Teaching Sustainability Competencies across the Disciplines

A Guide for Instructors

2025 Edition

The Scaling Up Sustainability Across the Curriculum Community of Practice,

Association for the Advancement of Sustainability in Higher Education (AASHE)

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Contents

Introduction: How to Use this Guide

Members of AASHE's Scaling Up Sustainability Across the Curriculum Community of Practice produced this guide for instructors in our curriculum development workshops and for others who seek to integrate sustainability across the curriculum in higher education.

Our goals were to:

- Help instructors understand the similarities and differences among the sustainability competencies frameworks produced by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the revised version, entitled the Key Competencies in Sustainability Framework (KCSF), so that instructors can decide whether to teach with one or both of these frameworks, and can map connections among the sets of competencies and ways of teaching them.
- Support instructors to integrate sustainability competencies into their courses by identifying and developing curricular and pedagogical resources, resources for assessing student learning, and relevant examples of the scholarship of teaching and learning in this field.

We encourage all readers to familiarize themselves briefly with the UNESCO and KCSF frameworks by reading the next section, which summarizes these two frameworks.

Readers interested in revising program-level learning outcomes and curricula (for a school or department, for example) will especially benefit from considering the frameworks in their entirety, and how their program can teach all of the competencies as an interrelated whole.

Instructors interested in incorporating one or more of the competencies into their teaching are encouraged to identify which competencies are most relevant to the instructors' courses, and to focus on the sections that provide resources for teaching each of these competencies. These resources include:

- Definitions of each competency
- Relevant student learning outcomes, organized by the levels of Bloom's Taxonomy (see Appendix A)
- Key concepts and methods
- Pedagogies and assessments of student learning (for additional resources, search the curriculum repositories listed in Appendix B)
- Examples of relevant scholarship of teaching and learning

Instructors who are looking for insights on how to teach about a specific topic (such as food, water, or policy) should use the find command to search the full document for the range of sustainability competencies that can be taught in relation to the topic.

Readers interested in offering professional development for their faculty or students to use the competencies may want to use the brief handout that defines the competencies and provides example pedagogies in Appendix C, as well as the online tutorial on the KCSF sustainability competencies for instructors and students.

University of San Francisco Environmental Monitoring students learn to measure "flow" in the Gleeson Library Reflecting Pool.

Image: zzzrandyzzz

1. Comparing the UNESCO and GCSE Sustainability Competencies

Based on a comprehensive literature review, Wiek et al. (2011) defined sustainability competencies as "knowledge, skills, and attitudes that enable successful task performance and problem-solving … with respect to real-world sustainability problems, challenges, and opportunities" (p. 204). These authors emphasized that sustainability education should not simply aim to teach individual competencies but also the interrelationships among them, which form a unified whole.

Drawing on de Haan (2010), Rieckmann (2012), and Wiek et al. (2011), the United Nations Educational, Scientific and Cultural Organization defined eight cross-cutting sustainability competencies relevant to the United Nations Sustainable Development Goals (SDGs). These competencies include systems thinking, anticipatory thinking, normative thinking, strategic thinking, collaboration, critical thinking, self-awareness, and integrated problem-solving (UNESCO, 2017, p. 10). To assess these competencies, UNESCO and Arizona State University scholars created the SDG Fitness Test, comprising 24 questions about four real-world scenarios (UNITAR, 2022).

Drawing on a Delphi Study conducted by Brundiers et al. (2021), an expert group convened by the Global Council for Science and the Environment (GCSE) developed a subsequent version of the UNESCO competencies framework called the Key Competencies in Sustainability Framework (KCSF). The KCSF was intended more specifically for higher education, for preparing students to enter professional settings, and to serve as accreditation standards for higher education sustainability programs (Brundiers et al., 2023). While much of the UNESCO framework remains in the KCSF version, there are differences in some titles and definitions of competencies. Table 1.1 outlines the key competencies for sustainability and the respective definitions from the UNESCO and KCSF frameworks.

Table 1.1. UNESCO and GCSE Sustainability Competencies

Competency	Definition
UNESCO: Systems thinking	UNESCO: The ability to recognize and understand relationships, to analyze complex systems, to think of how systems are embedded within different domains and different scales, and to deal with uncertainty.
KCSF: Systems thinking	KCSF: The ability to collectively analyze complex systems across different domains, sectors, and spatial and temporal scales using analytical concepts like cause-effect structures, cascading effects, inertia, feedback loops, interdependencies, and other systemic features.

Competency	Definition
UNESCO: Anticipatory	UNESCO: The ability to understand and evaluate multiple futures – possible, probable, and desirable; to create visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.
KCSF: Futures thinking	KCSF: The ability to collectively explore future developments and states, specifically to anticipate how sustainability challenges might evolve or occur over time (scenarios). This also includes collectively analyzing, crafting, and evaluating desired future states (visions). These visualizations of the future provide a foundation for researching evidence-supported alternative development pathways.
UNESCO: Normative	UNESCO: The ability to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge, and contradictions.
KCSF: Values thinking	KCSF: The ability to collectively identify, analyze, map, apply, reconcile, and negotiate sustainability principles, goals, and targets, as well as trade-offs. This also includes the ability to be aware of and specify one's own values. Because sustainability is an inherently normative concept centered on equity among people, between people and the environment, and across generations, values-thinking competency includes engaging with principles and practices emphasizing concepts of justice, equity, diversity, and inclusion.
UNESCO: Strategic thinking	UNESCO: the ability to collectively develop and implement innovative actions that further sustainability at the local level and further afield.
KCSF: Strategic thinking	KCSF: The ability to collectively design transformational systemic interventions, transitions, and governance strategies while accounting for strategic leverage points, power dynamics, uncertainty and surprises as well as social and organizational learning in navigating these strategies.
UNESCO: Collaboration	UNESCO: The ability to learn from others; to understand and respect the needs, perspectives, and actions of others (empathy); to understand, relate to, and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem-solving.
KCSF: Interpersonal	KCSF: The ability to motivate, enable, and facilitate collaborative and participatory sustainability research and collective problem-solving processes, and facilitate multi-, inter-, and transdisciplinary knowledge building and integration, which includes Western scientific knowledge as well as traditional ecological knowledge and indigenous knowledge and wisdom.

Competency	Definition
UNESCO: Critical thinking KCSF: (Not applicable)	UNESCO: The ability to question norms, practices, and opinions; to reflect on one's values, perceptions, and actions; and to take a position in the sustainability discourse.
UNESCO: Self-awareness KCSF: Intrapersonal	UNESCO: The ability to reflect on one's role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires. KCSF: The ability to be aware of one's own emotions, desires, thoughts, and behaviors as well as one's positionality and role in global society and in the local community. Intrapersonal competency involves the ability to reflect and act with self-awareness and to regulate, motivate, and continually evaluate one's actions and improve oneself, drawing on and developing emotional intelligence and resilience.
UNESCO: Integrated problem-solving KCSF: Integrated problem-solving	UNESCO: The ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive, and equitable solution options that promote sustainable development, integrating the other competencies. KCSF: The ability to solve complex sustainability problems in integrated ways i.e., the ability to work with others to integrate problem analysis, sustainability assessment, visioning and strategy building, and to prepare for implementing the co-created solution in the real world. This includes the ability to articulate the individual contributions of the previous key competencies to sustainability problem-solving processes and being familiar with different problem-solving frameworks and able to select the appropriate one to develop viable solution option in context-sensitive ways, recognizing that sustainability problem-solving is a long-term, iterative and collective process between planning, realization, adjustment and evaluation.
KCSF: Implementation UNESCO: (Not applicable)	KCSF: The ability to collectively carry out and realize planned sustainability strategies (e.g., sustainability action plan) on the ground, including implementation, adaptation, transfer, and scaling, in effective and efficient ways. Working toward a sustainability-informed vision over time involves monitoring and evaluating the realization process on the ground, addressing emerging challenges, and making adjustments.

2. Systems Thinking Competency

Definitions

UNESCO: Systems thinking	UNESCO: The ability to recognize and understand relationships, to analyze complex systems, to think of how systems are embedded within different domains and different scales, and to deal with uncertainty.
KCSF: Systems thinking	KCSF: The ability to collectively analyze complex systems across different domains, sectors, and spatial and temporal scales using analytical concepts like cause-effect structures, cascading effects, inertia, feedback loops, interdependencies, and other systemic features.

Learning Outcomes

Here we provide examples of student learning outcomes associated with the systems thinking competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives. These learning outcomes are drawn especially from Brundiers et al. (2023), and supplemented by ASUSOS (n.d.) and Zhang & Vanasupa (n.d.).

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- Define key concepts of systems thinking.
- Describe some benefits of systems thinking in sustainability problem-solving.
- Recall the concept of a dynamic system and the elements within a model of a dynamic system, such as system boundary.
- Articulate that the earth is essentially a closed system.
- Articulate that all material or energy input to (or output from) the system must be created from existing material or energy.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Explain how sustainability problems have emerged (from a historical, cultural, and spatial perspective).
- Describe in principle how different personal (and professional) activities contribute to, or solve or mitigate sustainability problems.

- Describe how multiple, different intervention points are relevant for sustainability problem-solving.
- Explain the conceptual difference between open and closed systems.
- Explain the relationship between events, patterns and system behavior.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Identify components that make up a system and define a system's boundary by analyzing events and patterns.
- Identify what events (or measures) serve as indicators for the behavior of the system.
- Discuss how modifying a driver changes the problem constellation (how interventions in drivers play out in a system).

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Analyze an existing system's structure, describing its properties, processes, and behaviors (e.g., nonlinearity, emergence, path dependence, balancing and reinforcing loops, leverage, drivers).
- Use graphical tools to model a system and its behavior (interactions, consequences).
- Apply systems thinking to analyze the concept of sustainability, and phenomena such as population growth, material flows, energy flows, water flows, etc.
- Recognize interdependencies of different systems (e.g., a nuclear power plant relies on a large reservoir of cold water as does the local ecosystem within that same body of water).
- Relate events and patterns of consumer behavior (including one's own) to the larger global economic system.
- Make connections between events and patterns from very different areas, such as political, social, health and safety, environmental, manufacturing, environmental, or economic systems.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Select, modify, combine and apply appropriate systems thinking methods (e.g., modeling, network analysis, robustness analysis) for analyzing systems, identifying problems that pertain to sustainability, and developing solutions.

- Critically reflect on one's own ways of systems thinking in the context of different ways of acquiring knowledge, including different scientific methods and traditional knowledge systems.
- Examine sustainability challenges as decision challenges, including how stakeholder interests, values, needs and influences become key drivers in problems and systems.

Create: Producing new or original work by assembling elements to form a coherent or functional whole, or reorganizing elements into a new pattern or structure; generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Develop, describe, and bound a system that captures the ecological, economic, and social elements and the relationships between them.
- Create basic systems diagrams of sustainability problems, using some empirical data to illustrate elements of the problem (e.g., adverse effects, feedback loops, stocks, processes, fluxes).
- Create a schematic graph that depicts the behavior of a particular event (or measure) over time.
- From the knowledge of a system and behavior-over-time graphs, create a causal loop diagram involving the major events (or measures) within a system.
- Diagnose a problem, create an intervention or alternative system to address the problem, or delineate alternative initial conditions that could lead to a more sustainable state.

Concepts and Methods

Below is a summary of major concepts and methods associated with systems thinking, adapted from Brundiers et al. (2023).

Concepts	Methods
Systems and systems dynamics (non-linearity, time, lags, surprises, uncertainty, etc.) Feedback loops, complex cause-effect chains (surface vs. root causes, attractors), cascading effects, thresholds, tipping and leverage points, legacy, inertia, resilience, adaptation, structuration, etc. Variables/indicators, systems, sub-systems, structures (e.g., archetypes),	Descriptive methodologies ("thick" description, narrative research methods) Modeling methods Qualitative methods (e.g., concept maps, network analysis) Quantitative modeling and simulations (e.g., STELLA, Life Cycle Assessment, Systems Mapping)

Concepts	Methods
functions, elements/stocks and processes/ interconnections/fluxes People and social systems: values and attitudes, ideologies, preferences, needs, collective perceptions, motives, actions and habits, decisions, power, tactics, politics, policies, laws, institutions, culture, etc. Across multiple temporal and spatial scales: local to global, short to long-term Across multiple and/or coupled domains: society, environment (ecosystems), economy, technology, etc.	Institutional-, decision-, governance-, and social-systems analysis, actor analysis, constellations analysis, syndrome approach and methods operationalizing Cultural Historical Activity Theory (CHAT) Methods to identify archetypes, leverage points, intervention points for disruption Participatory systems approaches, including participatory modeling, role-playing games and simulations Geographic Information Systems

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about systems thinking and sustainability.

Natural Sciences

Biology

Hydrologic Balance and Climate Change

The Carbon Cycle

Oceans in Peril: Pressures on Ocean Ecosystems

Environmental Studies and Sciences

Systems Thinking Course

Introduction to Systems Thinking (Sustainability 101 assignment)

Climate Justice

History of Food Systems

Energy from and to the Earth

Systems Thinking: Rio Grande River Flow

Future of Food

Social Sciences

Sociology

Systems thinking

Sociology of Food Systems and Agriculture

Globalization and the Environment (starts on p. 96 in this document)

Political Science

Introduction to Environmental Policy

Sustainability Approaches (Political Ecology)

Sustainability Science

Major Storms and Community Resilience

Regulating Carbon Emissions

Arts & Humanities

Humanity and Its Futures: Systems Thinking Approaches

Engineering

Urban Landscapes and Water Use

Urban Hydrology

Low Impact Development and Green Infrastructure

Urban Water - Atmospheric Environment Interactions

Business and Economics

Business

Sustainability in Business

Systems Thinking for Sustainable Development and Enterprise

Managing Global Sustainability Challenges

Circular Economy for Sustainability Professionals

Economics

Climate Change from the Socio-Environmental Systems Perspective

Financial Incentives of Open Access Resource Overuse

Health and Social Work

Composting Toilets

Global Food Security

Systems Thinking in One Health

Systems Thinking In Public Health

Health Systems, Systems Thinking & Advocacy for Change

Law and Policy

Policy and Governance of Sustainable Systems

Policy Coherence and Systems Thinking for Sustainable Development

Climate Change Policy

Interdisciplinary

Open University Systems Thinking Course (Open Access)

Sustainability Policy & Practice

Teach Systems Thinking (Resources for Teaching Systems Thinking)

Systems Thinking Module (and see this article and webinar on how to use the module)

Teaching Students About Systems Thinking

Resources for Teaching Systems Thinking

Systems Maps, Concept Maps, Mind Maps

Using Concept Mapping to Experientially Introduce Systems Thinking

Mind Mapping: A Systems Thinking Application for Change Management

Seeing Systems: Peace, Justice, and Sustainability Discussion Activity

Systems Models, Computer Models

Stella

ENROADS

Loopy and Visualizing Systems

The Systems Thinker

General Assessments

Assessment of Competency-based Sustainability Learning to Foster Systems Thinking and Critical Thinking

Assessing Systems Thinking: A Tool To Measure Complex Reasoning Through Ill-Structured Problems

Essay Assessments: Interdisciplinary and Systems Thinking

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about the systems thinking competency.

