discussion among workshop participants reflected on the importance of diversity, equity, and inclusion in sustainability education, both in the student and faculty population and as key concepts in sustainability. Workshop participants were in agreement that, to achieve the SDGs and other sustainability goals, the concepts of diversity, equity, and inclusion must be infused into sustainability education. Graduates of sustainability programs will engage a broad range of community, government, and corporate stakeholders and work in virtually every job sector identifiable; therefore, preparing a diverse workforce for sustainability careers across the globe is essential to the success of sustainability actions. As highlighted in Chapter 2, the current faculty, student, and workforce populations in most interdisciplinary environmental, sustainability, and energy programs do not reflect the national demographic proportions.

Improving diversity, equity, and inclusion throughout sustainability education programs requires higher education institutions to recruit and retain diverse students, staff, faculty, administrators, and boards, being inclusive of racial, ethnic, socioeconomic, sexual, gender, age, cultural, disability, and other diversity factors. As noted in Chapter 2, with the overview of science and engineering students, the situation on most campuses lags behind stated goals for initial enrollment and retention.

One notable area for sustainability education efforts is the nation's minority-serving institutions, which according to a National Academies of Sciences, Engineering, and Medicine report (NASEM, 2019), enroll about 5 million students, nearly 30 percent of the U.S. undergraduate college population. The report identifies minority-serving institutions as an “underutilized resource” critical to the national science, technology, engineering, and mathematics (STEM) workforce. Historically Black colleges and universities that provide sustainability programs include the School of the Environment at Florida A&M University; the Forestry, Ecology, and Wildlife Program at Alabama A&M University; the College of Agriculture, Environment, and Nutrition Sciences at Tuskegee University; the Marine Sciences Program at Savannah State University; and the Department of Marine and Environmental Science at Hampton University.⁴ High-Hispanic-enrollment institutions also have well-established environmental programs. NAU houses an Institute for Tribal Environmental Professionals and the Department of Applied Indigenous Studies.⁵ Tribal colleges also offer sustainability-related programming. For example, the College of Natural and Social Sciences at Haskell Indian Nations University supports “Indigenous-centered teaching and learning initiatives to advance systems of life-enhancement for all peoples and places on our Mother Earth” (Haskell Indian Nations University, 2020). In addition, the American Indian Higher Education Consortium (AIHEC) promotes programming at tribal colleges that encourages students to pursue STEM education (AIHEC, 2019). AIHEC has been involved in NSF-funded projects to advance climate change education that integrates traditional knowledge and western science. AIHEC is also collaborating with the Bureau of Indian Affairs' Tribal Resilience Program and the U.S. Geological Survey's Climate Adaptation Science Centers to support tribes developing and implementing climate resilience strategies to address their climate response priorities.

Community colleges—whether formally designated minority-serving institutions or not—educate many underrepresented minority students and can involve a more diverse population in sustainability education and careers. At the Santa Cruz, California, workshop, the committee learned about education efforts of the Silicon Valley Leadership Group.⁶ The Leadership Group connects technol-

⁴ See Florida Agricultural and Mechanical University School of the Environment, available at <http://www.famu.edu/index.cfm?environmentalscience>; Alabama A&M University Bachelor of Science in Forestry, available at <https://www.aamu.edu/academics/undergraduate-studies/bachelor-science-forestry.html>; Tuskegee University College of Agriculture, Environment and Nutrition Sciences, available at <https://www.tuskegee.edu/programs-courses/colleges-schools/caens/caens-departments>; and Hampton University Department of Marine and Environmental Sciences, available at <https://science.hamptonu.edu/mes>, all accessed on March 11, 2020.

⁵ See NAU Institute for Tribal Environmental Professionals, available at <http://www7.nau.edu/itep/main/Home>; Applied Indigenous Studies, available at <https://nau.edu/ais>, both accessed on March 11, 2020.

⁶ See Silicon Valley Leadership Group, available at <https://www.svl.org>, accessed on March 11, 2020.

ogy companies with the 19 community colleges in Silicon Valley and supports a student body that is 77 percent students of color. While sustainability is not the exclusive focus of the Silicon Valley Leadership Group, the initiative is an example of a way to create a more diverse sustainability workforce by providing graduates with certification in a related field (such as facilities management or energy technician) or with an associate's degree to move on to a bachelor's degree or beyond. The National Council for Science and the Environment provides *The Community College Handbook for Sustainability Education and Operations*, a report for sustainability education and operations at community colleges in the United States (NCSE, 2020). This iterative handbook provides information for community college faculty, administrators, staff, students, and community partners while inviting campuses to participate in a dialogue about their effective practices.

Environmental diversity pathway programs are another avenue to help students enter the field. Many such programs are housed in environmental nonprofits, community centers, neighborhood groups, and government entities. Diversity pathway programs help participants learn about career opportunities, engage in educational activities, and receive mentorship and other support. A relevant national program is the SEEDS (Strategies for Ecology Education, Diversity and Sustainability) program of the Ecological Society of America, established in 1996 to “reduce, over time, the serious under-representation within the field of ecology of individuals from certain minority groups” (ESA, 2020). One study of 1,039 environmental or sustainability-related organizations and agencies found that 173, or 16.7 percent, provided a diversity pathway program (Taylor et al., 2018). Most of those programs targeted younger students (as young as kindergarten), but about one-third were set up for college students or recent graduates. However, few of these programs reported offering career development, academic preparation, networking, or job market assistance as part of their programs. Similarly, very few offer post-program support in any of these areas. Understanding what is working with the initiatives that are going on—some of which were represented at the workshops—could be a way to build on these efforts for more expansive contributions to sustainability education. NSF’s Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science, or INCLUDES, program focuses on inclusive change in diversity in STEM education and leadership. Although the program is not focused on sustainability, it could be a useful resource for the sustainability community.

To help boost the number of underrepresented minority students, low-income students, and first-generation students who embark on sustainability careers, some colleges and universities are providing sustainability-related diversity pathway programs and leadership opportunities. Box 4-2 highlights two such programs at the University of Michigan.

Substantial research has been conducted in the areas of diversity, equity, and inclusion in STEM, and several studies discuss the need for effective pedagogy

BOX 4-2
National Sustainability-Related Diversity Pathway
Programs Housed at the University of Michigan

The Doris Duke Conservation Scholars Program

The University of Michigan provides sustainability leadership opportunities for undergraduates from around the United States. The Doris Duke Conservation Scholars Program (DDCSP) is a two-summer opportunity for students who are historically underrepresented in the conservation field, as well as allies. The program hosts 40 students each year. These scholars participate in the program because they (1) are interested in pursuing careers in conservation and sustainability, (2) have demonstrated leadership and want to continue enhancing those skills, (3) want to learn how to infuse diversity, equity, and inclusion in their conservation and sustainability work, (4) want to mentor and be mentored, and (5) are interested in building a multicultural network of people who can support each other's academic pursuits and careers as they move through the professional ranks. Each scholar spends two summers at the University of Michigan. During the first summer, scholars conduct research with a faculty member or research scientist who mentors them. In the second summer, scholars intern in conservation and sustainability nonprofits or government agencies in Southeast Michigan. Each scholar is assigned an internship site mentor. All faculty, research scientists, and internship site supervisors receive diversity, equity, and inclusion training from the DDCSP staff before they begin work with the scholars. The program also provides extensive diversity, equity, and inclusion training as well as career and leadership development training for scholars. All scholars participate in an end-of-summer capstone conference where they present the results of their research or assess their internship experiences. Research mentors, internship supervisors, faculty, and staff at the university's School for Environment and Sustainability (SEAS); students; and family members attend the capstone conference. During the school year, scholars participate in monthly webinars organized by DDCSP staff, meet with their campus mentors, make presentations about their summer experiences, and attend and make presentations at the New Horizons in Conservation Conference. The DDCSP experience culminates with a week-long capstone retreat that is held in Yellowstone and Grand Teton National Parks and the surrounding national forests. Scholars go on to pursue master's and doctoral degrees in conservation and sustainability at SEAS and other graduate programs. They also work in conservation and sustainability-related jobs, and have held prestigious fellowships such as the Environmental Leadership Program's RAY Marine Conservation Diversity Fellowship, Swarthmore College's President's Sustainability Research Fellowship, the Smithsonian Institution's internship in marine sciences, and the Fulbright Scholar Program. The University of Michigan is one of four institutions that participate in the DDCSP program, along with the DDCSP Collaborative, University of California, Santa Cruz, and University of Washington (Doris Duke Charitable Foundation, 2020).

continued

BOX 4-2 Continued

The Environmental Fellows Program is a graduate internship that is housed at SEAS. The program grew out of a collaboration between SEAS and the Environmental Grantmakers Association. The Environmental Fellows Program provides internships to 30 fellows each summer. After an intensive diversity, equity, and inclusion and environmental philanthropy orientation, fellows intern in environmental grantmaking foundations or with the grantees of foundations that sponsor the fellowships. Grantees range from the largest environmental organizations, policy groups, and environmental justice organizations to local government entities. Since 2016, more than 20 foundations that do environmental and sustainability grantmaking have sponsored more than 100 fellows to participate in the program. Fellows are drawn from graduate sustainability-related programs from around the United States. They are both master's and doctoral students. Foundations and internship host-site mentors receive diversity, equity, and inclusion training before fellows begin the internship. Each year fellows attend the Environmental Grantmakers Association's Annual Fall Retreat. While at the retreat, fellows make presentations about their research and internship experiences, meet with their foundation mentors, and build their network.

REFERENCE

Doris Duke Charitable Foundation. 2020. Doris Duke Conservation Scholars Program. <http://uwconservationscholars.org>, accessed on July 16, 2020.

and continuous support and mentoring. NRC (2013) states that programs that have increased the number of minority students graduating in STEM fields promote a comprehensive approach by integrating students into college academic and social systems, developing knowledge and skills, and supporting mentoring, monitoring, and advising. It also suggests that collaborations with professional societies focused on diversity could help connect minority students to education and training opportunities. For example, SACNAS, a professional society whose mission is “fostering the success of Chicanos/Hispanics and Native Americans, from college students to professionals, in attaining advanced degrees, careers, and positions of leadership in STEM,” runs multidisciplinary conferences, leadership and professional programs, and other initiatives to support underrepresented students and professionals.⁷ McDaris et al. (2019) suggest an attract-support-prepare framework to increase the number of students from underrepresented groups in the field of geosciences. They discuss that the adoption of research-based educational practices is needed, including (1) attracting a diverse group of students, (2) supporting them through graduation, and (3) preparing them for career success.

⁷ See SACNAS (Society for Advancement of Chicanos/Hispanics and Native Americans in Science), available at <https://www.sacnas.org/who-we-are>, accessed on July 20, 2020.

The Teach the Earth web portal (2020) provides access to extensive resources, models, and strategies to attract, support, and prepare students, as well as for faculty and the education community for broadening participation.

Several transuniversity programs were identified by workshop participants as well. The Global Sustainability Scholars program trains and supports undergraduate students and early-career professionals from underrepresented groups to work with leading scientists on critical sustainability challenges that face communities and environments in the future.⁸ The National Socio-Environmental Synthesis Center has a program to foster and support interdisciplinary, team-based synthesis research specifically for advanced graduate students, with the aim to develop a cohort of researchers committed to socio-environmental synthesis.⁹

These approaches will enhance the education of all sustainability students. But as an added benefit for increasing underrepresented minority populations, researchers Juan Garibay and Shirley Vincent (2018) observed, through a national sample of 343 degree programs, that environmental and sustainability programs “with a more inclusive curriculum and greater student compositional diversity are significantly more likely to report an increasing enrollment of students of color.” Garibay et al. (2020) find that the relationship between faculty values toward diversity content and its inclusion is greater at master’s colleges and universities, based on a national sample of 227 interdisciplinary environmental and sustainability programs within 149 higher education institutions.

Workshop participants noted that many sustainability programs are housed in universities that are located in urban areas populated by diverse communities, yet these surrounding communities are sometimes overlooked by faculty and students who favor traveling to distant places for educational and research experiences. Workshop attendees urged sustainability educators to collaborate with both local and distant communities to enhance student learning experiences. A comment echoed many times during the course of the workshop was to find ways to truly partner with a community—giving in addition to extracting, learning in addition to imparting theory-based knowledge, and, as one participant stressed, “being humble.” The community collaboration program Interdisciplinary Teaching about Earth for a Sustainable Future, or InTeGrate, provides models from university partners for broadening student participation in the geosciences and emphasizes how cultural relevance and community involvement are crucial for engaging student interest.¹⁰ Additionally, early recruitment strategies at the precollege levels contribute to success in STEM fields for students of color and could be useful to consider for

⁸ See Global Sustainability Scholars, available at <https://www.gsscholar.org>, accessed on March 11, 2020.

⁹ See National Socio-Environmental Synthesis Center, available at <https://www.sesync.org/for-you/educator/programs/graduate-programs>, accessed on March 11, 2020.

¹⁰ See InTeGrate, available at <https://serc.carleton.edu/integrate/programs/implementation/index.html>, accessed on November 5, 2020.

incoming students into sustainability programs (NASEM, 2019). In 2017, Wells Fargo committed \$50 million to American Indian/Alaska Native communities focusing on environmental sustainability, economic empowerment, and diversity and social inclusion, including leadership and career development training (Wells Fargo, 2017). Tribal governments and sovereign Nations could also provide internship and job opportunities in sustainability for undergraduate and graduate students.

Diversity, Equity, and Inclusion as Learning Outcomes

Sustainability is a normative science, meaning it explores not just possible futures but also desirable futures (van der Hel, 2018). With a commitment to well-being across generations (Matson et al., 2016), sustainability must tackle issues of fairness, difference, inclusion, and justice embedded in notions of well-being. The normative or values-thinking sustainability competency urges students to think what the present and future should be, to negotiate different and potentially competing values systems, and to search for solutions that are inclusive, just, and fair (Wiek et al., 2011). A focus on diversity, equity, and inclusion in sustainability education is driven by normative notions of the future we want, but also recognizes the practical value of embedding these principles in decisions to foster innovation and community buy-in for effective, enduring sustainability strategies. For students wishing to transform organizations, it is important they understand how values-thinking, including around diversity, equity, and inclusion, are important motivators of behavior and change (Frisk and Larson, 2011). Incorporating diversity, equity, and inclusion into sustainability education provides a basis for understanding sustainability challenges rooted in inequity and injustice, but also provides a tool kit for students to develop solutions with great transformative potential. Many workshop participants stressed that diversity, equity, and inclusion and explorations of justice should be a fundamental part of sustainability education for these reasons. One faculty member urged sustainability educators to go beyond “the usual 20 papers,” that is, to expand course and program content to include broad perspectives and areas of expertise.

Several institutions have incorporated Indigenous knowledge into their sustainability programs. The University of Montana offers an Indigenous Knowledge and Environmental Sustainability focus area within its environmental studies master’s program,¹¹ and NAU has a tribal elder on campus every semester to share insights and work with students and faculty.¹² It is essential to have greater emphasis on U.S. Indigenous populations for sustainability and equity issues, and the researching, understanding, teaching, and eventual implementation of sustainability practices.

¹¹ See University of Montana Environmental Studies, available at <https://hs.umt.edu/evst/graduate/focus-areas/indigenous-knowledge/default.php>, accessed on March 12, 2020.

¹² Described by Rod Parnell in his presentation at the Washington, D.C., workshop on February 13, 2019.

Workshop participants also urged sustainability educators to incorporate relevant history into the curriculum. They suggested that students graduating with sustainability degrees should have an understanding of the role that processes such as colonialism, conquest, land ownership and appropriation, segregation, and racism play in contemporary sustainability challenges. It is critical for sustainability students to understand the legal and public policy systems that underlie inequities. One workshop participant thought the process of anchoring the curriculum in relevant historical events is one way to “ground-truth” the curriculum.

Beyond increasing the numbers of diverse students enrolled, workshop participants urged that sustainability education incorporate diversity, equity, and inclusion into learning, engagement, and implementation processes by doing the following:

- Developing courses, field experiences, internships, stakeholder engagement, community partnerships, research, and other educational activities that are underpinned by knowledge of and understanding of social dynamics and social/environmental justice.
- Developing authentic, long-term partnerships that are reciprocal and respectful with communities, government, and nonprofits and for-profit organizations.
- Recognizing the existence of sustainability-related knowledge systems and expertise that exist outside of the academy.

Promoting strategies to improve the diversity, equity, and inclusion in sustainability education is critical to addressing underrepresentation in both the academic programs and the workforce. Additionally, addressing sustainability challenges requires a diversity of perspectives, backgrounds, and expertise and an understanding of how values can impede or motivate change. To this end, the committee offers the following recommendation:

Recommendation 4.2: Sustainability education programs should prioritize attracting and supporting students with varied backgrounds and lived experiences, supporting them for success in a variety of sustainability careers. This also requires attracting and retaining faculty from diverse backgrounds in sustainability education programs, with additional attention to equity, inclusion, and local and Indigenous knowledge in the content of the curriculum and the institutional settings.

FEDERAL SUPPORT OF SUSTAINABILITY PROGRAMS IN HIGHER EDUCATION

Policy makers have recognized the role that campus sustainability programs have in achieving societal goals. In 2008, Congress passed the Higher Education

Sustainability Act (HESA) of 2007 as part of the Higher Education Act (H.R. 4137),¹³ which established a competitive grant program through the Department of Education, in consultation with the Environmental Protection Agency, for universities and places of higher education to establish sustainability research programs, such as developing new alternative energy sources; develop and implement sustainability practices on campus; and create academic programs (AASHE, 2008). The intent of this legislation was to support and advance sustainability curriculums at colleges and universities to develop a workforce trained to be sustainable through multidisciplinary education, research, and outreach programs that address environmental, social, and economic dimensions of sustainability. Although the Higher Education Act was passed, HESA itself was only appropriated funding for 1 year, and no assessment or evaluation of the program is available. However, in November 2019, legislation was introduced in the U.S. Senate to reauthorize HESA through what the bill sponsors titled the Higher Education Sustainability Act of 2019 (S. 2928).¹⁴ The proposed legislation states the following:

From the amounts appropriated to carry out this section, the Secretary, in consultation with the Administrator of the Environmental Protection Agency, shall make grants to eligible entities to establish sustainability programs to design and implement the teaching and practice of sustainability, including in the areas of staff and faculty professional development, energy management, greenhouse gas emissions reductions, green building, waste management, transportation, resilience, green workforce, and other aspects of sustainability that integrate the local community with multidisciplinary academic programs and are applicable to the private and government sectors.

A member of Senator Sheldon Whitehouse's staff, legislative assistant David Caruolo, spoke virtually to the committee and attendees of the Santa Cruz workshop. He noted that one change in the current legislative proposal is the inclusion of development of the "green workforce" as an area eligible for a grant. This addition seems to be in keeping with workplace trends over the last decade that include the growth of the sustainability profession. He also noted that the issue of connecting local communities with universities frequently arose in deliberations around reauthorization, a theme that reflects comments made to the committee throughout its workshop process.

The committee noted that since 2008, the federal agencies that support sustainability research and initiatives have broadened beyond the Environmental Protection Agency, the only agency designated in the legislation as a collaborat-

¹³ Higher Education Opportunity Act, H.R. 4137, 110th Congress (2007–2008), Public Law No: 110-315, available at <https://www.congress.gov/110/plaws/publ315/PLAW-110publ315.pdf>, accessed on March 11, 2020.