Natural Sciences

Biology

The Theoretical Nature of Systems Thinking. Perspectives on Systems Thinking in Biology Education

Environmental Sciences and Studies

Teaching Systems Thinking Webinar

Social Responsibility and the World of Nature: An Interdisciplinary Environmental Studies Course for Inspiring Whole System Thinking and Environmental Citizenship

Examining Undergraduate Students' Systems Thinking Competency Through a Problem Scenario in the Context of Climate Change Education

Chemistry

Exploring Opportunities to Incorporate Systems Thinking Into Secondary and Tertiary Chemistry Education Through Practitioner Perspectives

Integrating the Molecular Basis of Sustainability into General Chemistry through Systems Thinking

Introduction to Systems Thinking for the Chemistry Education Community

Systems Thinking Approaches for International Green Chemistry Education

Applications of Systems Thinking in STEM Education

Systems Thinking for Education about the Molecular Basis of Sustainability

Social Sciences

Assessing (Social-Ecological) Systems Thinking by Evaluating Cognitive Maps

Educating Systems Thinking for Sustainability: Experience with a Developing Country

Integrating Social Science Research to Advance Sustainability Education

Arts & Humanities

Essays on Systems Thinking: Applications for Art Education

Systems Thinking and Interdisciplinarity in Disciplinary Design Education

Teaching Sustainability, Ethics and Scientific Writing: An Integrated Approach

Engineering

Systems Engineering in University Education with Focus on Systems Thinking

Sustainable Systems Engineering Course Design: Design for Systems and Society

Analyzing Sustainable Practices in Engineering Projects: A Systemic Approach

The Case for Systems Thinking in Undergraduate Engineering Education

Business and Economics

Using Systems Thinking to Educate for Sustainability in a Business School

The Power of Art to Foster Systems Thinking, One of the Key Competencies of Education for Sustainable Development (for a Management Course)

Health and Social Work

Planetary Health Pedagogy: Preparing Health Promoters for 21st-Century Environmental Challenges

Law and Policy

Promoting Systems Thinking and Pro-Environmental Policy Support through Serious Games

(Systems) Thinking Like a Lawyer

Systems Thinking and the Law in the Age of the Anthropocene

Interdisciplinary

What is Systems Thinking? A Review of Selected Literature Plus Recommendations

A Complete Set of Systems Thinking Skills

Systems Thinking for Systems Leadership: Promoting Competency Development for Graduate Students in Sustainability Studies

Systems Thinking for Campus Sustainability: Utilizing the University of Central Florida Campus as a Living Laboratory

Assessing Systems Thinking Skills in Two Undergraduate Sustainability Courses: A Comparison of Teaching Strategies

Fostering Students' Systems Thinking Competence for Sustainability by Using Multiple Real-World Learning Approaches

Using the U.N. SDGs to Foster Systems Thinking in Incoming First-Year Students (for STEM)

Systems Thinking (for evaluation)

3. Anticipatory or Futures Thinking Competency

Definitions

UNESCO: Anticipatory	UNESCO: The ability to understand and evaluate multiple futures – possible, probable, and desirable; to create visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.
KCSF: Futures thinking	KCSF: The ability to collectively explore future developments and states, specifically to anticipate how sustainability challenges might evolve or occur over time (scenarios). This also includes collectively analyzing, crafting, and evaluating desired future states (visions). These visualizations of the future provide a foundation for researching evidence-supported alternative development pathways.

Learning Outcomes

Here we provide examples of student learning outcomes associated with the anticipatory or futures thinking competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives. These learning outcomes are drawn especially from Brundiers et al. (2023) and supplemented by ASUSOS (n.d.; 2024).

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- Describe the basic structure of future thinking methods, including scenario construction, forecasting, backcasting, and visioning.
- Define concepts of the future – such as uncertainty, likelihood, plausibility, and desirability – as they pertain to sustainability.
- Describe the intergenerational concepts of sustainability.
- Describe some benefits of futures thinking in sustainability problem-solving.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Explain the types of knowledge that methods of futures thinking generate and how they can be used in sustainability problem solving activities.
- Explain sustainability-related concepts of the future, such as short-term versus long-term trends, uncertainty, path dependency, likelihood, plausibility, consistency and desirability.

- Discuss how emotions, including hope and fear, influence futures thinking.
- Interpret science fiction representations of sustainability futures and what these fictions see as the main drivers and outcomes of the future.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Outline basic scenarios and visions for one's own life and for familiar systems (like one's school) on different timescales; expand on these to a more global perspective.
- Use existing models, scenarios, and simulations to project future consequences of actions and interventions across different scales.

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Distinguish different concepts about the future, including short-term and long-term views, and the meaning of possible, probable, plausible, and desirable future states.
- Compare and contrast different cultural concepts of time and the future, and their implications for thinking about sustainability.
- Anticipate in principle (sketch trajectories of) how one's personal life, as well as personal and professional activities, might evolve over time and how they might contribute to, mitigate, or solve future sustainability problems.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Evaluate key historical and cross-cultural ideas of the future, recognizing that different groups have different ideas about the future.
- Critically reflect on one's own thinking about the future in the context of one's own background and values.
- Articulate and critically reflect on future consequences of actions and interventions across different scales.
- Evaluate the assumptions employed by sustainability models, scenarios, visions, and simulations.

Create: Producing new or original work by assembling elements to form a coherent or functional whole, or reorganizing elements into a new pattern or structure; generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Select, modify, combine and apply appropriate futures thinking sustainability methods to construct scenarios, develop simulations, or envision future states.
- Design a process to engage the public, scientists, and/or policy leaders in well-informed deliberation and decision-making about sustainable futures.
- Create artistic representations of sustainability futures that communicate what you see as the main drivers, potential outcomes, and desirable states.
- Create a vision for the future through a participatory process.

Concepts and Methods

Below is a summary of major concepts and methods associated with anticipatory and futures thinking, adapted from Brundiers et al. (2023).

Concepts	Methods
Concepts of time, including temporal phases (past, present, future), temporal scales (short, long), states, continuity (dynamics, paths), non-linearity Concepts of future developments (predictions, scenarios, visions) and related epistemic status (probability, possibility, desirability) and uncertainty Concepts of inertia, path dependency, non-interventions vs. concepts of disruptive interventions and pathways Concepts of consistency and plausibility of future developments, unintended consequences Concepts of risk, intergenerational equity, cross-cultural perspectives, precaution, anticipatory governance, biophysical limits Concepts of creativity, imagination, "real utopias," and emotions (fear, hope, etc.)	Backcasting and envisioning methods (e.g., story-telling and narrative research) Scenario methodology, including modeling Forecasting from statistical and simulation models Anticipatory multi-methodologies Participatory Action Research, anticipatory approaches (including Delphi and future workshop) Iterative approach to dealing with the future: as time passes one approaches the "future" and continually refines one's concept of the future Community visioning

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about the anticipatory or futures thinking sustainability competency.

Natural Sciences

Chemistry

Calculating Resilience, Tipping Points, and Restoration for Lakes at Risk from Acid Rain

Environmental Science

Climate Change and Food Security

Future Climate Change, Population Growth, and Water Issues

Future of Food—Climate Change Predictions Capstone Project

Water Science and Society—Future Scenarios and Climate Models

Climate Change Impacts on the Northwest Passage

Predicting Effects of Climate Change on Soil Loss

Machine Learning in Earth & Environmental Sciences

Biology

Modern CO2 Accumulation

Atmospheric Carbon: Can We Offset the Increase?

Gulf Stream Heat Budget and Europe's Mild Climate

Biology—Scientific Method and Historical Precipitation

Social Sciences

Environmental Studies

Regional Sea level Changes, A Tale of Two Cities (New York and Southern CA)

Future Food Scenarios Capstone Project

Communication

Teaching Risk and Crisis Communication in the Context of Natural Disasters

Using "Dante's Peak" to Discuss Response to Risk

Sociology

Climate Action Simulation

Social Ecology

Arts & Humanities

Speculative Fiction and the Environment in 20th-Century America

Graduate Seminar Aesthetics and the Anthropocene

Engineering

Runoff Generation from Varying Land Surfaces

Managed Retreat/Multi-Layered Protection

Hydrotopia

Capstone Project: Urban Water Portfolio

The Nile's Sinking Future

Water Sustainability in Cities—Planning and Decision Making

Business and Economics

Economic Geology

Financial Incentives of Open Access Resource Overuse

Economics—Abating Carbon Emissions

Land Management—State Electricity on Google Earth

Modeling Future Climate Predictions & Costs

Applied Time Series Analysis for Forecasting

Forecasting Time Series Data

Predictive Analytics & Data Mining

Health and Social Work

The Future of Food

The Changing Geographic Distribution of Malaria with Global Climate Warming

Exercise in a Changing Climate

Future of Food - Food Access and Food Deserts Summative Assessment and Capstone Project

Law and Policy

Dynamic Integrated Climate Economy (DICE) Modeling

Scenarios, Plans, & Future Cities

Simulation of International Negotiations to Reduce Greenhouse Gas Emissions

Interdisciplinary

Introductory Video to Futures Thinking

In-Class Visioning Activity

EnRoads Climate Solutions Simulator

Teach the Future - Teaching Tools, Textbook, and Resource Bank

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about the anticipatory or futures thinking competency.

Natural Sciences

Facilitating Transformative Science Education through Futures Thinking

Using COVID-19 to Teach Sustainability Futures Thinking

Futurising Science Education: Students' Experiences From a Course on Futures Thinking and Quantum Computing.

The Impact of Building a Training Program According to the Dimensions of Environmental Citizenship for Biology Teachers in their Future Thinking

Social Sciences

Imagine a World in which: Using scenarios in Political Science

Thinking about Future/Democracy: Towards a Political Theory of Futurity

Building Capacities for Transformative Change towards Sustainability: Imagination in Intergovernmental Science-Policy Scenario Processes

Future Scenarios for Socio-Ecological Production Landscape and Seascape

Arts & Humanities

Fictional Narratives for Environmental Sustainability Communication

Education for Sustainability: Developing Ecocritical Literature Circles in the Student Teacher Classroom

Imagining The Sustainable Future through the Construction of Fantasy Worlds

Science Fiction and Social Justice: Teaching Students to Consider Ethics, Sustainability, and Diversity Issues

Engineering

Framing Teaching for Sustainability in the Case of Business Engineering Education: Process-Centric Models and Good Practices

Engineers of the Future: Using Scenarios Methods in Sustainable Development Education

The Use of Engineering Design Scenarios to Assess Student Knowledge of Global, Societal, Economic, and Environmental Contexts

Business and Economics

Supporting Scenario Design in Planning Long-Term Business Strategies Based on Sustainability Scenarios

Narrating Future(S) with Others: Teaching Strategic Sustainability Management in a Relational Key

Scenario Planning as a Causal Evaluation Tool for IoT Business Model Innovation

Health and Social Work

Student Nurses Exposed to Sustainability Education Can Challenge Practice: A Cohort Study

Can a Sustainability and Health Scenario Provide a Realistic Challenge to Student Nurses and Provoke Changes in Practice? An Evaluation of a Training Intervention

A Cohort Study of Sustainability Education in Nursing

Law and Policy

Using Scenarios to Assess Policy Mixes for Resource Efficiency and Eco-Innovation in Different Fiscal Policy Frameworks

The Use of Scenarios in Legal Education to Develop Futures Thinking and Sustainability Competencies

Exploring the Usefulness of Scenario Archetypes in Science-Policy Processes: Experience across IPBES Assessments

Interdisciplinary

Beyond Colonial Futurities in Climate Education

Imagining the School of the Future through Computational Simulations: Scenarios' Sustainability and Agency as Keywords

Competencies and Pedagogies for Sustainability Education: A Roadmap for Sustainability Studies Program Development in Colleges and Universities

Pedagogies of Preparedness: Use of Reflective Journals in the Operationalisation and Development of Anticipatory Competence

Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal

Field Notes: Teaching Climate Change in Higher Education (blog)

Worry & Hope: What College Students Know, Think, Feel and Do about Climate Change

Beyond Sustainability: Positioning Regenerative Futures In a Philippine State University

Teacher Agency and Futures Thinking

Teaching Futures Thinking Literacy and Futures Studies in Schools

4. Normative or Values Thinking Competency

Definition

UNESCO: Normative	UNESCO: The ability to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge, and contradictions.
KCSF: Values thinking	KCSF: The ability to collectively identify, analyze, map, apply, reconcile, and negotiate sustainability principles, goals, and targets, as well as trade-offs. This also includes the ability to be aware of and specify one's own values. Because sustainability is an inherently normative concept centered on equity among people, between people and the environment, and across generations, values-thinking competency includes engaging with principles and practices emphasizing concepts of justice, equity, diversity, and inclusion.

Learning Outcomes

Here we provide examples of student learning outcomes associated with the normative or values thinking competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives. These learning outcomes are drawn from Brundiers et al. (2023), and supplemented by ASUSOS (n.d.), Markkula Center for Applied Ethics (n.d.), Normandale Community College (2023), Nova Southeastern University (2024), and Zinser (2020).

Note that the normative/values thinking competency addresses both individual ethics and systemic justice issues.