¹⁴ Higher Education Sustainability Act of 2019, S. 2928, 116th Congress (2019–2020), available at <https://www.congress.gov/116/bills/s2928/BILLS-116s2928is.pdf>, accessed on March 11, 2020.

ing entity with the Department of Education, a grant administrator. Other federal agencies currently support a variety of programs inclusive of sustainability activities, including the following:

- National Science Foundation: Environmental Engineering and Sustainability Cluster;¹⁵ its Science, Engineering, and Education for Sustainability activities previously supported sustainability research and education.¹⁶
- National Oceanic and Atmospheric Administration (NOAA): Office of Sustainable Fisheries; Climate Program Office; Office of Oceanic and Atmospheric Research; National Sea Grant College Program.¹⁷ NOAA supports U.S. engagement strategies for the United Nations Decade of Ocean Science for Sustainable Development.
- National Aeronautics and Space Administration: Research Opportunities in Space and Earth Science; Earth Sciences Division.¹⁸
- Department of Defense: National Defense Education Program for Science, Technology, Engineering, and Mathematics (STEM) Education, Outreach, and Workforce Initiative Programs; U.S. Army Corps of Engineers Institute for Water Resources.¹⁹
- Department of Energy: Energy Efficiency and Conservation Block Grant Program; Office of Energy Efficiency and Renewable Energy.²⁰
- National Institutes of Health: Global Health Research; National Institute of Environmental Health Sciences.²¹
- U.S. Department of Agriculture: Research, Education, and Economics.²²
- U.S. Geological Survey: Science and Decisions Center.²³

¹⁵ See NSF: Environmental Engineering Sustainability Cluster, available at https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505483, accessed on March 11, 2020.

¹⁶ See NSF: Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES), available at https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707&org=NSF, accessed on June 9, 2020.

¹⁷ See NOAA: Fisheries, available at <https://www.fisheries.noaa.gov/about/office-sustainable-fisheries>; CPO, available at <https://cpo.noaa.gov/Funding-Opportunities/FY-2020-Notice-of-Funding-Opportunity>; OAR, available at <https://research.noaa.gov/UN-Decade>; Sea Grant, available at <https://seagrant.noaa.gov>; all accessed on March 11, 2020.

¹⁸ See NASA: ROSES, available at <https://nspires.nasaprs.com/external/solicitations/summary.do?solId=%7bBCEE336B-D550-CCBA-1C8C-7A866DB06F45%7d&path=&method=init>, accessed on March 11, 2020.

¹⁹ See DOD: NDEP, available at <https://www.grants.gov/search-grants.html?agencyCode=DOD>; USACE, available at <https://www.iwr.usace.army.mil>; both accessed on March 11, 2020.

²⁰ See DOE: EECBG, available at <https://www.energy.gov/eere/wipo/energy-efficiency-and-conservation-block-grant-program>; EERE, available at <https://www.energy.gov/eere/office-energy-efficiency-renewable-energy>; both accessed on March 11, 2020.

²¹ See NIH: Global Health Research, available at <https://www.fic.nih.gov/ResearchTopics/Pages/default.aspx>; NIEHS, available at <https://www.niehs.nih.gov>; both accessed on March 11, 2020.

²² See USDA: REE, available at <https://www.ree.usda.gov>, accessed on March 11, 2020.

²³ See USGS: SDC, available at <https://www.usgs.gov/energy-and-minerals/science-and-decisions-center>, accessed on March 11, 2020.

- U.S. Agency for International Development: Bureau for Economic Growth, Education and Environment; Office of Education.²⁴

The range of federal programs and grants that support sustainability is larger than identified in the list. Fellows et al. (2018) provide a comprehensive listing of environmental research and development programs that support areas related to economic, societal, and environmental security and leadership, and many of these programs are broadly oriented toward improving sustainability. The NSF Advisory Committee for Environmental Research and Education (2015) presents both a decadal vision and recommendation for environmental research and sustainability education at NSF.

The Higher Education Sustainability Act of 2019 under consideration by Congress recognizes the role that universities play to “design and implement the teaching and practice of sustainability, including in the areas of staff and faculty professional development, energy management, greenhouse gas emissions reductions, green building, waste management, transportation, resilience, green workforce, and other aspects of sustainability.” Given the range of federal programs that currently support sustainability-related activities, other agencies would also be suitable to support grant programs for sustainability education and research. In addition, it is critical to ensure that minority-serving institutions, as codified by the U.S. Department of Education,²⁵ can compete effectively for access to the grants. This is consistent with the intent of the statement in Executive Order No. 12898, titled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*: “Each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.” (The White House, 1994). Therefore, the committee offers the following recommendation:

Recommendation 4.3: Federal agencies should increase their support for sustainability education programs, and they should include provisions for minority-serving institutions to apply for and receive grants to establish or revise sustainability education programs.

²⁴ See USAID: E3, available at <https://www.usaid.gov/who-we-are/organization/bureaus/bureau-economic-growth-education-and-environment>; E3/ED, available at <https://www.usaid.gov/who-we-are/organization/bureaus/bureau-economic-growth-education-and-environment/office-education>; both accessed on March 11, 2020.

²⁵ For a description of what constitutes minority-serving institution, see <https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html>, accessed on March 11, 2020.

SUSTAINABILITY EDUCATION RESEARCH AGENDA

The committee's statement of task includes a discussion of research agendas related to sustainability and the SDGs and the role of academic institutions to inform post-2030 processes. Just as *Our Common Journey: A Transition Toward Sustainability* (NRC, 1999) advocated for research into sustainability science as an interdisciplinary field, this committee recommends a sustainability education research agenda that addresses how the field has evolved and how it will continue to evolve. We suggest a focus on three broad themes that concern existing knowledge gaps in relation to sustainability education.

First, research is needed on the effectiveness of sustainability curricula, both for the purpose of program-level evaluation and as part of a global community of practice. Despite the growth in sustainability programs, both in the United States and internationally, there remains a gap in how to evaluate these programs (O'Byrne et al., 2015; Vare et al., 2019). While some programs may gauge their own efficacy or commission independent reviews, there is a dearth of shared criteria, indicators, or benchmarks by which to measure success. During the committee's third workshop in January 2020, participants discussed these gaps in evaluation, and identified several programs where individual evaluations are undertaken, or even commissioned by external evaluators, but without internal synthesis, public release, or reference to standardized criteria, limiting their relevance outside the institution. Research is also needed to understand what effect the addition of new sustainability curricula may have on higher education institutions overall, specifically considering funding and grants, the distribution of students among programs, and on academic or other practice-based collaborations.

A second gap concerns the sustainability workforce. A more systematic understanding of the current marketplace for sustainability jobs and pathways for students graduating from higher education institutions is critically needed. More and better data will allow educators to make sense of the increase in and diversity of sustainability-related jobs. Mapping those jobs into an ontology of the workforce may help distill new roles, point to trends, and note changing terminology, if they are monitored over time. Central to this research is to define what constitutes a sustainability job, who belongs to the sustainability workforce, and what data (with disaggregation) must be captured. Such research could also uncover the evolving definitions of a sustainability job and career path by different employers, from well-established public and private entities to start-ups led by recent graduates.

This report also notes the lack of data on the career pathways of sustainability graduates, and on whether these graduates feel prepared for the professional fields they enter. Likewise, little research exists about how persons currently working in sustainability fields were trained, and what aspects of a formal sustainability program may have been most beneficial. What influence does a sustainability curriculum—considering the diversity of concentrations, certificates, minors, majors, or graduate-level study—have on the employment patterns and

career decisions of graduates? Now that some sustainability programs have been in place for more than a decade, it should be possible to track post-graduation employment trends.

Research is needed to understand how core competencies in sustainability education programs may be converging, diverging, or otherwise evolving, and their relationship to a post-2030 agenda (Brundiers et al., 2020). It is also important to ascertain how the core competencies are translated into program-level learning outcomes, assessment tools, and effective curricula for a broad array of institutions of higher learning.

Finally, research is necessary into sustainability education itself to better understand how contextual factors enable and affect outcomes of these programs. Corcoran (2010) pointedly noted that “changes are necessary in curricula, pedagogy, policy, and institutional structures” in order for education to address the challenges of unsustainability. Sterling (2004) argued that addressing the current challenges of unsustainability requires change in educational culture that “builds on and goes beyond the traditions of environmental education and subsequent expressions of sustainability education.” Other researchers have made similar calls for change in sustainability education (Dawe et al., 2005; Cotton et al., 2009; Hart et al., 2016).

A wide range of student-centered, interactive, and inquiry-based pedagogies for sustainability education are already in place (Cotton et al., 2007; Cotton and Winter, 2010). Some are participatory and inclusive processes, transdisciplinary cooperation, experiential learning, service learning, community engagement, and organizational learning (see Chapter 3). However, research on the effectiveness of different pedagogies in sustainability higher education remains a very real and important need. Such research is necessary because “many of the core principles of integrating sustainability into higher education require substantial shifts in thinking and practice that may be out of reach of the individual lecturer and more challenging for some disciplines than others” (Cotton and Winter, 2010). Thus, research on sustainability pedagogies would produce a body of knowledge that individuals, institutions, and disciplines can utilize to strengthen their ability to successfully educate students to become effective change agents for sustainability (see Chapter 5).

The evolution of sustainability programs will include emerging areas highlighted during the committee’s workshops, such as artificial intelligence and machine learning, big data, and questions of ethics and bias within these enablers. Research is needed on how these tools may be used to assess sustainability and the performance of organizations (Nilashi et al., 2019; How et al., 2020), to advance or inhibit progress toward sustainable development and the SDGs (Goralski and Tan, 2019), and on whether mainstream application of these technologies may exacerbate existing inequalities based on embedded bias (Vinueza et al., 2020).

During the committee's report review process, the novel coronavirus pandemic has sparked concerns about the significant impact of health- and disease-related shocks on the sustainability of existing economic and social organizations within the United States and abroad. COVID-19 is a system "shock" in the parlance of resilience (Walker et al., 2004; Walker and Salt, 2006), one that has exposed and exacerbated existing racial and socioeconomic inequalities in health care, employment, education, and housing. The response to, and recovery from, COVID-19 will shape the next decade and impact the ability to achieve the SDGs by 2030. This presents further opportunities for sustainability education research, particularly around effective ways to educate students to address systemic inequalities, collective action and public goods, and the role of cities and subnational government within the multilateral system. Such research may also help sustainability education programs to better prepare students for a post-2030 agenda (Susskind et al., 2020).