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- Describe the basic structure of values-based methods, including sustainability assessments and visioning; link these methods with the types of knowledge they generate and their use in sustainability problem-solving activities.
- Describe some benefits of values-thinking in sustainability problem-solving.
- Describe anthropocentric and biocentric approaches to environmentalism.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Distinguish claims of fact from claims of value in sustainability contexts (with the understanding that facts are also defined within social contexts).
- Explain the difference between intrinsic and extrinsic values, and between holistic and individualistic ethical systems.
- Describe intra- and inter-generational equity and explain their importance for sustainability.
- Explain the influence of values on stakeholder actions and activities.
- Explain key sustainability principles, why they are part of the overarching concept of sustainability, and how they are used in values thinking (e.g., justice, equity, human dignity, fairness; social-ecological systems integrity, responsibility).
- Explain normative concepts, including goals, values, ethics, equity and justice, and recognize that human thoughts and actions are based on values.
- Recognize ethical and justice issues specific to the context of the environment.
- Explain how one's own values shape behavior that affects others.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Explain theories and concepts of ethics and justice and apply them to a variety of sustainability issues.
- Identify the impacts and trade-offs, as seen from various justice/ethics perspectives, of different courses of action.
- Apply normative principles specific to sustainability – such as socio–ecological system integrity, livelihood sufficiency and opportunity (and for whom/what, including nonhumans), and intergenerational equity – to diverse situations or issues.
- Apply environmental ethics and justice frameworks to assess complex current events.
- Clarify one’s own values and incorporate environmental ethics into everyday decision-making.

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Analyze ethical and justice issues to arrive at reasoned responses to sustainability problems that take into account their environmental, economic, and social dimensions.
- Recognize and explain differences in normative values among individuals, groups, and cultures, and understand how these differences guide their behavior and impact sustainability visions.

- Analyze the ethical and equity aspects involved in the approaches to the environment taken by diverse spiritual, economic, legal, and cultural perspectives.
- Explain the ways in which environmental understandings are intertwined with and influenced by spiritual, cultural, and socio-economic factors.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Evaluate competing ethical and justice claims that inform environmental debates, such as those made by the conservation, preservation, environmental justice, and sustainable development traditions.
- Evaluate reasons used to support sustainability decisions and their underlying values and normative assumptions.
- Identify and justify one's own sustainability values, preferences, and norms, and use them to defend a position on a contemporary issue.
- Assess how your sustainability values have been influenced by your social-economic and cultural positionality (class, race/ethnicity, gender, sexual orientation, nationality, physical ability, etc.)
- Identify who had the power to set the agenda, voice opinions, and set the parameters for what should matter in a sustainability decision-making process, and analyze whose voices were missing from that process.
- Develop both critical and empathic evaluations of others' values related to sustainability, and how others' prioritize these values differently.
- Select indicators and targets to assess the sustainability impacts of one's personal and employment activities, and how they might be more ethical and just.
- Navigate and negotiate value conflicts or dilemmas that may arise in sustainability projects, and critically reflect on the participants' norms, values, and preferences.

Create: Producing new or original work by assembling elements to form a coherent or functional whole, or reorganizing elements into a new pattern or structure; generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Respond to calls for environmental justice by proposing a decision-making process about a sustainability issue that would expand the influence of marginalized communities whose livelihoods and wellbeing are affected by the decision.
- Articulate and employ diverse normative understandings or principles about the value of the natural world to generate alternative solutions to environmental problems.

- Propose a new sustainability policy that effectively addresses a problem of justice, equity, human or animal rights, or rights of nature.
- Create artistic representations of contemporary ethical debates or normative visions of sustainability.
- Design a new technology or product inspired by a particular normative vision of sustainability, such as environmental justice for marginalized communities.

Concepts and Methods

Below is a summary of major concepts and methods associated with normative or values thinking about sustainability, adapted from Brundiers et al. (2023).

Concepts	Methods
Value self-awareness (what do I value?) Positionality, related privileges, normalized oppression, and biases Impacts on sustainability of colonialism, imperialism, capitalism, sexism, heterosexism, racism, ableism, ageism Intrinsic versus extrinsic values, worldviews, ethics, morals and moral obligations/ duties, religious values; legal pluralism, human rights, animal rights, and rights of nature, etc. Sustainability principles, goals, targets, thresholds (tipping points) Concepts of sustainability and justice: environmental justice (distributive, procedural, recognition, restorative, and epistemic justice, and just transitions); racial, economic, and gender justice; intergenerational and interspecies justice Concepts of fairness, equality, equity, responsibility, safety, well-being, social-ecological integrity, resilience, the precautionary principle (Un)sustainability of past, current or future states, (un)sustainability of current	Envisioning methods (e.g., backcasting), in which visioning elements represent underlying values Individual values clarification methods (e.g., audit of individual or household energy consumption, moral dilemma discussions, role modeling) Social values identification methods (e.g., surveys, interviews, focus groups, giving-voice-to-values, narrative research methods, philosophical debate, discourse analysis) Multi-criteria assessment methods (normative component of assessment methods such as Life-Cycle Assessment, Multi-Attribute Utility Theory, Alternatives Assessment, sustainability indicators, cost-benefit analysis, etc.) Methods for power/equity analysis Risk analysis, especially involving the interaction of cumulative environmental risks and social vulnerabilities Sustainability efficiency analysis Participatory methods (e.g. negotiation methods, reconciliation, consensus

practices for ecosystem diversity and health, planetary boundaries Concepts of risk, harm, damage, dissent, power relations, imbalances, hegemonies Concept of reinforcing gains ("win-win") and tradeoffs	building, collective-memory work, action research conversations)

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about normative or values thinking and sustainability.

Natural Sciences

Biology

The Demise of the Monarch Butterfly

Indigenous Food Relationships

Biology and Sustainability: Linkages to Buddhist and Indigenous Philosophical Perspectives

Biogeosciences—The Sixth Extinction Reading Quiz

Biogeosciences—The Sixth Extinction Letter to Potential Donors Assessment

Environmental Science—Scientific Debate and the Nature of Certainty Assessment

Environmental Geology

Land-Use Change and Stakeholders Simulation

Social Sciences

Green Political Thought

Race, Space, and Environmental Justice

Land Use, Climate Change, and Cultural Imperialism in the Philippines and Malaysia

Land Use and Cultural Imperialism Writing Assessment

Geoscience Ethics Assessments

Arts & Humanities

Applying Environmental Ethics to Current Events and Individual Choices

Environmental Ethics: Obligations to Nature

Global Environmental Literature: Consumerism at Home and around the Globe

Personal Waste Assessment and Performance

“Victorian Literature - Writing Water Then and Now” Writing Rubrics

Ethics of Fast Fashion Assignment Rubric

Engineering

Sustainability and Robotics

Selecting Sites for Renewable Energy Projects

Colorado River Water Supply and Adaptation Strategies

Business and Economics

Management: Creating Social, Environmental, and Economic Value

Sustainable Business Development: Roles of Consumers, Government, Private Institutions

Sustainable Behavior of Consumers, Firms, and Societies

Sustainable Global Enterprise

Building a Sustainable Future: Business Model Innovation as a Force for Good

Sustainability Ethics and Financial Capital

Economics of Water Allocation Footprints Summative Assessment

Health and Social Work

Epidemiology, Environmental Health, and Ethics

The Food We Eat Can Have a Positive Impact on Climate Justice

Tracking the Carbon Footprint and Medical Waste in Drug Design

The Impact of Globalization on Diet and Culture

Environmental Justice and Freshwater Resources Summative Assessment

Women, Children, Poverty and Water Assessment

Food Systems in Action Summative Assessment

Law and Policy

The Externalities Game: Environmental Externalities, Collective Action Problems, and Negotiations

Greenhouse Gas Emissions Reduction Legislation Role-Play Exercise

Energy Culture as a Determinant of Countries' Positions in Climate Negotiations

Carbon Emissions Game and Op-Ed Writing Assessment

Managing the Risks of Lead Exposure

Interdisciplinary

The Lifestyle Project: Reducing Personal Environmental Impacts

Egoism, the Tragedy of the Commons, Carbon Footprints, and Corporate Sustainability

Ethical Implications of Climate Change - Course and Syllabus

Environmental Justice in the Water Wars of Cochabamba, Bolivia Assessment

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about the normative and values thinking sustainability competency.

Natural Sciences

Integrating Green Chemistry into Chemistry Education

Education for Sustainability Meets Confucianism in Science Education

Environmental Sustainability in Education: Integration of Dilemma Stories into a STEAM Project in Chemistry Learning

Indigenous Values and Sustainability

Social Sciences

Disciplinary and Theoretical Approach to the Pro-Environmental Orientation of the Education for Sustainable Development

Curriculum for Citizenship and Sustainability

Sustainable Development and Values Education in the Jordanian Social Studies Curriculum

Arts & Humanities

Aesthetics and Education for Sustainability

Arts and Design Education for Sustainable Development

Art, Sustainability and Partnerships

Environmental Philosophy: A Biocultural Ethic Approach to Education and Ecotourism for Sustainability

Engineering

Sustainability Awareness in Engineering Curriculum through a Proposed Teaching and Assessment Framework

Sustainable Engineering Ethics: Teaching Sustainability as a Macroethical Issue

Teaching Ethics and Sustainability to Informatics Engineering Students, an almost 30 Years Experience

Engineering Students' Human Values as Rhizomatic Lines of Sustainability

Engineering Students' Conceptualizations of Sustainability

Design for Impact (D4I): A Framework for Teaching Sustainability in Engineering Design

Business and Economics

Emerging Perspectives On Sustainability In Business Schools: A Systematic Literature Review Of Pedagogical Tools In Teaching Sustainability

Reframing Business Sustainability Decision-Making with Value-Focussed Thinking

Thinking Globally, Teaching Sustainability: Embedding Sustainability in International Business Studies and Addressing Student Responses

Sustainability, Human Values and the Education of Managers

Health and Social Work

Exploring the Potential of Ethics of Care for a Transformative Perspective of Sustainability in Social Work Education

Sustainability and the Common Good: Catholic Social Teaching and 'Integral Ecology' as Contributions to a Framework of Social Values for Sustainability Transitions

Law and Policy

The Impact of Sustainability Awareness and Moral Values on Environmental Laws

Centring Knowledge Democracy within Policy-Making for Sustainability and Resilience: A Discussion of the Kenyan Drylands

Interdisciplinary

Values Education for Sustainability in a Global Culture

The New Unimore Interdisciplinary Teaching on Transversal Sustainability Skills

Integrating Character Education and the Values Aspect of Environmental and Sustainability Education: An Interdisciplinary Study Exploring Common Ground, Tensions, and Feasibility

Holding Complexity: Lessons from Team-Teaching an Interdisciplinary Collegiate Course on Urban Sustainability

Approaching Vagueness: Teaching Critical Thinking with Sustainability as Metaphor

5. Strategic Thinking Competency

Definitions

UNESCO: Strategic thinking	UNESCO: the ability to collectively develop and implement innovative actions that further sustainability at the local level and further afield.
KCSF: Strategic thinking	KCSF: The ability to collectively design transformational systemic interventions, transitions, and governance strategies while accounting for strategic leverage points, power dynamics, uncertainty and surprises as well as social and organizational learning in navigating these strategies.

Learning Outcomes

Here we provide examples of student learning outcomes associated with the strategic thinking competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives. These learning outcomes are adapted from Brundiers et al. (2023), and supplemented by ASUSOS (n.d.), CPAPP (2023), and Södertörn University (2022).

Note: we also recommend examining learning outcomes for the implementation competency, which is closely related to the strategic thinking competency.

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- Describe the basic structure of building strategies for change (strategies such as transitions, interventions, resilience, and adaptation) toward sustainability.
- Describe some benefits of strategic thinking in sustainability problem-solving.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Explain basic concepts of intentionality and decision-making in sustainability strategy.
- Explain common decision dilemmas in strategic interaction (i.e., situations with several actors who are entirely or partly dependent on each other for important outcomes) from the perspectives of individuals and systems.
- Explain theories of change relevant to sustainability.

- Identify and explain key concepts associated with sustainability transitions, social learning, and organizational change, such as barriers, power dynamics, assets, roles, effectiveness, etc.
- Explain concepts of strategic thinking as they relate to sustainability, such as leverage points, transition agendas, feasibility, stakeholder alliances and resistance.
- Explain the relationship between strategic thinking and goal conflicts in biological, economic, and social systems.
- Explore strategies that could ensure that one's personal and job activities positively contribute to sustainability transitions.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Apply strategic thinking successfully to complex sustainability dilemmas.
- Define and apply sustainability strategies to one’s academic field, campus operations, or campus-community relationships.
- Apply strategic thinking about sustainability in simulations or actual interactions with others through role-plays, games, or campus or community policy deliberations.

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Assess how natural, economic, and social systems interact to foster or prevent sustainability.
- Analyze and explain local, national, or global sustainability strategies, policies, or governance using a multidisciplinary approach.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Identify factors that affect the success or failure of sustainability transitions and interventions and evaluate their relative influence.
- Measure the effectiveness of strategies against sustainability goals and targets on individual and organizational levels.
- Identify and evaluate ethical dilemmas in strategic interaction.
- Evaluate and contrast research methods to investigate strategic thinking.
- Critically reflect on one’s own approach to strategic thinking about sustainability regarding effectiveness, alliances, and outcomes.

- Reflect on one's own behaviors, interpretations, and impulses in situations involving strategic interaction.
- Integrate sustainability principles into the development of one's personal and professional plans.

Create: Producing new or original work by assembling elements to form a coherent or functional whole, or reorganizing elements into a new pattern or structure; generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Design and conduct a participatory action research project with a community partner aimed at identifying and advancing sustainability policies, practices, or products.
- Create a strategy for addressing a sustainability problem including scoping, goal setting, identifying targets and milestones, developing timelines, and developing assessment methods.
- Design strategies that intervene in a defined system or problem constellation, such as how to make your campus or a particular industry more sustainable.
- Select, modify, combine and apply appropriate strategic thinking tools and methods (e.g. risk assessments, transition management, gap analysis and SWOT analysis) for constructing strategies and interventions leading to sustainable solutions.
- Propose reforms of corporate or government policy or governance to address sustainability challenges.
- Design movements, campaigns, and other large-scale interventions for sustainability by choosing and integrating social change methods.

Concepts and Methods

Below is a summary of major concepts and methods associated with strategic thinking and sustainability, adapted from Brundiers et al. (2023).

Concepts	Methods
Intentionality, goals, objectives Mitigation and adaptation Leverage points: legal/regulatory, economic, social, educational Disruption, transgression, and creative destruction	Methods to design governance arrangements, policies, institutions, incentives and incentives structures Methods to assess their effectiveness Decision support methodologies Transition management methodology

Measures of success, viability, feasibility, effectiveness Obstacles and barriers: resistance, reluctance, path dependency, habits, unintended consequences, inertia Synergies Instrumentalization and alliances: critical friends, stakeholder networks, power dynamics Social learning: real world implications, political understanding, intervention timing, tuning for audience Social movements, resource acquisition and mobilization	Organizational (change) management, including methods to support social learning and reflexivity Participatory Action Research Methods to support changes in habits, behaviors and practices, including social-emotional learning to develop motivation to act, designing campaigns and movements, community organizing, etc. Methods to build networks, form connections, identify allies Power analysis and mapping

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about strategic thinking and sustainability.

Natural Sciences

Renewable Energy and Environmental Sustainability

Coastal Processes, Hazards, and Society

Biogeochemical Assessment - Nutrient Challenge (and rubric)

Biogeochemistry Assessment - Water Balance (and rubric)

Addressing Energy-Related Environmental Injustice (and rubric)

Social Sciences

Lead in the Environment: Addressing Child Lead Poisoning

Community Flood Risk Assessment from Rising/Surging Seas Project

Mock United Nations Climate Negotiations Exercise (and rubric)

Principles of Environmental Campaigns

Social Construction of E-Waste Issue and Campaigns

Global Strategic Communication Capstone

Environmental Advocacy Project

Carbon Emissions Regulation Op-Ed

Post-Disaster Recovery Plan (and rubric)

Arts & Humanities

Digital Photography: Visualizing Sustainability Data Related to a Campus Sustainability Strategic Plan

Designing Virtual Reality and Games to Teach Sustainability Strategies

Rhetorical Analysis of Community Organization's Strategic Communication about Water

Art and Sustainability (group project)

Engineering

Biomaterial Characterization Assignment

Reinforced Concrete Design

Using MATLAB to Analyze Campus Waste Data and Create Recommendations

Diversity, Design, and Innovation in STEM

Urban Water Planning and Decision-Making Group Activity (and rubric)

Business and Economics

Business Strategy for Sustainability

Strategy and Sustainability

Business Strategy for Environmental Sustainability

Corporate Sustainability: Reporting and Strategy

Aligning Stakeholder Analytics & Strategy

Sustainable Marketing

Digital Strategies for Sustainability in Global Markets

Strategic Economics and Data-Driven Decision-Making
Global Business Perspectives (Management in Spain)

Contemporary Business Issues: Climate Change

Hotel Management Simulation: Net Zero Climate Emissions

Making Sustainable Business Decisions in Four Different Industries and Their Effect on People (Social), Planet (Environment), and Profit (Economics)

The True Cost of Burning Coal

B-Academics (requires paid membership)

Health and Social Work

Health Communication Campaign Planning

Environmental Health (including risk management strategies)

Infancy, Environmental Impacts on Maternal & Infant Health

Courting Environmental Justice: Science, Community Knowledge and Public Health

Bridging Computer Science and Sustainable Transportation to Design an Equitable Green Future

Law and Policy

Environmental Policy and Politics

Introduction to Environmental Policy

Policy and Governance in Sustainable Systems

Law, Sustainability, and Development

Using Sim City for Learning Sustainability

Interdisciplinary

Adapting to a Changing World

Environmental Management for Sustainability

Using Food Security in Introduction to Urban Sustainability

Map Your Local Hazards Module

Hydrotopia—Toward a Hydraulic Society in the American West

Interdisciplinary Problem-Solving Project for the Science Classroom (and assessment guide)

A Game-Based Social Resilience Workshop: Thinking about Communal Response to Change (and assessment guide)

Lead Change, Change the World

Writing Op-Eds, Small Personal Essays and Blog Posts

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about the strategic thinking sustainability competency.

Natural Sciences

Using COVID-19 to Teach Sustainability Futures Thinking

Social Sciences

Social Science Pedagogy as a Way of Integrating Sustainable Education and Global Citizenship into the Initial Training of Pre-Primary Teachers

Arts & Humanities

Explorations in Teaching Sustainable Design: A Studio Experience in Interior Design/Architecture

Strategic Thinking on the Teaching Reform of Environmental Design from the Future to the Present

Engineering

Design for Impact (D4i): A Framework for Teaching Sustainability in Engineering Design

Sustainable Architectural Design Education: A Pilot Study in a 3rd Year Studio

Business and Economics

Integrating Sustainability into Strategic Decision-Making: A Fuzzy AHP Method for the Selection of Relevant Sustainability Issues

The Need for Sustainability and CSR in Undergraduate Business Education

Corporate Strategy for Sustainability: Reflections of Prospective Entrepreneurs

Health and Social Work

PH WINS and the Future of Public Health Education

Law and Policy

The Role of Environmental Law Education for Sustainable Development

Interdisciplinary

Ground Truths: Community-Engaged Research for Environmental Justice

Developing a Multi-Hazard Mitigation Strategy

How to Become a Better Strategic Thinker

Active Learning as Enabler of Sustainability Learning Outcomes: Capturing the Perceptions of Learners During a Materials Education Workshop

A Design Thinking Approach to Teaching Sustainability

Strategic Sustainability by Serious Gaming: A Case Study of STRASUS

6. Collaboration or Interpersonal Thinking Competency

Definitions

UNESCO: Collaboration	UNESCO: The ability to learn from others; to understand and respect the needs, perspectives, and actions of others (empathy); to understand, relate to, and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem-solving.
KCSF: Interpersonal	KCSF: The ability to motivate, enable, and facilitate collaborative and participatory sustainability research and collective problem-solving processes, and facilitate multi-, inter-, and transdisciplinary knowledge building and integration, which includes Western scientific knowledge as well as traditional ecological knowledge and indigenous knowledge and wisdom.

Learning Outcomes

Here we provide examples of student learning outcomes associated with the collaboration or interpersonal thinking competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives. These learning outcomes are drawn from Brundiers et al. (2023), and supplemented by ASUSOS (n.d.), Hmelo-Silver (2004), and Suffolk University Boston (n.d.).

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- State the basic types, phases and techniques of teamwork and stakeholder engagement in sustainability projects.
- Define what interdisciplinary and transdisciplinary collaboration mean.
- List some of the benefits of interpersonal competency in sustainability problem solving.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Explain general concepts critical to interpersonal interactions, including listening, oral/written communication, negotiation, conflict management and resolution, teamwork, stakeholder engagement, empathy, etc.
- Explain the basic benefits of listening, communication, teamwork, stakeholder engagement, and other interpersonal skills for one's personal (social) activities, civic engagement, and professional job.
- Understand the dynamics of effective group communication.

- Describe the characteristics and best practices of interpersonal communication and collaboration, teamwork, and project engagement.
- Understand the importance of a shared goal.
- Identify different groups of stakeholders relevant to a project.
- Identify for each of the different groups of stakeholders the appropriate communication approaches (medium, language, message) to engage them.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Work effectively and respectfully in teams on projects, employing teamwork and project management concepts and tools.
- Demonstrate leadership skills both as a team leader and team member by overcoming barriers to collaboration, motivating team members, resolving conflicts, and ensuring the well-being of oneself and one's team.
- Demonstrate professional behavior as a team member and in stakeholder engagements by providing and receiving constructive feedback, coping with unanticipated challenges and high stress levels, and navigating disagreement and misunderstandings.
- Conduct stakeholder interviews in lower risk settings and identify and empathize with different perspectives and values.
- Participate in stakeholder engagements in supportive roles to allow for participatory observation/learning and practicing.
- Demonstrate team skills, including conflict resolution, negotiation, compromise, trust building and professional conduct.

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Analyze an audience in order to appropriately translate complex sustainability issues and convey effective messages using various communication platforms.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Critically reflect on a team's and one's own communication and collaboration preferences and approaches.

Create: Producing new or original work by assembling elements to form a coherent or functional whole; reorganizing elements into a new pattern or structure through

generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Design a process to engage stakeholders, the campus, or the community to address an environmental risk or sustainability policy decision.
- Facilitate a process for engaging the campus or the community in making sustainability policy recommendations by employing empathy and respecting values, beliefs, and norms of others.
- Apply the problem-based learning cycle (identify facts, generate hypotheses, identify knowledge deficiencies, apply new knowledge, abstraction, evaluation) to address a unique sustainability situation.
- Collaboratively organize an arts festival, teach-in, performance, or event about sustainability issues on your campus or in your community.

Concepts and Methods

Below is a summary of major concepts and methods associated with the collaboration or interpersonal competency, adapted from Brundiers et al. (2023).

Concepts	Methods
Functions, types, and dynamics of collaboration and stakeholder engagement (within and beyond academia; interdisciplinarity, transdisciplinarity) Strengths, weaknesses, success, and failure in teams; different levels of teamwork (ranging from information exchange to co-creation) Concepts of leadership, including personal and interpersonal leadership (e.g., distributed, transformative, pedagogic leadership) Concepts of trans-cultural thinking, pluralism, diversity Limits and opportunities of cooperation, competition, empathy (on individual and group levels), and compassion	Stakeholder analysis (e.g., interest vs. power matrix, who to include, why or why not?) Participatory methods involving stakeholders, including negotiation, mediation, deliberation, constructive conflict management methodology, consensus strategies, cooperative inquiry, integrative design Participatory methods for facilitation and reflection on group processes and structures Teamwork methods, such as developing team contracts, interpersonal communication (written, verbal, non-violent communication), and methods to resolve conflicts in teams Methods for mindfulness, compassion and empathy building in responsible decision

Concepts of solidarity, ethnocentrism, decentration, bias towards ingroups Concepts of conflict management Concepts of emotional intelligence and multiple-intelligences framework	making; enhancing capacities to engage in discussion with open-mindedness and in a non-judgmental manner Interdisciplinary and transdisciplinary research approaches, participatory action research, community-engaged research

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about the collaboration or interpersonal competency and sustainability.

Natural Sciences

Environmental Science

Addressing Energy-Related Environmental Injustice (activity)

Impacts of Environmental Change on Horses (assessment)

Geoscience Undergraduate Curricula (collaborative research project)

Global Changes and Sustainability (collaborative research project)

Social Sciences

Community-Driven Research and Environmental Justice

Indigenous Sustainability & Environmental Justice

Stakeholder Collaboration: Organizing for Environmental Justice and Equitable Solutions

Stakeholder Outreach: Effective Communication of Complex Environmental Threats

Society and Sustainability

Environmental Stewardship and Social Justice

Field Work Planning & Investigation (assessment)

Arts & Humanities

Finding Our Place on a Changing Planet

Sustainable World

Finding Our Place on a Changing Planet (final project)

Using Media to Document Public Attitudes on Waste (film/video project)

Engineering

Technological, Social, and Sustainable Systems (interdisciplinary approach)

Water Sustainability in Cities (team project)

Business and Economics

Indigenous Sustainability Entrepreneurship

Aligning Stakeholder Analytics & Strategy

Communications and Stakeholder Management for Project Success

Engaging Stakeholders

Business Strategy for Sustainability (team assignments)

Digital Strategies for Sustainability in Global Markets (team consulting project)

Health and Social Work

Community-Based Participatory Research

Urban and Environmental Health

Environment, Health & Technology (interdisciplinary approach)

Law and Policy

Role of Science and Scientists in Collaborative Approaches to Environmental Policymaking

Natural Resource Policy and Sustainability (collaborative governance module)

Policy and Governance Of Sustainable Systems (interdisciplinary, collaborative policy analysis research)

Interdisciplinary

Advanced Community Based Participatory Research

Collaborative Planning for Sustainability

Collaboration Leadership for Environmental Professionals

Team Contracts for Collaborative Work

AACU Teamwork Rubric

Peer Evaluation for Team Projects

Stakeholder Mapping

Project Based Learning

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about the collaboration or interpersonal thinking competency.

Natural Sciences

Collaboration and Sustainability: Making Science Useful, Making Useful Science

The Advantages of Collaborative Learning in Science Lessons

Who Produces Knowledge? Transforming Undergraduate Students' Views of Science through Participatory Action Research

Social Sciences

Leaving the Lectures Behind: Using Community-Engaged Learning in Research Methods Classes to Teach about Sustainability

Arts & Humanities

Research Informed Sustainable Development through Art and Design Pedagogic Practices

Merging the Arts and Sciences for Collaborative Sustainability Action: A Methodological Framework

Arts Education and Sustainability: Promoting Citizenship and Collaborative Work

Engineering

Cross-Institution Collaborative Learning (CICL) to Connect Water Resources Design with Sustainability Analysis

Teaching Students to Collaborate with Communities: Expanding Engineering Education to Create a Sustainable Future

A Design-Based Learning Approach for Fostering Sustainability Competency in Engineering Education

Collaborative Learning with Sustainability-Driven Projects: A Summary of the eps@isep Programme

Business and Economics

Transactional Learning and Sustainability Co-Creation in a University – Business Collaboration

A Collaborative Game-Based Learning to Enhance Ecological Economics Teaching

Co-learning for Sustainable Design: The Case of a Circular Design Collaborative Project In Ireland

Why Collaboration Will Be Key to Achieving the Sustainable Development Goals

Health and Social Work

Education for Sustainable Healthcare: A Transdisciplinary Approach to Transversal Environmental Threats

Community-engaged Sustainable Health Care Education

Law and Policy

Facilitating Collaborative Partnerships in Education Policy Research: A Case of Multi-Stakeholder, Co-Investigation for Monitoring and Evaluation of Education for Sustainable Development

Reflections on Integrating the Political into Environmental Education through Problem-Based Learning and Political Ecology

Interdisciplinary

Student-Centered Learning and Sustainability: Solution or Problem?

Mapping a Sustainable Future through Conceptualization of Transformative Learning Framework, Education for Sustainable Development, Critical Reflection, and Responsible Citizenship: An Exploration of Pedagogies for Twenty-First Century Learning

Beyond Interpersonal Competence: Teaching and Learning Professional Skills in Sustainability

Learning Processes for Interpersonal Competence Development in Project-Based Sustainability Courses – Insights from a Comparative International Study

Community and Environmental Sustainability

Curriculum for Collaborative Learning in Sustainability at QUT

Social Design through Facilitation and Collaboration: Sustainability Education Experiments in Planning and Design Courses

Collaborative Learning Techniques: A Handbook for College Faculty

Getting Started With Team-Based Learning

7. Critical Thinking Competency

UNESCO: Critical thinking GCSE: (Not applicable)	UNESCO: The ability to question norms, practices, and opinions; to reflect on one's values, perceptions, and actions; and to take a position in the sustainability discourse.