Hence, the committee makes the following recommendation:

Recommendation 4.4: To strengthen and support sustainability education programs, research should be conducted on (i) the effectiveness of sustainability curricula for achieving program-level goals and contributing positively to communities of practice, along with impacts on activities within higher education institutions overall; (ii) the marketplace for sustainability jobs and pathways for students to secure those opportunities; (iii) how core competencies and content areas in sustainability programs may be converging, diverging, or otherwise evolving; and (iv) how these programs will prepare students for a post-2030 agenda for sustainable development.

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5

Developing a Sustainability Workforce

Chapter 3 outlines the conceptual underpinnings necessary for a robust sustainability curriculum, which include the need to develop competency in five realms, to develop capacities to act on these competencies, and to have the knowledge foundation to build on these capacities in a variety of contexts. Chapter 4 examined how these concepts are realized in institutions, and how to address impeding factors. In Chapter 5, the focus turns to developing and supporting the individual student, maintaining that a sustainability graduate can become, ideally, an agent of change to create a more sustainable world.

CONSIDERATIONS BEYOND THE ACADEMIC

Before summarizing the research and related information about developing change agents, it is important to recognize a self-evident and sometimes ignored reality. Simply put, students are individuals who do not abandon their identities when they enter a classroom or work at a field site. This reality was expressed by workshop participants in different ways—in the challenges they face and how sustainability programs can offer some solutions.

Students face many economic pressures. As noted in Chapter 3, students may be unable to take advantage of experiential learning opportunities in different locations that require additional travel costs or unpaid/underpaid internships. Even with financial aid, students are faced with high living costs that lead them to take on one or more jobs. The Urban Institute estimates that 11 percent of students in 4-year colleges experience food insecurity (Blagg et al., 2017). An administrator at the University of California, Santa Cruz, the site of the committee's third workshop, acknowledged the impact of the area's high cost of living on

student well-being. The farm run by the university's Center for Agroecology and Sustainable Food Systems was set up more than 50 years ago to experiment with different types of plant and animal products. Its harvests now also go to provide fresh produce, ready-to-eat meals, and other food at a low cost to students.

Many students entering sustainability courses and degree programs are propelled by a desire to change the world. Some of those students come from communities and neighborhoods that are themselves disproportionately affected by poverty, climate change, air pollution, unsafe drinking water, and other problems. One student from the Santa Cruz workshop reported a dean at another university asserting to her that environmental justice was not an "academic discipline" and therefore had no part in the classroom. Yet, drawing on these lived experiences can improve the learning outcomes for all.

The idea of "wraparound services" has gained traction in higher education. While it is beyond the scope of this report to go into these services in detail, several participants pointed out that students must have sustainability in their own life to become an effective sustainability student and, ultimately, sustainability professional.

DEVELOPING CHANGE AGENTS

Theory and research regarding the role of change agents in achieving SDGs provides important insights into the design of sustainability programs. Change agents are people who play a significant role in "initiating, managing, or implementing change" (Caldwell, 2003). To address complex sustainability issues, change agents may be challenging long-held assumptions, practices, and/or policies. According to Van Poeck et al. (2017), change agency "is always related to political struggles on what, how, who, why, and when to change." Further, they state, change agents need to understand the technical or scientific solutions, but that is not enough: "Rather, it is a matter of engaging with the multi-dynamic complexity of wicked problems, including tensions between stability and change, short term and long term, local and global, rich and poor, etc."

An analysis by Van Poeck et al. (2017) drew on examples of change agents in varied sustainability education settings in Belgium and Denmark. The authors mapped the roles that change agents played on two axes (see Figure 5-1). The vertical axis looked at instrumental versus open-ended agency: in other words, operating more as a networker or facilitator (open-ended) versus more as a manager or exemplar (instrumental). The second axis graphs personal detachment versus involvement. Against these axes, they identified four main types of sustainability change agents: Technician, Convincer, Mediator, and Concerned Explorer. A change agent's role and performance will change over time, depending on the challenge at hand, the circumstances, the stages in the person's career, and other factors.

Sustainability practitioners can draw from other change management models. For example, the Situational Leadership Model, developed by Paul Hersey and Ken Blanchard and first introduced as the "Life Cycle of Leadership" (Hersey and

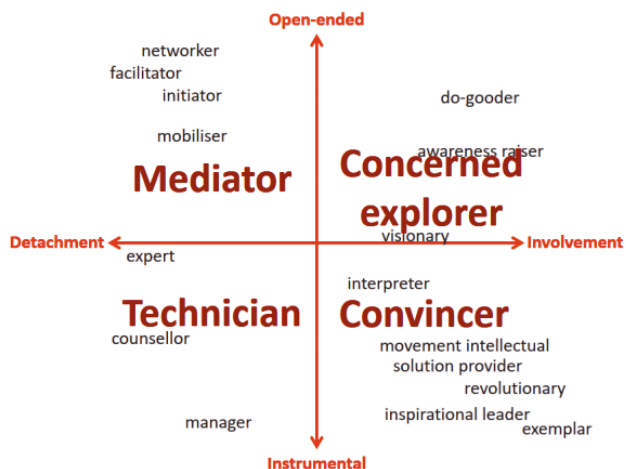


FIGURE 5-1 Ideal typology of change agents.
SOURCE: Van Poeck et al. (2017).

Blanchard, 1969), proposes a taxonomy consisting of four leadership styles, including telling, selling, participating, and delegating, and a framework for matching each style to specific situations (Thompson and Glasø, 2015). The model asserts that successful leadership is both task relevant and relationship relevant, and leaders adapt their management style based on groups and individuals according to the situation as they possess different levels of capability and experience. Another example includes the Cohen-Bradford Model of Influence without Authority developed by Allen R. Cohen and David L. Bradford. The model consists of six steps for how to influence others when authority is not present, including (1) assume all are potential allies; (2) clarify your goals and priorities; (3) diagnose the world of the other person; (4) identify relevant currencies, theirs, yours; (5) dealing with relationship; and (6) influence through give and take (Cohen and Bradford, 2005).

Workshop participants concurred with the idea that sustainability programs have a role to play in preparing their students to become change agents—while in school and in their careers. They noted that students often enter their programs already motivated to effect change, but they require knowledge and skills to do so. In addition to the competencies and content areas described in Chapter 3, students need to understand theories of change and leadership. A three-level youth engagement model, in which students start by working on a project, then serve in an advisory role, and then feel prepared to take leadership, was provided by one workshop participant as an example for preparing students for leadership and independence.¹ Workshop participants also emphasized the power of agile learning

¹ See Act for Youth’s statement on youth engagement in organizations, available at http://actfor.youth.net/youth_development/engagement, accessed on March 11, 2020.

methods for leadership training in innovation to solve complex sustainability challenges. One example is the Blue Pioneers Program’s training of innovation leaders to solve ocean sustainability challenges via the raw case method (see Box 5-1).

A network of higher education institutions known as A Network for Graduate Leadership in Sustainability, or ANGLES, was formed to encourage leadership

BOX 5-1

The Raw Case Method in the Blue Pioneers Program

The raw case method of learning was pioneered by several faculty members at the Yale School of Management and Middlebury Institute of International Studies (MIIS) and initially used in regular courses such as Business and Global Issues at MIIS (Shi and Dow, 2019). Raw case learning presents student teams with a specific and demanding assignment that requires teams to collectively discover, analyze, decide, and communicate about a complex problem and relevant solutions. The learning happens in an open, real-time information space.

The Blue Pioneers Program (BPP) at MIIS uses the raw case method in its 2-week accelerator program for innovative solutions to wicked problems (Rittel and Weber, 1973) in ocean conservation and sustainable use. The BPP is inspired by the importance of the blue economy in Asia’s sustainable development and the need for leaders and entrepreneurs who can build organizations that innovate to solve these challenges. A typical raw case assignment of the BPP accelerator program asks students to develop a specific organizational-level strategy to scale up their team’s innovative solution idea into outsized positive impact on solving a wicked ocean problem. For example, the 2019 program assignment was for a real organization, Think Beyond Plastics Foundation, to accelerate innovations in green and sustainable chemistry and alternative models of product fulfillment toward eliminating fossil fuel-based plastics from the packaging industry. Program participants learn by doing, along with on-demand minilectures, coaching, and mentoring, culminating with evaluation of final presentations by a diverse panel of experts.

The BPP experience with this pedagogical approach has shown that participants are highly motivated to take an active role in learning under the weight and urgency of such an assignment—faced with a problem wicked enough to paralyze teams for a couple of days. Faculty have learned to deliver custom, just-in-time teachings that are most helpful to the student project teams. The intense learning environment is also conducive to developing soft skills such as high-performance teamwork and collaborative leadership. The 5-year experiment at MIIS has had more than a dozen examples where unconfident and inexperienced new graduate students went through the overwhelming learning process and transformed themselves into forward-looking, practical, and capable professionals with deliverables that won prestigious case competitions.

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development for sustainability graduate students (see Box 5-2). The ANGLES network encourages the “entire higher education enterprise to become change agents in order to deal with today’s sustainability challenges at multiple levels of agency: as individuals, communities, organizations, networks and systems” (Kremers et al., 2019). The network has identified five critical change-agent capacities: (1) transdisciplinary collaboration and community; (2) intellect and innovation; (3) emotional intelligence and well-being; (4) energy and commitment; and (5) reflexivity, reflection, and action (Kremers et al., 2019). Net Impact is an organization that mobilizes next-generation emerging leaders to use their skills and careers to make a positive impact in the world (Net Impact, 2020). With more than 400 chapters in nearly 40 countries, the organization supports a global network made up of local chapters on university campuses, in cities, and in companies, and runs programs, campaigns, and events to help students build leadership skills and experiences related to sustainability.