Student Learning Outcomes

Here we provide examples of student learning outcomes associated with the critical thinking competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives. Some of these learning outcomes are adapted from the cognitive learning objectives for the United Nations Sustainable Development goals suggested in UNESCO (2017), as well as NIES (n.d.), ASUSDP (n.d.), SNSM (n.d.).

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- Define the pillars of sustainability – economic, environmental, and social – and why they are interrelated.
- Identify which human activities – on a global, national, local and individual level – contribute most to climate change.
- Recall statistics that describe inequalities of access to and attainment of sustainability education, and major reasons for these inequalities.
- Identify different energy resources and their respective advantages and disadvantages for sustainability.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Explain trends and relationships in graphical data about sustainability issues.
- Find your own examples of sustainability-related journalism, or advertising or other strategic communication; summarize and question their claims.
- Drawing on research literature, explain why health campaigns succeed or fail to promote environmental health and well-being.

- Provide examples that demonstrate how education and lifelong learning opportunities for all can be key drivers of sustainable development.
- Summarize ways in which gender, income, race, ethnicity, religion, physical ability, or other factors affect the distribution of environmental burdens and benefits, and opportunities to participate in environmental decision making.
- Distinguish key concepts in sustainability – such as extreme and relative poverty, traditional environmental risk assessment and cumulative impacts assessment, etc.) and critically reflect on their underlying empirical and normative assumptions.
- Explain how sustainability problems are often characterized by uncertainty, complexity, and/or normative ambiguity or conflict.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Apply sustainability-related conceptual frameworks, techniques, or tools in your discipline to represent the causes, scope, and/or potential remedies for a sustainability issue or problem.
- Use an online calculator to calculate your personal carbon, water, or waste footprint.
- Apply discipline-specific and context-specific skills for communicating standpoints on sustainability issues effectively through writing, speaking, and other forms of public discourse.

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Compare and contrast the major models of sustainability (such as the three pillars, the sustainability doughnut etc.) or sustainability discourses (conservation, preservation, environmental justice, etc.) – to identify their advantages, assumptions, and omissions.
- Identify and distinguish examples and techniques of advertising, strategic communication, journalism, research, and other forms of sustainability-related discourse.
- Analyze power structures and social and cultural systems that shape individual and communal life, social choices, and humanity's impact on the natural world in a local, national, or global context.
- Identify embedded biases and assumptions in social, political and economic systems and discourses as they shape human impacts on the natural world.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Assess the accuracy and credibility of sustainability-related claims in examples of advertising, journalism, policy platforms, political communication, and other forms of public discourse.
- Evaluate and compare the sustainability of your and other communities' systems in meeting their needs for food, energy, transport, water, safety, waste treatment, inclusion or accessibility, education, integration of green spaces and disaster risk reduction.
- Assess the strengths, weaknesses, and gaps in your own sustainability education, including at your current institution.
- Conduct a failure analysis on a technology or technical system.
- Draw on rationales and frameworks for civic, professional, and personal engagement to articulate your role in contributing to a more sustainable world.
- Evaluate complex and changing problems from multiple analytical perspectives, considering alternative solutions and diverse ethical and cultural approaches.

Create: Producing new or original work by assembling elements to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Develop an argument supported by evidence about how to address a sustainability challenge, such as renewable energy generation, participatory sustainable development, reducing plastics pollution, etc.
- Conduct original research on a sustainability issue and draw recommendations based on your evidence about norms, practices, or policies for individuals, groups, or societies.
- Develop informed judgments about the value and risk of emerging technologies for addressing sustainability.
- Design or redesign a technology that addresses an unsustainable norm, practice, or impact in your field.
- Create an artwork that represents a vision of a sustainable norm or practice, or well-researched recommendations for how to use materials more sustainably in a particular artistic medium.

Concepts and Methods

Below is a summary of major concepts and methods associated with the critical thinking competency, adapted from UNESCO (2017), as well as NIES (n.d.), ASUSDP (n.d.), SNSM (n.d.).

Concepts	Methods
Models of sustainability, sustainable development, and environmental justice Environmental discourses: conservation, preservation, animal liberation, rights of nature, anthropocentrism and ecocentrism, etc. Frameworks for sustainability education, including competencies, skills, knowledge, etc. Environmental uncertainty, complexity, and/or normative ambiguity or conflict	Textual interpretation: content analysis, discourse analysis, narrative analysis, etc. Techniques for analyzing argumentation and for surfacing and questioning assumptions (ideological analysis, analysis of stereotypes and biases, deconstruction, etc.) Environmental mapping (e.g., of burdens and amenities as they relate to race or income of populations) Environmental ethnography and auto-ethnography (photovoice, etc.) Curriculum and pedagogy design and assessment Evaluation research methods Risk assessment, alternatives assessment, vulnerabilities assessment, and analysis of cumulative impacts of risks Legal and policy analysis Failure analysis

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about critical thinking and sustainability.

Natural Sciences

Developing Student Literacy on Risk, Resilience, and Strategies for Living with Disaster Uncertainty

Top 15 World Agricultural Commodities—Summative Assessment

Social Sciences

Know Your Audience! Audience Analysis Exercise to Increase Audience Centered Communication and Teaching of Risk and Resilience

Environmental Justice

Society and Sustainability

Urban Sustainability

Arts & Humanities

Exploring Environmental and Sustainability Issues and Policy Using Film

Writing and Critical Reasoning Issues in Sustainability

Issues in Sustainability

Writing about Sustainability

Engineering

Environmental Sustainability

Sustainability in Engineering

Failure Analysis

Business and Economics

Critical, Creative, and Analytical Thinking in Business

Critical Thinking Strategies for Business Decisions

Sustainability Reporting

Sustainable Business

Sustainability Driven Innovation

Health and Social Work

Climate Change, the Environment, and the Future of Public Health

Sustainability, Medicine, & Health

Introduction to Environmental Health

Law and Policy

Analysis Of Environmental Impact

Environmental Policy Analysis

Introduction to Environmental Policy and Planning

Environmental Law

Interdisciplinary

Pathways to Sustainability – An Interdisciplinary Approach

Interdisciplinary Methods in Social-Ecological Research

Sustainability Project Assessment Rubric

Critical Thinking and Reflection Assessment Rubric

AACU VALUE Rubric for Critical Thinking

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about critical thinking and sustainability.

Natural Sciences

Emerging Ideas in Sustainability Science: Critical Thinking and Lifelong Environmental Learning

Critical Thinking and Normative Competencies for Sustainability Science Education

The Trend of Critical Thinking Studies in Biology Education through Online Learning: A Systematic Review

Critical Thinking Skills of Environmental Changes: A Biological Instruction Using Guided Discovery Learning-Argument Mapping

Developing Critical Thinking Skills towards Biology Course Using Two Active Learning Strategies

Promoting Critical Thinking In General Biology Courses: The Case Of The White Widow Spider

Social Sciences

Social Science Pedagogy as a Way of Integrating Sustainable Education and Global Citizenship into the Initial Training of Pre-Primary Teachers

Leaving the Lectures Behind: Using Community-Engaged Learning in Research Methods Classes to Teach about Sustainability

Disciplinary-specific Critical Thinking in Sociology

Political Discourses as a Resource for Climate Change Education: Promoting Critical Thinking by Closing the Gap between Science Education and Political Education

Arts & Humanities

Making and Assessing Art in the Sustainability Classroom

Critical and Creative Thinking as a Form of Making in Art Education

Engineering

Supporting Sustainability Thinking in Postgraduate Design Education

Fostering Sustainability and Critical Thinking Through Debate—A Case Study

Sustainability and Critical Thinking in Civil Engineering Curriculum

Development of the Consumption Journey Tool to Improve Awareness and Critical Thinking on Sustainability in Engineering Students

Engineering Students' Conceptualizations of Sustainability

Business and Economics

Critical Approaches to Sustainability in the Business Communication Classroom: A Developmental Perspective

An Assessment of Critical Reflection in Management Education for Sustainability: A Proposal on Content and Form of Shared Value Rationality

Sustainable Business Ethics Education

Health and Social Work

Promoting Critical Thinking through Socratic Questions in Health Sciences Work-Integrated Learning

Environmental Social Work: Implications for Accelerating The Implementation of Sustainable Development in Social Work Curricula

Sustainability, Human Rights, and Environmental Justice

Law and Policy

Environment and Sustainability Education Research as Policy Engagement: (Re-) Invigorating 'Politics as Potentia' in South Africa

Embedding Sustainability Literacy in the Legal Curriculum: Reflections on The Plymouth Model

Teaching Water Resource Economics for Policy Analysis

Interdisciplinary

Emerging Ideas in Sustainability Science: Critical Thinking and Lifelong Environmental Learning

Education for Sustainable Development and Critical Thinking Competency

Visual Literacy Intervention for Improving Undergraduate Student Critical Thinking of Global Sustainability Issues

Approaching Vagueness: Teaching Critical Thinking with Sustainability as Metaphor

8. Self-Awareness or Intrapersonal Competency

Definition

UNESCO: Self-awareness	UNESCO: The ability to reflect on one's role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.
KCSF: Intrapersonal	KCSF: The ability to be aware of one's own emotions, desires, thoughts, and behaviors as well as one's positionality and role in global society and in the local community. Intrapersonal competency involves the ability to reflect and act with self-awareness and to regulate, motivate, and continually evaluate one's actions and improve oneself, drawing on and developing emotional intelligence and resilience.

Learning Outcomes

Here we provide examples of student learning outcomes associated with the self-awareness or intrapersonal competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives. Some of these learning outcomes are adapted from Brundiers et al. (2023) and UNESCO (2017).

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- Define key concepts – such as privilege, power, intersectionality, capabilities, emotional intelligence – as they relate to sustainability.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Describe one's positionality within the community and global society, and which aspects of one's identity are sources of privilege and power related to sustainability.
- Identify personal experiences and observations related to power and positionality, and their effects on individual thoughts and feelings (of safety, compassion, stress, connection, etc.) about sustainability, and on the broader culture's views of sustainability.

- Identify how fundamental human rights and capabilities relate to sustainability, and their impact on personal well-being.
- Identify personal perspectives and their potential influence on sustainability views and decisions (e.g., about design, policy, rights and responsibilities, etc.)
- Identify sources of personal risk and resilience in the face of sustainability challenges, such as climate grief, environmental trauma, etc.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Apply self-reflective techniques and skills (mindfulness, meditation, faith-based practices, etc.) to identify and regulate one's thoughts and emotions about sustainability or in response to sustainability crises.
- Apply techniques for checking one's implicit and explicit biases towards other people and the natural world.
- Employ techniques for checking personal bias in data analysis (such as tests for intercoder reliability, etc.)

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Engage in reflexive journaling or auto-ethnography to identify formative events, people, media messages, and so on, in one's personal sustainability biography; compare and contrast the results with a different person's biography.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Assess how increased self-awareness, emotional intelligence, and resilience impact decision-making and interactions in advocacy efforts, fostering personal growth and effectiveness.
- Evaluate potential impacts of one's positionality on data gathering, analysis and interpretation, and consider the ethical implications.
- Assess the similarities and differences between one's rights and one's actual capabilities to influence sustainability issues – as a consumer, citizen, community member, and professional.

Create: Producing new or original work by assembling elements to form a coherent or functional whole, or reorganizing elements into a new pattern or structure; generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Develop comprehensive self-care plans that integrate mindfulness practices, emotional regulation techniques, and community support systems to enhance resilience and sustain engagement in sustainability work.
- Develop advocacy campaigns or policy proposals informed by principles of healing or restorative justice, that aim to address root causes of oppression and promote holistic well-being within one's own life and community.
- Design a technology or create an artwork that reinforces capacities for resilience and flourishing for oneself and others.
- Author personal accounts of one's roles, attitudes, and responsibilities concerning sustainability issues.
- Create a personal development plan (PDP) to reflect on one's sustainability-related learning, performance, and achievement and to plan for personal, educational, and professional development.
- Construct a portfolio or ePortfolio to compile sustainability-related work, reflect on growth, and share items with professors, advisors, and potential employers.

Concepts and Methods

Below is a summary of major concepts and methods associated with the self-awareness or intrapersonal competency, adapted from GCSE (2024) and UNESCO (2017).

Concepts	Methods
Intersectionality: how groups' and individuals' multiple sources of identities (race, gender, class, etc.) result in unique combinations of discrimination and privilege.	Autoethnography
Positionality and role in global society and in the local community, including environmental, social, and economic privileges and burdens or oppressions	Environmental psychology (ecopsychology): research and practice of meditation, mindfulness, nature therapy, etc.
Self-regulation, self-motivation, self-evaluation and improvement, resilience	Feminist, Black Feminist, and Queer theory and research methods for studying intersectionality and positionality
Emotional intelligence: Understanding and managing one's own emotions and the emotions of others	Healing justice, restorative justice, and reconciliation for understanding trauma and resilience, self-care and collective care, confronting personal experiences of collective history, repairing unjust relationships
Capabilities and flourishing: people's capacity to achieve the lives they value	Analysis of human capabilities, flourishing, wellbeing, and happiness

and to flourish, rather than merely having the right or freedom to do so Nature deprivation and the healing benefits of time spent in nature	Role-plays and subsequent reflections on one's thoughts, feelings, and actions

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about the self-awareness or intrapersonal competency and sustainability.

Natural Sciences

An Activity to Introduce the Geoscience Perspective

Living and Eating on Earth (Quest 2 assignments)

Energy and Society

Impact of Materials on Society (self-reflection components)

Social Sciences

Who am I in a Changing Climate?

Introduction to Sustainability (ecological footprint assignment)

Introduction to Sustainable Practices (self-reflection assignment)

Environmental Communication (reflections assignment)

Introduction to Ecopsychology

Ecological Psychology (course journal assignment)

Ecopsychology II (final paper)

Engaging Contentious Political Issues

Global Sustainable Development (self-reflection on projects assignment)

Arts & Humanities

A Sense of Place Collage Essay

Rethinking Sustainability through the Humanities: Multi-Sensory Experience and Environmental Encounter Beyond the Classroom

A Lifestyle Project for the Humanities

Engineering

Examining your Earthquake Hazard

Seismic Evaluation of Buildings

Environmental Engineering and Sustainability Leadership (reflective journal)

Business and Economics

Flourishing at Work and Beyond: Foundations of Positive Organizational Scholarship

Ecological Economics (analysis of human flourishing)

Water Footprints

Climate Change from the Socio-Environmental Systems Perspective

Health and Social Work

Education, Social and Emotional Learning

Predictions and Evacuation

Sustainability, Medicine, & Health (final project)

Law and Policy

The Lifestyle Project

Interdisciplinary

Sustainability & Self-Care

Sustainability Leadership for the Twenty-First Century

Foundations of Community Sustainability II

Introduction to Sustainability

Global Learning Program: Land, Food and People - Addressing Environmental Justice through Mutual Aid in Puerto Rico (final presentation)

Contemplative Inquiry on Climate Change: Playing with Perspectives

Afghan Poppies, Climate Change and War: Thinking Systemically About Us and Them

Justice, Power, and Activism: What the Goldman Environmental Prize Winners Teach Us about Resilience and Democracy

Identifying Your Misconceptions & Logical Fallacies about Climate Science

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about the self-awareness or intrapersonal competency.

Natural Sciences

Enhancing Decision-Making in STSE Education by Inducing Reflection and Self-Regulated Learning

Teaching Methods in Biology Education and Sustainability Education Including Outdoor Education for Promoting Sustainability—A Literature Review

Social Sciences

How Teachers Can Open Up for and Handle Poignant Experiences of the Conflictual Aspects of Sustainability Issues

Political Emotions in Environmental and Sustainability Education

'Doing' Socio-Political Sustainability in Early Childhood: Teacher-as-researcher Reflective Practices

Arts & Humanities

Achieving Sustainability in the Philosophy of Art Teaching and Learning

How Philosophizing the Dialogos Way Can Promote Education for Sustainable Development

Drawing Sustainability: Helping Students to Know What They Know

From the Art of Reflection to the Art of Noticing: A Shifting View of Self-Tracking Technologies' Role in Supporting Sustainable Food Practices

Engineering

Self-evaluation of Industrial Case Studies with Iterative Improvements to Support Chemical and Biological Systems Engineering and Sustainability Teaching and Learning

Teaching Engineering Ethics with Sustainability as Context

Reshaping Teaching for Sustainability in Business Engineering – A Pilot Study on Students' Outlooks and Learning Expectations

Self-Evaluation and Reflection for Professional Development of Chemical Engineering Students

Implementation of Transformative Sustainability Learning into Engineering Curriculum

Business and Economics

The Strategic Process of Developing Social Aspects of Sustainability through the Vision Reflection in Business Education

Matching International Business Teaching with the UN Sustainable Development Goals: Introducing Bi-directional Reflective Learning

Sustainability in Management Education: Contributions from Critical Reflection and Transformative Learning

Health and Social Work

Sustainability Pedagogy in Practice: An Example from Health Education

Expanding the Ecological Consciousness of Social Work Students: Education for Sustainable Practice

Integrating the Natural Environment in Social Work Education: Sustainability and Scenario-based Learning

Encouraging Self-Reflection in Social Work Students: Using Personal Construct Methods

Interdisciplinary

Beyond Colonial Futurities in Climate Education

A Competency Framework to Assess and Activate Education for Sustainable Development: Addressing the UN Sustainable Development Goals 4.7 Challenge

Inner Development Goals: Background, Method and the IDG Framework

Inner Development Goals Phase 2 Research Report

Reflective Practices in Sustainability Education

The Use of Reflective Pedagogies in Sustainability Leadership Education—A Case Study

Student Perceptions of Reflection and the Acquisition of Higher-Order Thinking Skills in a University Sustainability Course

9. Integrated Problem-Solving

Definitions

UNESCO: Integrated problem-solving KCSF: Integrated problem-solving	UNESCO: The ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive, and equitable solution options that promote sustainable development, integrating the other competencies. KCSF: The ability to solve complex sustainability problems in integrated ways, i.e., the ability to work with others to integrate problem analysis, sustainability assessment, visioning and strategy building, and to prepare for implementing the co-created solution in the real world. This includes the ability to articulate the individual contributions of the previous key competencies to sustainability problem-solving processes and being familiar with different problem-solving frameworks and able to select the appropriate one to develop viable solution options in context-sensitive ways, recognizing that sustainability problem-solving is a long-term, iterative and collective process between planning, realization, adjustment and evaluation.

Learning Outcomes

Here we provide examples of student learning outcomes associated with the integrated problem-solving competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives. These learning outcomes are drawn from Brundiers et al. (2023), supplemented by CREducation Project (n.d.) and Portland Community College (n.d.).

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- Describe local or prominent cases of social movements and organizational changes for sustainability.
- Identify and define central and secondary sustainability problems, problem-solving styles or frameworks, or known methods of transition and transformation.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Describe some benefits of the integrated problem-solving competency and explain how the sustainability problem-solving competency integrates other competencies.
- Discuss associations between disparate facts and methods, which may be cross-disciplinary.
- Recognize attributes of collaboration, risk-taking, multi-disciplinary awareness, and imagination in achieving creative responses to problems.
- Explain the historical roots of sustainability problems.
- Align theories and practices (praxis) that help to address sustainability challenges.
- Describe sustainability problem-solving techniques used by professionals in your field.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Apply knowledge or theories you have learned in one situation to address a new sustainability problem.
- Select and apply a problem-solving framework and/or methods to an emerging sustainability problem.
- Apply the sustainability problem-solving competency to activities in one's own life, internships, and in and professional jobs.
- Select and use appropriate concepts and methods from a variety of disciplines to solve problems effectively and creatively.
- Interpret and use written, quantitative, and visual text effectively in presenting diagnoses and solutions to problems.

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Integrate sustainability competencies (such as combining systems thinking with futures thinking) to solve a problem.
- Analyze data using concepts and methods associated with two or more sustainability competencies to understand a problem and explore potential solutions.
- Compare and contrast solutions that emerge from combining different sustainability competencies.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Assess how the root causes of sustainability problems over time have limited the effectiveness of previous solutions.
- Justify your choice of multiple methods, concepts, and/or technologies associated with two or more sustainability competencies to research, solve, and present solutions to problems.
- Evaluate your understanding of a sustainability problem and potential solutions from different perspectives, especially of people who would question or disagree.

Create: Producing new or original work by assembling elements to form a coherent or functional whole, or reorganizing elements into a new pattern or structure; generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Create original research, designs, plans, or artworks that analyze a sustainability problem and how it might be solved.
- Adapt previous solutions to new data and conditions.
- Create a sustainability solution that integrates multiple disciplines, perspectives, and other competencies.

Concepts and Methods

Below is a summary of major concepts and methods associated with the integrated problem-solving competency, adapted from Brundiers et al. (2023).

Concepts	Methods
Processes, transitions and transformations (and other change dynamics) Roadblocks and barriers (resistance to change) Triggers and supporting factors Social movements, and organizational change and learning Shifting power, politics, and authority, and their roles in transition processes	Transition management Organizational change management Mapping interventions and intended outcomes Adaptation research methodology Integrated foresight and backcasting or mitigation Actionable and transformational planning methodologies Transdisciplinary case studies Transformational sustainability research framework

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about the integrated problem-solving competency and sustainability.

Natural Sciences

Determining Carbon Storage in Garcelon Bog

Interdisciplinary Problem Solving: Sustainable Water Systems

Environmental Problems

The Interconnected Nature of the Atmosphere, Hydrosphere, and Biosphere (Modeling the Carbon Cycle Assessment)

Investigating Oceanographic Issues and Solutions (Human Impacts on Oceans Assessment)

A Growing Concern (Agricultural Fact Sheet and Recommendations Assessment)

Human's Dependence on Earth's Mineral Resources—Phosphorus Mining and Impacts (Addressing Phosphate Extraction Assessment)

Process Oriented Guided Inquiry Learning and example learning activities

Social Sciences

Theories in Environmental Social Sciences

Environmental Sociology

Data Set Analysis (Assessment Using Qualitative and Quantitative Data)

Major Storms and Community Resilience (Town Hall Meeting Assignment)

Arts & Humanities

Philosophical & Theoretical Foundations of Sustainability Leadership in Education

Philosophy & the Environment

Engineering

Problem Solving for Sustainable Engineering (Lesson Plan)

Environmental Engineering Analysis Tools

Engineering Design for a Sustainable Future

Urban Water Atmospheric Environment Interactions (Urban Heat Islands and Flooding Assessment)

Water Sustainability in Cities—Planning and Decision Making (Sustainable Water Design Assessment)

Ocean Sustainability and Geoengineering (Carbon Geoengineering Assessment)

Artificial Intelligence Meets Sustainability

Artificial Intelligence for Sustainable Development

Business and Economics

AI for Human Well Being

Challenges and Solutions in Business Sustainability

Business and Environmental Sustainability

Environmental Economics and Regulation

Ecological Economics

Economics - Tragedy of the Commons (Assessments)

Financial Management

Predictive Analytics & Data Mining

Health and Social Work

Health and Sustainability

Environmental Health Policy & Practice

Intervening in Global Public Health, Sustainability, and Preventive Medicine

Regional Case Study Community Action Plans (Food Security Assessment)

Women and Water (Safe Drinking Water Assessment)

Managing the Risk of Lead Exposure (Policy Memo Assessment)

Law and Policy

Energy & the Environment

International Environmental Politics

Environmental Policy Analysis

Policy & Governance of Sustainable Systems

Interdisciplinary

Life Cycle Assessment Modeling

Practicum in Innovative Sustainability Leadership

Environmental Problem Solving through Inquiry and Dialogue

Problem-Solving for a Sustainable Transition

AACU VALUE Problem Solving Value Rubric

Gamification - Blog Post on Designing Learning with Games and Simulations

Case-Based Learning Guide and Examples

Rubric for Assessing Feedback in Problem Solving in STEM

Rubric for Assessing Analytics in Problem Solving in STEM

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about the integrated problem-solving competency.

Natural Sciences

Exploring Innovative Strategies in Problem Based Learning to Contribute to Sustainable Development: A Case Study

Teaching Discipline-Based Problem Solving

Integrating Problem- and Project-Based Learning Opportunities: Assessing Outcomes of a Field Course in Environment and Sustainability

Beyond Structure-Function: Getting at Sustainability within Biomimicry Pedagogy

Teaching Sustainability and Environmental Justice in Undergraduate Chemistry Courses

Becoming an Actionable Scientist: Challenges, Competency, and the Development of Expertise

Social Sciences

Tackling Wicked Problems in Teaching and Learning: Sustainability Issues as Knowledge, Ethical and Political Challenges

Sustainability: Teaching an Interdisciplinary Threshold Concept through Traditional Lecture and Active Learning

From Polyps to Politics: Using a Coral Reef Living Laboratory in a Politics of Sustainability Course

Arts & Humanities

Integrating Sustainability Issues into English Language Courses at University

Teaching Sustainable Development and Environmental Ethics: The IBMB-Concept of Bringing Theory and Practical Cases Together

Philosopher-as-Liaison? Lessons from Sustainable Knowledge and American Philosophy

Engineering

Reshaping Teaching for Sustainability in Business Engineering – A Pilot Study on Students' Outlooks and Learning Expectations

Wicked Problems in Engineering Education: Preparing Future Engineers to Work for Sustainability

Embedding Sustainable Development (SD) and Interdisciplinary Project Based Learning (PBL) in the EPS: An Opportunity to Break Down Silos in Engineering

Sustainable Development Needs: A Transformed Engineering Education

Business and Economics

Problem-Posing in Management Classrooms for Collective Sustainability Transformation

Lenses on the Post-Oil Economy: Integrating Entrepreneurship into Sustainability Education through Problem-Based Learning

Incorporating Global Sustainability in the Business Language Curriculum

Collaborative Problem Solving in a Complex Governance System: Amsterdam Airport Schiphol and the Challenge to Break Path Dependency

Health and Social Work

Can a Sustainability and Health Scenario Provide a Realistic Challenge to Student Nurses and Provoke Changes in Practice? An Evaluation of a Training Intervention

A Sustainability Framework to Guide Community Assessment and Problem Solving

Law and Policy

The Green Building Project: Promoting Political Science Learning through a Collaborative Research Approach

Sustainability Policy-Making as a Dynamic, Agent-Based System of Systems

Applying Enquiry and Problem Based Learning to Mission-Oriented Innovation Policy: From Policy to Pedagogy to Teaching and Learning Practice

Interdisciplinary

A Framework for Teaching Socio-Environmental Problem-Solving

A General Problem-Solving Approach for Wicked Problems: Theory and Application to Chemical Weapons Verification and Biological Terrorism

Rethinking Environmental Education: Reflections on AAU UNESCO Center Certificate Course of Problem-Based Learning

Assessment Strategies for Enquiry and Problem-based Learning

Overcoming the Terrors of the Either/Or

Sustainability Education: A Dance Between Knowledge and Experience

A Slippery Cousin To ‘Development’? The Concept of ‘Impact’ in Teaching Sustainability in Design Education

10. Implementation Competency

Definitions

KCSF: Implementation UNESCO: (Not applicable)	KCSF: The ability to collectively carry out and realize planned sustainability strategies (e.g., a sustainability action plan) on the ground, including implementation, adaptation, transfer, and scaling, in effective and efficient ways. Working toward a sustainability-informed vision over time involves monitoring and evaluating the realization process on the ground, addressing emerging challenges, and making adjustments.

Learning Outcomes

Here we provide examples of student learning outcomes associated with the implementation competency, organized according to Bloom's Taxonomy (see Appendix A), from simpler to more complex learning objectives.

Note: we also recommend examining learning outcomes for the strategic thinking competency, which is closely related to the implementation competency.

Remember: Recalling facts and concepts, including retrieving, recognizing, and recalling relevant knowledge from long-term memory.

- Define the goals, objectives, scope, and metrics for evaluating one's sustainability project, plan, or strategy.
- Define basic concepts of implementation, such as transfer, scaling, monitoring, adaptation, and evaluation.