Achieving the Sustainable Development Goals will require change agents from multiple disciplines beyond the small percentage who study sustainability in depth (i.e., undergraduate majors or minors and/or as graduate students). All students must feel empowered to create change for a better future. As one participant noted, “Every student will have to deal with sustainability in his or her [or

BOX 5-2

A Network for Graduate Leadership in Sustainability

Established in 2017, ANGLES (A Network for Graduate Leadership in Sustainability) is a network of higher education professionals engaged in graduate student leadership development, with a mission for growing the capacity for collective leadership and impact on sustainability by accelerating and improving leadership development in graduate education. ANGLES hopes to develop a generation of societal change agents capable of drawing on scholarly expertise and leadership capabilities to catalyze collective impact on sustainability challenges. The idea is to benefit from shared learning across institutions.

As of this writing, participating institutions include Arizona State University, Brown University, Colorado State University, Cornell University, Duke University, Leopold Leadership Program,* MARINE (Monterey Area Research Institutions’ Network for Education), McGill University, National Socio-Environmental Synthesis Center, University of British Columbia, University of California (UC) Santa Barbara, UC Santa Cruz, University of Maine, and University of Minnesota.

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ANGLES (A Network for Graduate Leadership in Sustainability). n.d. <http://anglesnetwork.com>.

*In early 2020, the Leopold Leadership Program transitioned to a new name: Earth Leadership Program. See <https://www.earthleadership.org>.

their] lifetime.” One idea proposed was establishing a core requirement course across the academy to teach sustainability principles, which would then serve as a reference when embarking on other fields. A participant at the Washington, D.C., workshop noted that students are demanding to be listened to as partners and demanding transparency and accountability, sincerity, and authenticity. Rage and anger is what propels social justice, another said, but a positive vision can help create sustained change.

An academic program in sustainability, with its roots in evidence and objectivity, traditionally does not teach “rage and anger,” nor should it. As one participant urged, “Students need to go beyond their passions and learn evidence-based decision-making, then how to communicate and persuade to implement change.” These are within the purview of a strong sustainability program.

Sustainability by its nature disrupts the status quo in many domains and will require the development of a sustainability workforce that is capable of guiding effective transitions to sustainable practices. Students are entering sustainability programs with the desire to “change the world for the better.” Academic programs can harness this motivation with the necessary competencies, knowledge, and skills described in this report. As such, the committee makes the following recommendation:

Recommendation 5.1: Completion of a sustainability program in higher education should improve students’ ability to design, implement, and lead proactive change toward a sustainable world. Thus, sustainability education programs should provide training and mentoring support to enhance capacities of their graduates to translate knowledge to effective action to meet emerging local, regional, national, and global needs.

ENHANCING COLLABORATION AMONG SUSTAINABILITY PROFESSIONAL SOCIETIES

As sustainability programs emerge and evolve, students, faculty, and program directors would benefit from opportunities to share best practices, obtain guidance on career paths for students, and join a network or community to share ideas and develop shared principles and values. Professional societies play a role in facilitating community building and resource sharing through convening groups. They also present an entity that can set standards and determine parameters for program evaluations and potential accreditation, as well as lead efforts for standardized data collection about students, employees, and employers. Such capabilities would be valuable to both sustainability education programs and the sustainability workforce. Professional societies are also responsible for setting the standards for professional actions and behaviors by that profession.

A number of organizations are helping to shape the landscape for sustainability educators, students, and professionals, including the following:

- Association for the Advancement of Sustainability in Higher Education (AASHE):² Launched in 2005, its mission is “inspiring higher education to lead the sustainability transition.” AASHE holds an annual conference for sustainability educators in higher education institutions. Many universities participate in its Sustainability Tracking, Assessment and Rating System, which measures sustainability performance of higher education institutions, with an increasing emphasis on adoption and delivery of sustainability curricula. Through the system, universities receive a medal ranking—bronze, silver, gold, or platinum. AASHE also offers professional development training along with toolkits and resources. As of this writing, it has 719 members in North America.
- National Council for Science and the Environment (NCSE):³ Established in 1990, NCSE’s mission is to “improve the scientific basis of environmental policy and decision making.” Member institutions include approximately 100 universities and colleges, 20 community colleges or college districts, and 2 international university members (this latter program was just launched). The NCSE Alliance of Sustainability and Environmental Academic Leaders (formerly known as the Council of Environmental Deans and Directors) meets twice per year, engages in communities of practice (including one on sustainability education), engages with policy makers in an Academic–Federal Dialog, and receives training on science policy communications.
- Second Nature:⁴ Founded in 1993, the mission of Second Nature is a commitment to “accelerating climate action in, and through, higher education.” In 2006, it launched the Presidents’ Climate Leadership Commitments with dedicated targets for climate change action. This initiative formed the basis for the Climate Leadership Network, which includes more than 600 universities and colleges. The organization provides grant funds, solutions toolsets, convenings, and other activities to forward climate change action with universities and colleges.
- Sustainability Curriculum Consortium (SCC):⁵ The purpose of the SCC is to build “collective capacity as educators and change agents, along with the administrators and stakeholders who can support them, to improve the way sustainability is perceived, modeled, and taught.” Through webinars and other convenings, the SCC brings together experts on sustainability

² See <http://www.aashe.org>, accessed on March 10, 2020.

³ See <https://www.ncseglobal.org>, accessed on March 10, 2020.

⁴ See <https://secondnature.org>, accessed on March 10, 2020.

⁵ See <http://curriculumforsustainability.org>, accessed on March 10, 2020.

curricula to share best practices and ideas and seek partnership opportunities for sustainability educators.

- International Society of Sustainability Professionals:⁶ The mission of the society is to “advance sustainability in organizations and communities around the globe.” It provides collaboration and partnership opportunities for members as well as training, including a Sustainability Professional Certification offered in partnership with Green Business Certification Inc.
- Association for Environmental Studies and Sciences (AESS). The AESS is a “faculty-and-student-based professional association in higher education, designed to serve the needs of environmental scholars and scientists who value interdisciplinary approaches to research, teaching, and problem-solving” (AESS, 2020). The AESS has held an annual meeting since 2009 to address an interdisciplinary approach to environmental issues and sustainability.
- National Association of Environmental Professionals (NAEP). The mission of the association is “to be the interdisciplinary organization dedicated to developing the highest standards of ethics and proficiency in the environmental professions” (NAEP, 2020). It is designed for professionals from the public and private sectors to promote excellence in decision-making relating to environmental, social, and economic impacts.

Corporate sustainability organizations continue to grow, reflecting the change in sustainability as a “nice to have” or form of corporate social responsibility to the recognition of sustainability as a “need to have” and for establishing competitive advantage. Some examples include GreenBiz, Ceres, Sustainable Brands, and the World Business Council for Sustainable Development.⁷ Alongside these have grown sustainability-reporting organizations for businesses such as CDP (formerly Carbon Disclosure Project), Global Reporting Initiative, and the United Nations Global Compact initiative.⁸ Successful sustainability education programs will need to pay attention to trends and needs identified by these organizations for both curriculum development and career pathways in sustainability.

During the committee’s second workshop in Washington, D.C., a participant suggested the need to create peer-to-peer networks on two levels: among leadership (embodied by the Council of Environmental Deans and Directors, since renamed to the Alliance of Sustainability and Environmental Academic Leaders) and through a professional society (through the Association for Environmental Studies and Sciences). Including a research component and opportunities for interfacing between academics and the user community are also important, as the annual

⁶ See <https://www.sustainabilityprofessionals.org>, accessed on March 10, 2020.

⁷ See <https://www.greenbiz.com>, <https://www.ceres.org>, <https://sustainablebrands.com>, and <https://www.wbcd.org>, all accessed on March 10, 2020.

⁸ See <https://www.cdp.net/en>, <https://www.globalreporting.org>, and <https://www.unglobalcompact.org>, all accessed on March 10, 2020.

conference of the NCSE provides. Another participant supported these ideas, but emphasized that sustainability includes more fields than environmental science. Several participants said they would find value in the networking and leadership opportunities that a professional society could offer, although it was pointed out that it would be a challenge to balance the multiple disciplines that make up the field with providing relevant information and opportunities. Despite the challenge, many participants, especially those starting out in their careers, expressed the desire to be part of the kind of community that a professional society could offer.

ACCREDITATION

One role played by professional societies in the United States is to serve as an accreditor. More than 50 professional societies accredit the college and university programs in their areas of expertise.⁹ The committee's statement of task (see Box 1-1 in Chapter 1) requested that the committee consider the feasibility of accreditation of sustainability programs to strengthen them and to further engage with the Sustainable Development Goals. According to the U.S. Department of Education, which oversees accrediting organizations, benefits of accreditation include the following:

- Creating a culture of continuous improvement of academic quality at colleges and universities and stimulating a general raising of standards among educational institutions.
- Involving faculty and staff comprehensively in institutional evaluation and planning.
- Establishing criteria for professional certification and licensure and for upgrading courses offering such preparation.
- Assessing the quality of academic programs at institutions of higher education.

At all three workshops, the committee posed a series of questions to elicit the perspectives of educators and end users on the desirability of accreditation for sustainability programs. While participants agreed about the need to strengthen existing sustainability programs and provide guidance for emerging ones, no clear consensus emerged on the topic. Some participants saw accreditation as a way to build credibility and to improve programs. Several drew upon other efforts they have been involved in or observed. Public administration was referred to as an example of a discipline that has gained in stature since accreditation began in

⁹ See Department of Energy, available at <https://www2.ed.gov/admins/finaid/accred/accreditation.html#history>, accessed on April 10, 2020.

1970.¹⁰ In contrast to this relatively recent effort, another said her forestry and natural resources department has been involved in accreditation carried out by the Society of American Foresters since 1935. She pointed to the value of the periodic examination not only for the external review but also as a process of reflection for the faculty, students, and administration. One workshop participant noted accreditation can provide greater legitimacy to a field of study, with public policy and landscape architecture as examples. Another suggested that accreditation could help break down the disciplinary silos identified as an impediment, build a cross-cutting program, and provide some value as a credential, especially small institutions that might see it as a valuable counterweight to larger ones.

Others, however, expressed concern that accreditation would pose an obstacle or a bar to entry. An institution may decide not to expand or initiate a program with accreditation requirements. For example, the Accreditation Board for Engineering and Technology has been evaluating chemical engineering programs at universities in the United States since the 1930s; however, California Institute of Technology's chemical engineering department and Stanford University have recently decided not to pursue accreditation in order to modernize their curricula and offer students more flexibility in designing programs (Arnaud, 2017). Accreditation might hamper diversity efforts, a few people pointed out, especially if less-resourced schools where underrepresented minorities attend in greater numbers are discouraged from the field. Another concern related to employment security, including people already in the workplace, if an applicant had not graduated from an "accredited program."

End users at the workshops did not consider accreditation a critical aspect in their hiring. While they said they did require graduation from an accredited program vital in fields such as architecture, several said they are more concerned with a sustainability applicant's course work, internships, and competencies. Another employer said she envisioned a future in which "all jobs become sustainability jobs," and accreditation would narrow, rather than broaden, the field.

Many workshop participants pointed to certifications that individuals could earn and may be considered more valuable to an employer than accreditation of their colleges and universities; examples cited included the International Organization for Standardization's ISO 14001 requirements for environmental management systems and the U.S. Green Building Council's Leadership in Energy and Environmental Design certification, among others.¹¹ A benefit in such programs is that individuals must continue their education and training to remain certified.

In consideration of possible accreditation in the future, several participants suggested strategies that are more voluntary and less rigorous than a full-bore

¹⁰ Network of Schools of Public Policy, Affairs, and Administration is the accrediting body—self-described as the "Global Standard in Public Service Education Network of Schools of Public Policy, Affairs, and Administration."

¹¹ See ISO 14000, available at <https://www.iso.org/iso-14001-environmental-management.html>; LEED rating system, available at <https://www.usgbc.org/leed>; both accessed on March 12, 2020.

accreditation program, yet still useful to students and other stakeholders. The Canadian Environmental Certification Approvals Board was mentioned as one such assessment that might serve as, at least in the short to medium term, a way for programs to self-measure their performance.

The Sustainability Curriculum Consortium and National Council on Science and the Environment have had some discussions about accreditation, according to several workshop participants familiar with the effort. They felt that agreement over a common body of knowledge for sustainability needs to emerge first. During this report's preparation, a community of practice was established within the Council of Environmental Deans and Directors, facilitated by the NCSE (currently known as the Alliance of Sustainability and Environmental Academic Leaders), and this would be a useful development to track.

As sustainability education programs continue to increase and evolve, it is important for existing professional societies concerned with sustainability to consider strategies that could strengthen higher education programs. Such strategies could include opportunities for professional development, networking, collaboration, and data collection, and the development of metrics for assessing, certifying, and/or accrediting programs. Additionally, industries could work with these organizations to meet sustainability goals and objectives, establish targets, and encourage students to bring innovation and creativity to address sustainability challenges and opportunities. Therefore, the committee recommends the following:

Recommendation 5.2: Professional societies focusing on sustainability education should pursue collaborative opportunities to (i) provide forums for convening sustainability students, researchers, and professionals; (ii) build partnerships with the public and the private sectors; (iii) offer formalized training and mentorship; (iv) promote information sharing; (v) develop shared principles and values; (vi) establish a model for assessing sustainability programs; and (vii) establish and lead a cross-sectoral effort to track and analyze employment in sustainability-focused jobs.

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6

Final Thoughts and Summary of Recommendations by Stakeholder

Sustainability education for undergraduate and graduate students is still in its early stage, but the tremendous growth and evolution of curricula and programs provides an opportunity to address the urgent environmental, economic, and societal challenges of communities worldwide. The highly interdisciplinary nature of the field provides a variety of access points for students from all backgrounds and disciplines to learn sustainability knowledge and principles. In addition, the continued growth of sustainability programs will shape the experiences of future undergraduate and graduate students and may one day become a staple of higher education studies. The higher education community should engage with the recommendations put forth in this report so that there is a cohesive guide to students and faculty in selecting their programs, a reference for employers to understand the qualifications for sustainability graduates, and a foundation for potential accreditation in the future.

Education is core to achieving sustainability goals. From K–12 through continuing education and training, education provides a way to equip people with the knowledge and skills to address sustainability challenges, whether framed as the United Nations Sustainable Development Goals or otherwise. By focusing on undergraduate and graduate education, the committee has shown how higher education institutions play a vital role in research, collaborative action, and workforce development. Our recommendations suggest ways forward in addressing the competencies, capacities, and content areas that students should master; the ways that academic institutions can offer a rich learning experience to a diverse and inclusive student body; and how the sustainability workforce can be strengthened to benefit the entire nation and the world now and into the future.

To clarify the obligations of various stakeholders to strengthen sustainability programs in higher education, the following section reorders the committee's recommendations by stakeholder. While recommendations are assigned to a stakeholder, their implementation will often require collaborative efforts by several or all stakeholders.

COMMITTEE RECOMMENDATIONS BY STAKEHOLDER

Federal agencies should

- Increase their support for sustainability education programs, and provisions should be included for minority-serving institutions to apply for and receive grants to establish or revise sustainability education programs. (Recommendation 4.3)
- Support research on (i) the effectiveness of sustainability curricula for achieving program-level goals and contributing positively to communities of practice, along with impacts on activities within higher education institutions overall; (ii) the marketplace for sustainability jobs and pathways for students to secure those opportunities; (iii) how core competencies and content areas in sustainability programs may be converging, diverging, or otherwise evolving; and (iv) how these programs will prepare students for a post-2030 agenda for sustainable development. (Recommendation 4.4)

Senior leaders of higher education institutions, from presidents to deans, should

- Embrace sustainability education as a vital field that requires specifically tailored educational experiences and the development of core sustainability-focused competencies and capacities delivered through courses, majors, minors, certifications, research, and graduate degrees in sustainability. (Recommendation 3.1)
- Encourage the development of, implementation of, and participation in interdisciplinary sustainability programs that bridge disciplinary silos by fostering effective strategies such as team teaching, curriculum planning, interdisciplinary advising and preparation of graduate students, and educator trainings across departments about competencies and content areas of sustainability. Sustainability programs can be launched and evolve under a variety of institutional arrangements, but a commitment to and value of inclusivity and interdisciplinarity is of fundamental importance, particularly from top leaders of higher education institutions. (Recommendation 4.1)

Directors of sustainability programs, supported by their deans and directors, in higher education should

- Encompass key and emerging sustainability content areas to prepare students to address complex sustainability challenges in a real-world setting while incorporating problem-based and solution-oriented approaches to sustainability. (Recommendation 3.2)
- Develop curricula and programs covering the highly interdependent, varied, and complex contexts of sustainability (including organizational contexts), to develop their ability to discern and address historical and contemporary trajectories and consequences of sustainability processes, and to apply their learning in experiential learning settings (community, organizational, service) so that learners can be more effective implementers of effective transitions toward sustainability. (Recommendation 3.3)
- Prioritize attracting students with varied backgrounds and lived experiences, supporting them for success in a variety of sustainability careers. This also requires attracting and retaining faculty from diverse backgrounds in sustainability education programs, with additional attention to equity, inclusion, and local and Indigenous knowledge in the content of the curriculum and the institutional setting. (Recommendation 4.2)
- Provide training and mentoring support to enhance capacities of their students to translate knowledge to effective action, thereby improving students' ability to design, implement, and lead proactive change toward a sustainable world. (Recommendation 5.1)

Faculty in sustainability should

- Collaborate with sustainability professionals to address global sustainability challenges and opportunities. Professional societies focusing on sustainability education should pursue collaborative opportunities to provide forums for convening sustainability students, researchers, and professionals; build and expand partnerships with the public and private sectors; offer formalized training and mentorship; develop shared principles and values; establish a model for assessing sustainability programs; and establish and lead a cross-sectoral effort to track and analyze employment in sustainability-focused jobs. (Recommendation 5.2)
- Incorporate key and emerging sustainability content areas to prepare students to address complex sustainability challenges in a real-world setting while incorporating problem-based and solution-oriented approaches to sustainability. (Recommendation 3.2)
- Train students to understand the highly interdependent, varied and complex contexts of sustainability (including organizational contexts), to de-

velop their ability to discern and address the historical and contemporary trajectories and consequences of sustainability processes, and to apply their learning in experiential learning settings (community, organizational, service) so that learners can be more effective implementers of effective transitions toward sustainability. (Recommendation 3.3)

- Conduct research on (i) the effectiveness of sustainability curricula for achieving program-level goals and contributing positively to communities of practice, along with impacts on activities within higher education institutions overall; (ii) the marketplace for sustainability jobs and pathways for students to secure those opportunities; (iii) how core competencies and content areas in sustainability programs may be converging, diverging, or otherwise evolving; and (iv) how these programs will prepare students for a post-2030 agenda for sustainable development. (Recommendation 4.4)

Sustainability professionals in the private sector and nongovernmental organizations should

- Collaborate with faculty leaders and other sustainability professionals to address global sustainability challenges and opportunities. Professional societies focusing on sustainability education should pursue collaborative opportunities to provide forums for convening sustainability students, researchers, and professionals; build and expand partnerships with the public and private sectors; offer formalized training and mentorship; develop shared principles and values; establish a model for assessing sustainability programs; and establish and lead a cross-sectoral effort to track and analyze employment in sustainability-focused jobs. (Recommendation 5.2)

Appendix A

Definitions of Key Terms and Phrases Used in the Report

Sustainable Development

We use *sustainable development* with reference to its original use in *Our Common Future* (WCED, 1987, 37), and define it as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” This is consistent with its use in the United Nations Sustainable Development Goals and similar contexts in which the term refers to the intergenerational balance between economic, environmental, and social constraints in the pursuit of human development. Culture is increasingly included as a sustainability constraint (Pereira Roders and van Oers, 2011).