Understand: Constructing meaning from oral, written, and graphic messages by exemplifying, classifying, summarizing, inferring, locating, recognizing, reporting, translating, or explaining.

- Describe common funding sources, organizational dynamics, processes, challenges, and monitoring and evaluation criteria and techniques for implementing a sustainability project or plan in your field.
- Identify common legal and ethical considerations relevant to project or campaign implementation in your field.

Apply: Using information in new situations, or carrying out a procedure for executing, implementing, solving, interpreting, operating, or sketching.

- Research and apply lessons from the approaches and outcomes of similar sustainability plans, projects, or strategies implemented by others.
- Select an appropriate organizational structure (e.g., coalition, network, affinity groups) and decision-making processes (e.g., hierarchical, decentralized, consensus-based) for advancing a sustainability initiative.
- Identify and make plans to address likely barriers, benefits, and incentives for stakeholders of one's plans during implementation.
- Identify and adapt agreements, contracts, or memoranda of understanding used to implement similar projects to participants in your project.
- Employ appropriate frameworks to guide implementation of your plans (e.g., design thinking, social marketing, direct action, community organizing, asset-based community development, litigation, community arts projects, documentary filmmaking).
- Develop mechanisms for ongoing evaluation and adaptation, in response to evolving circumstances and outcomes.
- Identify the kinds of expertise that will support successful implementation of your initiative, and incorporate stakeholders and allies with relevant knowledge and skills.

Analyze: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose, differentiating, organizing, comparing, contrasting, distinguishing, examining, experimenting, questioning, or testing.

- Explain how multiple strategies can make complementary contributions to larger projects or campaigns (such as assimilative and assertive tactics, social media and face-to-face outreach, and community organizing, policy advocacy, cultural- or arts-based advocacy, and litigation).
- Assign appropriate roles and responsibilities to members of your group or organization based on an analysis of their skills and interests, and of the needs of the situation.
- Establish timelines for completing phases, for reaching milestones for the project or strategy, and for reflection.
- Conduct pilot tests, trials, or proof-of-concept projects to test for viability, effectiveness, and unforeseen problems.

Evaluate: Making judgments based on criteria or standards by checking, critiquing, weighing, arguing, defending, judging, or justifying a position.

- Critique strategy and implementation approaches of sustainability case studies, explaining factors contributing to success or a lack thereof.
- Adapt and employ techniques for performing formative and summative evaluation of one's sustainability project or campaign during implementation.

Create: Producing new or original work by assembling elements to form a coherent or functional whole, or reorganizing elements into a new pattern or structure; generating, planning, or producing; designing, constructing, developing, formulating, or authoring.

- Cultivate strategic capacity in change groups through diverse and relevant knowledge and connections, effective decision-making processes, and strong relationships.
- Creatively implement strategies toward a sustainable solution, including adapting strategies and tactics based on progress or setbacks.
- Adapt, scale or replicate one's sustainability project, plans, or strategy in new situations.
- Adapt and extend one's plans to new populations and places.
- Create new organizations, coalitions, or networks to strengthen and extend one's plans.

Concepts and Methods

Below is a summary of major concepts and methods associated with the implementation competency, adapted from Brundiers et al. (2023) and UNESCO (2017).

Concepts	Methods
Goals, objectives, scope, and metrics for projects, plans, or strategies Adaptation, transfer, scaling, monitoring, and evaluation Social movements, social entrepreneurship, social innovation Community organizing and community development Organizational behavior, organizational change	Implementing any methods included in the Social Change Wheel Design thinking (prototyping, testing, user experience research, etc.) Social marketing, campaign design, strategic communication, framing and messaging Evaluation research - formative and summative, short-term and long-term

	Action research, participatory action research, community-engaged research and learning Community organizing, organizational development and management, nonviolent direct action Asset-Based Community Development (ABCD)

Pedagogies and Assessments

Below are links to example syllabi, assignments, lesson plans, and assessments of student learning about the implementation competency and sustainability.

Natural Sciences

Applied Sustainability

Sustainability in Action

Applied Sustainability in Contemporary Culture

Social Sciences

Social Action

Transformations: Commoning and Social Action

Research and Sustainable Development

Environmental Justice: Race, Class, Equity, and the Environment

Climate Justice and Social Action

Transformative Food Systems Seminar

Food Justice, Community, and Peace

Sustainable Solutions to Poverty

Arts & Humanities

Religion, Ecology, & Environmental Ethics

Field Research in the Ecological Arts

Intro to Printmaking (sustainability theme)

Environmental Film Making

Engineering

Solar Structures

(Sustainable) Design Thinking II

Civil and Environmental Engineering Senior Design

International Senior Design Field Experience

Business and Economics

Sustainable Business: Strategy & Innovation

Social Entrepreneurship and Sustainable Development

Sustainable Innovation Management

Sustainability Inspired Product and Service Design

Design for Social and Sustainable Business Innovation

Circular Economy for Sustainability Professionals

Future Fashion - Sustainable Systems and Strategies

Health and Social Work

Case Study Group Work-Problem Identification

Social Work Practice with Communities & Organizations

Practicum in Public Health

Law and Policy

Campus Greenhouse Gas Emissions Inventory

Collective Urban Policy Change

Strategies for Sustainable Solutions: Design Thinking in Public Services

Interdisciplinary

Action to Enhance Sustainability

Applied Sustainability

Writing Op-Eds, Small Personal Essays and Blog Posts

Lead Change, Change the World

Teaching Social Action (model course, example syllabi, teaching materials)

Center for Story-Based Strategy (strategic communication materials)

Community Toolbox (teaching materials)

Guide to Public Narrative (teaching materials, cases)

Have the Talk: Climate Conversations (lesson plan)

Momentum Community (community organizing training materials)

UNESCO Stories on Promising Practices Advancing the SDGs (case studies)

Scholarship of Teaching and Learning

Below are examples of research on teaching and learning about the implementation competency.

Natural Sciences

Integrating Deep Ecology and Adaptive Governance for Sustainable Development: Implications for Protected Areas Management

Addressing Sustainable Development: Promoting Active Informed Citizenry through Trans-Contextual Science Education

Natural Science Education Concept for Sustainable Development

Social Sciences

A Sociology of Climate Change Responses

Teaching Urban Sociology and Urban Sustainability on Two Feet, Two Wheels, and in Three Cities: Our Experience Teaching Sustainable Cities in North America

A Case Study of Sustainability and Civic Engagement in a Sociology of Food Course

Art and Humanities

A Global Humanities Approach to the SDGs

Teaching Art a Greener Path: Integrating Sustainability Concepts of Interior Design Curriculum into the Art Education Curriculum

Engineering

Systematic Review of How Engineering Education Is Advancing the SDGs

Implementation of the New Urban Agenda on a Local Level: An Effective Community Engagement Methodology for Human-Centered Urban Design

Business and Economics

Designing a Course for Developing Sustainability Competencies

Promoting Education for Sustainability through Game-Based Learning: Using the Sustainable Strategies Game to Improve Students' Knowledge and Skills of Sustainable Business Practices

Framing Teaching for Sustainability in the Case of Business Engineering Education: Process-Centric Models and Good Practices

Meeting the Growing Demand for Sustainability-Focused Management Education: A Case Study of A PRME Academic Institution

Defining Sustainability Core Competencies in Business and Management Studies Based on Multinational Stakeholders' Perceptions

Integrating Sustainability in the Business Administration and Management Curriculum: A Sustainability Competencies Map

The Tempered Radicals: How Employees Push Their Companies–Little by Little–To Be More Socially Responsible

Health and Social Work

Integrating Sustainability Development Education Program In Nursing to Challenge Practice Among Nursing Interns In Health Care

Implementing Environmental Sustainability Educational Intervention in Dental Hygiene Instruction

Law and Policy

Effective Adaptive Governance of Socio-Ecological Systems (SES)

Climate Adaptation as Strategic Urbanism: Assessing Opportunities and Uncertainties for Equity and Inclusive Development in Cities

Transition Management for Sustainable Development: A Prescriptive, Complexity-based Governance Framework

Collaborations in Environmental Initiatives for an Effective “Adaptive Governance” of Social–Ecological Systems: What Existing Literature Suggests

Interdisciplinary

”Being A Good Person in the System We Already Have Will Not Save Us:" Interpreting How Students Embody and Narrate the Process of Social Change for Sustainability Using an Agency/Structure Lens

Undergraduates in A Sustainability Semester: Models of Social Change for Sustainability

Local to Global Justice: Roles of Student Activism in Higher Education, Leadership Development, and Community Engagement

Climate Change Competencies from the Perspective of Finnish Youth

Fostering Sustainability Competencies and Ethical Thinking in Higher Education: Case Sustainable Chocolate

Interdisciplinary Perspectives On Sustainability In Higher Education: A Sustainability Competence Support Model

What Motivates Students to Be Sustainability Change Agents in the Face of Adversity?

A Process for Transition to Sustainability: Implementation

Teaching Innovation and Sustainability through International Interactive Workshops

Project-based Learning for Environmental Sustainability Action

Effectiveness of Education for Sustainability: The Importance of an Action-Oriented Approach

Innovation Challenges: Developing Sustainability Competencies through Experiential Learning

Empowering Lecturers and Students with Constructivist, Community-Engaged Pedagogies to Support Sustainable Development Goals

References

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives: complete edition*. Addison Wesley Longman, Inc.

ASUSDP (Appalachian State University Sustainable Development Program) (n.d.). *Sustainable development student learning outcomes*. https://sd.appstate.edu/student-learning-outcomes

Armstrong, P. (2010). *Bloom's Taxonomy*. Vanderbilt University Center for Teaching. https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

ASUSOS (Arizona State University School of Sustainability) (n.d.). *Core sustainability competencies*. https://schoolofsustainability.asu.edu/degrees-programs/what-you-will-learn/

ASUSOS (Arizona State University School of Sustainability) (2024). *Games for the future: Seeing sustainability*. https://www.nisenet.org/sites/default/files/catalog/uploads/seeing_sustainability_facilitator_guide_2020-02-18_0.pdf

Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S., Dripps, W., Habron, G., Harré, N., Jarchow, M., Losch, K., Michel, J., Mochizuki, Y., Rieckmann, M., Parnell, R., Walker, P., & Zint, M. (2021). Key competencies in sustainability in higher education: Toward an agreed-upon reference framework. *Sustainability Science, 16*(1), 13-29. https://doi.org/ghwhkg

Brundiers, K., King, J., Parnell, R., & Hiser, K. (2023). *A GCSE proposal statement on key competencies in sustainability: Guidance on the accreditation of sustainability and sustainability-related programs in higher education*. Global Council for Science and the Environment. https://tinyurl.com/2jz42bnw

CPAPP (Cal Poly Academic Programs and Planning) (2023). Sustainability learning objectives. CalPoly. https://academicprograms.calpoly.edu/content/academicpolicies/sustainability_lo

CREducation Project (n.d.). *Problem solving skills and objectives*. https://www.creducation.net/resources/problem_solving_skills/

de Haan, G. (2010). The development of ESD-related competencies in supportive institutional frameworks. *International Review of Education, 55*(2), 315–328. https://doi.org/fpx3sd

GCSE (Global Council for Science and the Environment) (2024). *Thinking through sustainability challenges with key competencies in sustainability*. Global Council for Science and the Environment. https://sites.google.com/asu.edu/gcselevel1/home

Hmelo-Silver, C.E. (2004). Problem-based learning. What and how do students learn? *Educational Psychology Review 16*(3), 235-266.

Markkula Center for Applied Ethics (n.d.). *Philosophy lesson plan: Ethics and the environment.* https://www.scu.edu/media/ethics-center/environmental-ethics/Philosophy-Lesson-Plan.pdf

NIES (Nelson Institute for Environmental Studies). *Sustainability undergraduate certificate learning goals*. University of Wisconsin–Madison. https://nelson.wisc.edu/undergraduate/sustainability-certificate/learning-goals/

Normandale Community College (2023). *PHIL 1140 Environmental Ethics*. https://www.normandale.edu/_files/documents/course-outlines/phil/PHIL%201140%20Environmental%20Ethics.pdf

Nova Southeastern University (2024). *PHIL 3360 Environmental Ethics*. https://libguides.nova.edu/phil3360

Portland Community College (n.d.). Core outcomes: Critical thinking and problem solving.https://web.archive.org/web/20240403215503/https://www.pcc.edu/core-outcomes/co-criticalthinking-problemsolving/

Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures, 44*(3), 127-135. https://doi.org/czvwbn

Södertörn University. (2023). *Strategic thinking*. Södertörn University. https://www.sh.se/rest-api/cpl/syllabus?code=1029PS&period=20233&lang=en

Suffolk University Boston (n.d.). *Course goals and learning objectives for collaborative, cooperative, team-based and problem-based learning*. https://www.suffolk.edu/-/media/suffolk/documents/academics/research-at-suffolk/ctse/course_goals_collaborative_learning_pdftxt.pdf?la=en&hash=F5A97C907CA7746846FD3B980A49FBE137C6F5A6

SNSM (School of Natural Sciences & Mathematics (n.d.). *Essential learning outcomes for sustainability*. Stockton University. https://stockton.edu/sciences-math/sustainability/sust-elos.html

UNESCO (United Nations Educational, Scientific and Cultural Organization) (2017). *Education for sustainable development goals: Learning objectives*. https://www.unesco.org/en/articles/education-sustainable-development-goals-learning-objectives

United Nations Institute for Training and Research. (2022). *Presenting UN SDG: Learn's SDG fitness test*. High-Level Political Forum on Sustainable Development. https://tinyurl.com/mr3beb4m