Sustainability

Sustainability refers to achieving individual, societal, and environmental well-being in present and future generations. The pursuit of sustainability explicitly links social, economic, and environmental goals. It requires understanding and working with the dynamics of socio-environmental systems (Matson et al., 2016). Different communities, initiatives, and scholars have articulated different specific goals, approaches, and outcomes in pursuit of sustainability (NRC, 1999; Quental et al., 2011; UN, 2015). Conceptions of sustainability range from those with an instrumental focus, such as the triple bottom line of benefiting “people, planet and profit” (McDonough and Braungart, 2002), and the three pillars of sustainability, with a focus on reconciling economic, social, and environmental goals (Purvis et al., 2019), to visionary aspiration for sustainability as the possibility of human and other life flourishing indefinitely on Earth (Ehrenfeld and Hoffman, 2013). The irreducibility of different goals, approaches, and outcomes is an inherent

characteristic of sustainability (Lélé and Norgaard, 1996; Quental et al., 2011) and underpins this report's themes and recommendations. It also offers entry points for integrating many academic fields, practitioner partners, and career paths into interdisciplinary sustainability curricula and programs in higher education.

Sustainability Education

Sustainability education refers to all aspects of student learning about sustainability in postsecondary or higher education. It includes student engagement in curricular and pedagogical aspects of instruction, student research, and student experiential learning at the undergraduate and graduate levels. Sustainability education is related to Education for Sustainable Development, or ESD, and environmental education.¹ All three seek to develop a set of overlapping competencies in students; sustainability education encompasses the focus of ESD on processes and the focus of environmental education on ecosystems and the environment. Sustainability education seeks to link human and environmental well-being, thereby going beyond understanding the nature of environmental systems to include a focus on intra- and intergenerational human well-being. Its orientation is normative and interventionist, asking students to consider what the future should be and what we do to make it happen. This includes empathy and consideration of different value systems with a commitment to justice and equity (Jones et al., 2010; Moore, 2005b; Victor, 2009).

In this report the terms *sustainability education* and *sustainability in higher education* are used interchangeably. Sustainability initiatives for campus operations, such as reducing water use, installing renewable energy systems, or reducing food waste may be part of the student educational experience. Where the report mentions such campus sustainability projects or initiatives, the words “project” and “initiative” are used, respectively, to describe them.

Sustainability Education Programs/Sustainability Programs in Higher Education

This report uses the terms *sustainability education programs* and *sustainability programs in higher education* interchangeably. “Programs” covers the range of educational, research, and engagement activities that are part of educational and curricular offerings, and it includes undergraduate and graduate majors and associated degree programs, minors, certificate programs, concentration or specialization areas, practicums, service, and/or experiential learning activities. The term also includes curricular and pedagogical practices as well as basic and applied research on sustainability issues. Chapter 2 provides examples of different

¹ See UNESCO *What is Education for Sustainable Development*, available at <https://en.unesco.org/themes/education-sustainable-development/what-is-esd>, accessed on September 23, 2020.

types of sustainability education programs. Many disciplines, from architecture to zoology, include sustainability issues but are not sustainability programs, per se. What distinguishes a sustainability education program is its integrated focus on the economic, environmental, and social dimensions of human development (Moore, 2005a).

Sustainability Curricula

Sustainability curricula refers to all the curricular and pedagogical concepts, activities, products, and processes associated with sustainability education programs as defined above (Thomas, 2004). These curricula vary widely across institutions because the interdisciplinary academic field of sustainability is still developing, and there is as yet no accredited standard curriculum for sustainability education (Rowe, 2007; Brundiers et al., 2020).

Sustainability Science Research

Sustainability science research, a component of many sustainability in higher education programs, refers to use-inspired basic and applied research that advances both “useful knowledge and informed action” on sustainability issues (Clark, 2007). Student participation in sustainability science research may occur within higher education institutions or outside at other institutions that conduct such research, including corporations, foundations, think tanks, government agencies or nonprofit and other civic society organizations (Hirsch-Hadorn et al., 2006). Sustainability science research is discussed further in Chapter 2.

Sustainability Education Research

The definition of *sustainability education research* differs from the definition of sustainability science research. Sustainability education research focuses on issues of curriculum, pedagogy, student learning, and the assessment and evaluation of educational processes, programs, and outcomes, including the relationship of student learning and training with career trajectories and labor market outcomes. Sund and Lysgaard (2013) appeal for grounding this research in educational philosophy and emphasizing this research on the process of “education” aimed at “enhancing the acquisition of knowledge and understanding, and supporting the development of independent thought” as a key element of sustainability education.

Environmental Education

Environmental education refers to the range of subjects in education about the environment and spans a broad range of disciplinary subfields, such as envi-

ronmental science, environmental engineering, ecology, environmental chemistry, environmental economics or ecological economics, environmental sociology, environmental anthropology, environmental history, and environmental humanities. Environmental education may include topics that are relevant to and included in sustainability education, but when it focuses solely on principles and processes of the natural environment or seeks only to apply knowledge from a specific discipline to environmental challenges, it is different from sustainability education. That is, sustainability education's consideration of the natural environment always is within the broader context of the social and economic environments in which generations of humanity live (Pearson et al., 2005). Similar to how engineering draws on physics or medicine draws on biology, sustainability education draws on and integrates disciplinary knowledges to teach students how to develop interventions to solve problems and improve well-being.

The committee notes, however, that many interdisciplinary higher education programs that call themselves “Environmental Studies” or “Environment Sciences” align with the attributes of sustainability education (see the definition for this term). For instance, a large survey of U.S. interdisciplinary environmental programs found consensus in defining the field as “an applied, interdisciplinary focus on the interface of coupled human-natural systems with a normative commitment to sustainability” (Vincent and Focht, 2011). The survey also found a positive relationship between enrollment and program inclusion of sustainability (in core principles, course work, and research and service learning opportunities), preparing students to be change agents and providing community service. These parallel major features of sustainability education are addressed in Chapters 3 and 4 of this report.

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Appendix B

Abbreviations and Acronyms

AASHE	Association for the Advancement of Sustainability in Higher Education
ACUPCC	American College and University Presidents Climate Commitment
AESS	Association for Environmental Studies and Sciences
AIHEC	American Indian Higher Education Consortium
ANGLES	A Network for Graduate Leadership in Sustainability
ASU	Arizona State University
BLS	U.S. Bureau of Labor Statistics
BPP	Blue Pioneers Program at the Middlebury Institute
CHANS	Coupled human and natural systems
CSP	Coastal Science and Policy, University of California, Santa Cruz
DDCSP	Doris Duke Conservation Scholars Program
EfS	Education for Sustainability
EGA	Environmental Grantmakers Association
ESD	Education for Sustainable Development
ESG	Environmental, social, and governance
HESA	Higher Education Sustainability Act

IESE	Interdisciplinary Environmental, Sustainability, and Energy
IFSTAL	Interdisciplinary Food Systems Teaching and Learning
INCLUDES	Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science
MIIS	Middlebury Institute of International Studies
NASA	National Aeronautics and Space Administration
NCSE	National Council for Science and the Environment
NIH	National Institutes of Health
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
SDG	Sustainable Development Goal
SEAS	School for Environment and Sustainability, University of Michigan
SEEDS	Strategies for Ecology Education, Diversity, and Sustainability
STARS	Sustainability Tracking, Assessment, and Rating System
STEM	Science, Technology, Engineering, and Mathematics
UC	University of California
UCSC	University of California, Santa Cruz
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WCED	World Commission on Environment and Development

Appendix C

Biographies of Committee Members

ANNE R. KAPUSCINSKI (*Chair*) is director of the Coastal Science and Policy Program and professor of the Environmental Studies Department at the University of California, Santa Cruz. Her current research aims to shift aquaculture, the world's fastest-growing food sector, toward sustainability. Her past research examined impacts of dams, fish hatcheries, aquaculture, and genetic engineering on fish conservation. Dr. Kapuscinski previously served as the inaugural Sherman Fairchild Distinguished Professor of Sustainability Science and former chair of the Environmental Studies Program at Dartmouth College. Prior to Dartmouth, while a professor of fisheries and conservation biology at the University of Minnesota, she led the development of and 2007 launch of an interdisciplinary undergraduate minor in sustainability studies. She participates actively in the science-policy interface, presently as chair of the Board of Directors of the Union of Concerned Scientists and as a member of the California Ocean Protection Council Science Advisory Team, and has been a scientific advisor to the U.S. Secretary of Agriculture (under three administrations), U.S. Food and Drug Administration, World Health Organization, Food and Agriculture Organization of the United Nations, Global Environment Facility, European Union Food Safety Agency, and state of Minnesota, and has served on four U.S. National Academy of Sciences committees. Dr. Kapuscinski received her B.A. in biology from Swarthmore College and her M.S. and Ph.D. in fisheries from Oregon State University.

ARUN AGRAWAL (NAS) is Samuel Trask Dana Professor at the School for the Environment and Sustainability at the University of Michigan. His research and teaching emphasize the politics of international development, institutional change, and environmental conservation. He has written critically

on Indigenous knowledge, community-based conservation, common property, population and resources, and environmental identities. Since 2013, Dr. Agrawal has served as the editor-in-chief of *World Development*, and his recent work has appeared in *Science*, *Proceedings of the National Academy of Sciences of the United States of America*, *Conservation Biology*, and *Development and Change*, among other journals. Preceding his work at the University of Michigan, Dr. Agrawal held teaching and research positions at Yale University; University of Florida; McGill University; University of California, Berkeley; and Harvard University, among others. Dr. Agrawal received his Ph.D. in political science (1992) from Duke University.

CHRISTOPHER BOONE is dean of the College of Global Futures and professor in the School of Sustainability at Arizona State University (ASU). His research contributes to ongoing debates in sustainable urbanization, environmental justice, vulnerability, and global environmental change. At ASU, he has taught classes on sustainable urbanization, urban and environmental health, principles and methods of sustainability, environmental justice, interdisciplinary methods for socio-ecological research, and sustainable design (Innovation Space). Dr. Boone earned his Ph.D. in geography (1994) from the University of Toronto.

ERIN BROMAGHIM serves as the director of Olympic and Paralympic Development in the Office of the Mayor of the City of Los Angeles. In this role, Ms. Bromaghim is focused on realizing the city's plans to make Los Angeles more sustainable, inclusive, resilient, and innovative as they prepare to host the Olympic and Paralympic Games in 2028. This legacy includes her work as a Conrad N. Hilton Foundation Fellow, through which she uses the framework of the United Nation's Agenda 2030 to align, measure, and track the city's progress toward the 17 Sustainable Development Goals. She previously served as a senior civilian with the U.S. Air Force, where she managed multiple complex defense, intelligence, and security reform efforts over nearly 14 years with the Defense Department. Ms. Bromaghim entered federal civil service as a Presidential Management Fellow with the U.S. Navy, later working for the Office of the Secretary of Defense and NATO. She received her B.A. from Wake Forest University and an M.A. from Georgetown University, and completed additional studies at the University of Havana, Stanford University, and Harrison Metal.

GARRICK E. LOUIS is associate professor of engineering systems and environment at the University of Virginia. He is director of the Small Infrastructure and Development Center. His research seeks to provide sustained access to basic human services, including water and sanitation, to developing communities. He holds B.S. and M.S. degrees in chemical engineering and a Ph.D. in engineering and public policy. His honors include the 2000 Presidential Early Career Award for Scientists and Engineers from the National Science Foundation, 2006–2007

American Association for the Advancement of Science Energy Environment and Natural Resources Fellow, 2014 Design and Health Faculty Fellow at the University of Virginia, and 2015–2016 Jefferson Science Fellow in the Office of Global Food Security at the U.S. Department of State, and he is the Global Fulbright Specialist for the U.S. Department of State.

DORCETA E. TAYLOR is a professor of environmental justice at Yale School of the Environment. Prior to this appointment, Dr. Taylor was a professor of environmental sociology at the University of Michigan’s School for Environment and Sustainability (SEAS). She served as the James E. Crowfoot Collegiate Chair of Environmental Justice and the director of diversity, equity, and inclusion at SEAS, and held a joint appointment with the Program in the Environment. Dr. Taylor is the former Field of Studies coordinator for SEAS’ Environmental Justice Program and a past chair of the American Sociological Association’s Section on Environment and Technology. She received dual doctorates in sociology and forestry and environmental studies from Yale University in 1991, a master of arts and master of philosophy from Yale University in sociology and forestry and environmental studies in 1988, and a master of forest science from the Yale School of Forestry and Environmental Studies in 1985. Dr. Taylor is the recipient of several awards, including the National Audubon Society Women in Conservation Award, the Burton V. Barnes Award for Academic Excellence from the Michigan Chapter of the Sierra Club, the Charles Horton Cooley Award for Distinguished Scholarship from the Michigan Sociological Association, the Frederick B. Buttler Distinguished Contribution Award from the Section on Environment and Technology of the American Sociological Association, and the William Freudenberg Lifetime Achievement Award of the Association for Environmental Sciences and Studies.

Appendix D

Workshop Agendas

This appendix provides the agendas of the committee’s three public workshops, from which they gathered input for the recommendations issued in this report. Summaries of the three workshops are available at <http://www.nap.edu/>.

The first workshop was held December 7, 2018, at the Cynthia and George Mitchell Foundation in Austin, Texas. This workshop was structured as a series of interactive discussions composed of trainers (faculty and other educators) and end users (public- and private-sector employers)—first in two separate groups and then in plenary. They considered such issues as best practices, trends, and gaps related to sustainability education.

At the second workshop, held February 13, 2019, at the National Academies in Washington, D.C., a similar set of breakout and plenary discussions took place. In addition, Rod Parnell, professor of geology and environmental science, Northern Arizona University, made a keynote presentation about current practices and advances in sustainability education with an emphasis on key competencies.

The third workshop took place January 24, 2020, at the University of California, Santa Cruz. The committee structured this workshop around a series of panels consisting of students and recent alumni, end users, and educators. In addition, a member of the staff of Senator Sheldon Whitehouse (D-RI) spoke about a current legislative initiative around sustainability education.

Workshop 1, December 7, 2018**STRENGTHENING SUSTAINABILITY PROGRAMS AND CURRICULA
AT THE UNDERGRADUATE AND GRADUATE LEVELS****Workshop Agenda**

The Cynthia and George Mitchell Foundation
1300 Guadalupe, Suite 250
Austin, TX

- 8:30 am – 9:00 am** **Welcome remarks and kickoff**
- Chair Anne Kapuscinski welcomes the attendees and frames their work
 - Marilu Hastings from the Mitchell Foundation discusses their support for this project
 - Chair Anne Kapuscinski provides context for the day’s activities
- 9:00 am – 10:00 am** **Breakout Session 1**
- Participants break out into 2 groups, representing either “Trainer Perspectives” or “End User Perspectives”; session moderated by committee members
- 10:00 am – 10:15 am** **Break**
- 10:15 am – 11:00 am** **Report out from Breakout Session 1 and Group Discussion**
- 11:00 am – 12:00 pm** **Breakout Session 2**
- Participants break out into 2 mixed groups; session moderated by committee members
- 12:00 pm – 1:00 pm** **Break**
- 1:00 pm – 1:45 pm** **Report out from Breakout Session 2 and Group Discussion**
- 1:45 pm – 3:00 pm** **Whole group discussion with new questions**
- 3:00 pm – 3:30 pm** **Final discussion and closing remarks**
- 3:30pm** **Workshop adjourns**

Workshop 2, February 13, 2019**STRENGTHENING SUSTAINABILITY PROGRAMS AND CURRICULA
AT THE UNDERGRADUATE AND GRADUATE LEVELS****Workshop Agenda**

The National Academy of Sciences
2101 Constitution Avenue
Washington, D.C.

- 9:00 am – 9:30 am** **Welcome remarks and kickoff**
- Board Director Tom Rudin welcomes participants and kicks off the workshop
 - Chair Anne Kapuscinski welcomes the attendees and provides context for the day’s activities
- 9:30 am – 10:30 am** **Breakout Session 1**
- Participants break out into 3–4 groups, representing either “Trainer Perspectives” or “End User Perspectives”; session moderated by committee members
- 10:30 am – 10:45 am** **Break**
- 10:45 am – 11:30 am** **Report out from Breakout Session 1 and Group Discussion**
- 11:30 am – 12:30 pm** **Breakout Session 2**
- Participants break out into 3–4 mixed groups; session moderated by committee members
- 12:30 pm – 1:30 pm** **Break**
- 1:30 pm – 2:15 pm** **Report out from Breakout Session 2 and Group Discussion**
- 2:15 pm – 3:15 pm** **Whole group discussion with new questions**
- 3:15 pm – 3:30 pm** **Break**
- 3:30 pm – 4:15 pm** **Presentation: Current Practices and Advances**
Rod Parnell, Ph.D., Professor of Geology and Environmental Science, Northern Arizona University
- 4:15 pm** **Workshop adjourns**

Workshop 3, January 24, 2020**STRENGTHENING SUSTAINABILITY PROGRAMS AND CURRICULA
AT THE UNDERGRADUATE AND GRADUATE LEVELS****Workshop Agenda**

Seymour Marine Discovery Center
100 McAllister Way
Santa Cruz, CA 95060

8:00 am – 8:30 am **Breakfast**

8:30 am – 9:00 am **Opening remarks**

- Katharyne Mitchell, Ph.D., Dean of Social Sciences at University of California, Santa Cruz
- Chair Anne Kapuscinski welcomes the attendees and provides context for the study

9:15 am – 10:30 am **Panel 1 – Perspectives from Sustainability Students and Alumni**

Discuss experiences, challenges, and opportunities in sustainability education programs

- Natalie Arora (B.A.), Susa Ventures
- Rafid Shidqi (M.S. Student), Coastal Science and Policy, UC Santa Cruz
- Angela Xiong (M.A.), Ascent Environmental
- Leehi Yona (Ph.D. Student), Stanford University
- Casey Zweig, (M.S. Student), Wells Fargo Fellow in Coastal Science and Policy, UC Santa Cruz

10:30 am – 10:45 am **Break**

10:45 am – 12:00 pm **Panel 2 – Perspectives from End Users**

Discuss the sustainability skills and competencies valued by hiring organizations

- Kelly Damewood, Chair, California Certified Organic Farmers
- Mike Mielke, Senior Vice President, Silicon Valley Leadership Group
- Harold Mitchell, Founder and CEO, ReGenesis
- Alvaro Sanchez, Environmental Equity Director, The Greenlining Institute

12:00 pm – 1:00 pm Discussion on Current Sustainability Education Legislation

Discuss relevant federal legislation for supporting sustainability programs in higher education.

- David Caruolo, Legislative Assistant to Senator Sheldon Whitehouse of Rhode Island

1:00 pm – 2:15 pm Panel 3 – Perspectives from Faculty

Discuss the sustainability skills and competencies valued in the research and academic community, as well as ideas for strengthening sustainability programs

- Bill Clark, Harvey Brooks Professor of International Science, Public Policy and Human Development, and Chair, International and Global Affairs Program, John F. Kennedy School of Government, Harvard University
- Kristi Kremers, Director of Graduate and Faculty Leadership Programs, Institute on the Environment, University of Minnesota
- Pamela Matson, Goldman Professor in the School of Earth, Energy and Environmental Sciences, Department of Earth System Science, Stanford University
- Yuwei Shi, Professor of Strategic Management, Middlebury Institute of International Studies
- Erika Zavaleta, Howard Hughes Medical Institute Professor, Ecology and Evolutionary Biology Department, University of California, Santa Cruz

2:15 pm – 2:30 pm Higher Partnerships with Local Communities

- David Palter, Workforce Development Director, Silicon Valley Leadership Group

2:30 pm – 2:45 pm Plenary discussion and final remarks**2:45 pm Workshop adjourns**