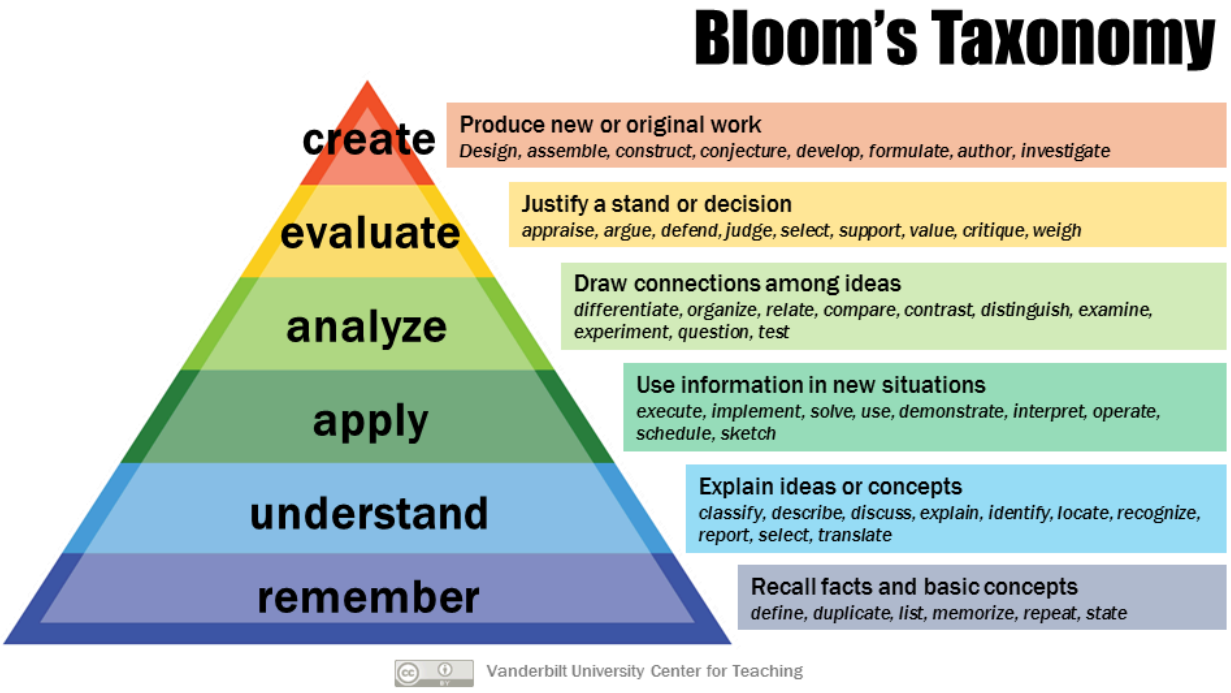
Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science, 6*(2), 203–218. https://doi.org/c6hkjf

Zhang, J. Q., & Vanasupa, L. (n.d.). *Learning objectives: Systems thinking*. https://core.ac.uk/download/pdf/19155688.pdf

Zinser, J. (2020). *PHI 380: Environmental ethics.* University of Wisconsin - Stevens Point. https://www3.uwsp.edu/syllabus/syllabi/PHIL%20380-W01%20%20SP22%20Zinser.pdf

Appendix A. Bloom's Taxonomy

This well-known taxonomy is widely used by instructors to write student learning outcomes, and to design well-aligned curriculum, pedagogy, and assessments. Simpler learning objectives, such as understanding and remembering, are listed at the base of the taxonomy, while more complex learning outcomes are listed at the top. Benjamin S. Bloom and his colleagues developed the original version of the taxonomy in 1956. Shown here is a revised version developed in 2001 by a team of psychological and educational researchers (Anderson & Krathwohl, 2001). For more about the uses and versions of Bloom's taxonomy, see Armstrong (2010).



Source: Armstrong (2020)

Appendix B. Teaching Tools and Curriculum Repositories

This handout includes a list of teaching tools that can be used in sustainability education and a list of curriculum repositories where you can search for syllabi, lesson plans, cases, and other teaching materials.

Contents

Teaching Tools

These are mapping databases, simulations and games, and datasets that can be used in sustainability education.

United States

Earth - A hypnotic visualization of global weather conditions, ocean surface temperatures, ocean waves, and other planetary conditions, updated every 3 hours to 1 day. Created by NullSchool Technologies.

EJSCREEN: Environmental Justice Screening and Mapping Tool (removed) - *The official version of this site has been removed by EPA but pending litigation may restore it; in the meantime, use the archived version hidden on the EPA website or from Public Environmental Partners*. Created by the U.S. Environmental Protection Agency, this tool allows users to map environmental, health, and demographic disparities across the U.S.

EnviroAtlas - Created by the U.S. Environmental Protection Agency to map and provide

data about the benefits people receive from nature or ecosystem services.

Environmental Working Group's Tap Water Database – Provides data on local water systems' compliance with legal limits of contaminants and with EWG's more protective standards.

HealthyPeople.gov - Database of health disparities created by the U.S. Office of Disease Prevention and Health Promotion.

Public Lab - Archive of a site that provides tools, support, and an archive of citizen science projects on community-based environmental monitoring and assessment.

Toxics Release Inventory Data and Tools - U.S. EPA data on the volume of toxic chemicals managed or released into the environment annually in local areas.

United States Environmental Protection Agency Learning Center (removed) - *The official version of this site has been removed by EPA but pending litigation may restore it; in the meantime, use the archived version hidden on the EPA website or from the Internet Archive.* Training portal with online resources to build the capacity of EPA's partners to advance environmental justice, including instruction in how to use EPA's tools and databases like mapping and data tools, community focused tools, and guides to EPA grant applications.

United States Environmental Protection Agency Archives - Search for archived climate and environmental justice datasets and tools that EPA has removed from its official website in the hidden archive on EPA's site or on the Public Environmental Data Partners website. Other groups are archiving datasets linked in the Data.gov data portal and making them findable in other locations. Individual researchers are also uploading datasets in searchable repositories like OSF, run by the Center for Open Science. To check whether data currently still available might disappear, consult this checklist from MIT Libraries.

Water Justice Toolkit: A Guide to Address Environmental Inequities in Frontline Communities - American Rivers' report, including legal resources for communities experiencing water injustice.

Global

Environmental Justice Atlas - Database of social science case studies of environmental justice conflicts around the world for teaching, networking, and advocacy. Academics and activists collaborate to write the case studies. Created by Institute of Environmental Science and Technology (ICTA) at the Universitat Autònoma de Barcelona.

Google Earth Engine - Combines satellite imagery and geospatial datasets with planetary-scale analysis capabilities. Can be used to detect changes, map trends, and quantify differences on the Earth's surface.

NOAA Sea Level Rise Viewer - This web mapping tool can visualize community-level impacts from coastal flooding or sea level rise (up to 10 feet above average high tides). It also provides photo simulations of how future flooding might impact local landmarks, and data related to water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss and migration, and mapping confidence. Maps and links can be shared via email and social media.

Open Supply Hub – an open source mapping database that includes supply chain data for multiple sectors, including apparel, automotive, beauty, consumer goods, electronics, energy and utilities, fashion, food and beverage, furniture, and sporting goods.

Reacting to the Past - Educational games, some of them on sustainability-related topics.

WikiRate.org - A collaborative online platform and research resource that enables users to pose in-depth questions and share information about the environmental, social, and governance (ESG) practices and impacts of corporations.

Higher Education Curriculum Repositories

These are searchable collections of syllabi, assignments, and lesson plans for college and graduate students.

Sustainability

AASHE Curriculum Hub - Search for materials in your discipline. If your university is an AASHE member (check whether they are a member here), you can create an account using your university e-mail to access “members only” materials.

American Sociological Association - Environmental Sociology - Syllabi organized into lower division and upper division/graduate courses on environmental sustainability.

Beyond Benign - Curricular resources on teaching green chemistry for K-higher education.

CLEAN - Climate and energy teaching materials for K-higher education.

Climate Resources for Educators - Created by U.S. Global Change Research Program, this collection of teaching resources for middle school through college levels includes climate change and human health lesson plans; teaching climate using the National Climate Assessment; climate literacy framework and energy literacy framework; climate, wildfire, and wildlands toolkit; National Park Service climate change education videos.

Compass Education - A global movement of educators for a sustainable world. Provides tools to promote systems thinking, experiential learning pedagogy, global systems, and sustainability.

Environmental Sociology Syllabi and Instructional Materials - Useful for all of the social sciences.

Foodprint - Find inspiration and materials here for introductory lesson plans about impacts of the food system and steps that students can take to eat more sustainably.

InTeGrate Teaching Materials - Search for materials in your discipline or for interdisciplinary resources. Especially strong on geosciences and STEM, but also how they can be integrated into other fields. See also: the SERC Assessment Tools and Learning Assessments.

International Society for Environmental Ethics — Syllabi Collection - A gold mine of syllabi for the environmental humanities and environmental studies in general.

MIT Climate Portal - Syllabi, curricula, and pedagogy for teaching about climate issues in multiple disciplines.

OER Commons Climate Education - Climate-related teaching resources for K-12 and higher education.

SCU Public Curriculum Repository - Example lesson plans and syllabi taught at SCU (available to anyone).

Teaching Resources for Faculty - Santa Clara University Center for Sustainability page of resources, including 24 ways to integrate sustainability into your courses, student project ideas, and other resources on teaching sustainability.

Teaching Resources from the Center for Sustainable Systems - PowerPoint presentations and outlines designed for a post-secondary audience that educate about

consumption and pollution topics such as ozone depletion and resource extraction, as well as a very thorough guide to environmental laws.

United Nations Sustainable Development Goals

The SDGs in the Classroom Toolkit - York University's extensive collection of resources for teaching the SDGs.

Sustainable Development Goals - Resources for Educators - UNESCO. "A collection of pedagogical resources, ideas for classroom activities, multimedia education resources and good practices for each of the 17 SDGs, as well as global SDG resources designed for three education levels." Also, a fun way to connect to individual actions: Good Life Goals.

ESD Expert Net (n.d.). *Teaching the Sustainable Development Goals*. Bonn: Engagement Global. Learning objectives and case studies related to each SDG.

The United Nations Sustainable Development Goals Project - Sources on how to teach the SDGs using inquiry-based and project-based learning.

Environmental Justice

Environmental Justice Activity Collection - Lesson plans and assignments for teaching environmental justice across the disciplines, like English and especially geography, at the university level. The website also provides other teaching materials for teaching sustainability through workshops and webinars.

Environmental Justice and Sustainability Research Toolbox **-** Santa Clara University's interdisciplinary collection of EJ research methods and paradigms; learning outcomes; multimedia scholarly content; online discussion prompts; and sample assignments and activities.

Environmental Justice in the Context of Sustainability - Includes many ideas for teaching environmental justice in the sciences with examples and guidance for different approaches at the university level.

Equitable Sustainability Literacy Guide - Learning tools and resources for teaching introductory environmental justice, including environmental racism, Indigenous rights, ecofeminism, climate migration, and food justice aimed at both institutions and companies.

MIT Climate Justice Instructional Toolkit - Lessons and slides for teaching climate justice across the curriculum.

Online Learning Opportunities: A Guide to Digital Environmental Justice Education in the Age of COVID-19 - Created by West Harlem Environmental Action, this guide includes lessons for grades 9-12, some of which can be adapted for introductory college courses.

Teaching Sustainability and Environmental Justice in the Humanities and Social Sciences - How to incorporate materials from the geosciences in humanities and social science courses at the university level.

21 Day Catholic Enviro Justice Challenge - Lessons and links on EJ and integral ecology, incorporating spiritual exercises, created by the Ignatian Solidarity Network. Can be used in a course or in informal learning contexts, such as student or faculty/staff organizations.

Business

Academy of International Business - Descriptions and links to additional case study repositories.

B Academics - Teaching, research, and professional development resources on Benefit Corporations and Labs (for paying members).

Curriculum Library for Employee Ownership - More than 600 teaching materials, including videos, cases, syllabi, teaching modules, and reading collections.

Doughnut Economics for University Courses - A website providing slide decks, videos, readings and activities for anyone seeking to teach using Kate Raworth's Sustainability Doughnut model.

Doughnut Economics Action Lab - Tools for analysis inspired by Kate Raworth's Sustainability Doughnut model. See also: Stockholm Resilience Center for graphics that use the Sustainability Doughnut model to show planetary environmental boundaries that have been exceeded.

The Embedding Project - A huge, well-organized array of resources and tools for practicing corporate sustainability, including resources organized by company function, databases of corporate sustainability goals and position statements, issue snapshots, and procurement resources. Also searchable by cross-cutting themes, such as systems, strategy, governance, value chains, culture, change agents, and storytelling.

Harvard Business School Publishing – Case studies and other teaching materials that are easily searchable.

Ideas Worth Teaching and Awards - Aspen Institute's weekly bulletins on business education and awards for exemplary courses and programs.

Ignited - Teaching materials organized by topic (e.g., Accounting & Finance, Economics, etc.), material type (case study, exam, data set, etc.), and students (undergraduate, graduate, etc.). Created for and by Jesuit Business School educators, but applicable to non-Jesuit educators too.

Ivey Business School - Finding aid to cases and business publications. Especially strong on global cases. Easily searchable by topic, including the UN SDGs.

Markkula Center for Applied Ethics - The Ethics and ESG Resource Center includes ethics cases and commentaries on ESG issues.

MIT Sloan Case Studies - Offers free cases on leadership, ethics, and global management, suitable for MBA courses.

Page Prize Database - Award-winning syllabi and modules from University of South Carolina's Darla Moore School of Business.

Regenerative Business Case Database - Profiles (but not written cases) of 84 regenerative business cases from 15 sectors.

Stanford Business School Case Studies – Finding aid to Stanford cases and some open access (free) cases relevant to sustainability. See also: podcases (audio recordings of cases).

UC Berkeley Haas Center for Equity, Gender, and Leadership – Original case studies and a compendium of additional cases related to diversity, equity, and inclusion (DEI) issues and perspectives.

United Nations Environment Programme Finance Initiative - A valuable source of information on Environmental, Social, and Governance (ESG) criteria for investors, banks, and financiers. See their finance sector tools for incorporating ESG criteria into financial practices and decisions, which students could use.

Civic Engagement, Policy, Politics

Search these for resources related to sustainability and environmental policy and politics.

Campus Compact - Repository of syllabi and other resources.

CSU Chico Civic Engagement - Methods to incorporate civic engagement in the classroom, handouts, and more.

Education for Democracy Knowledge Hub - Campus Compact resources for effective and constructive engagement in public life.

Journal of Peer Review (AACU): Special Issue - Civic Learning in the Major by Design - Publication of the Association of American Colleges and Universities.

Project Pericles Civic Engagement Resources - Large repository of syllabi and other resources.

Teaching Civic Engagement - Companion website to books of the same name, including syllabi and resources, from the American Political Science Association.

Teaching Social Action - Includes a model course, example syllabi and resources, for teaching how to make social change.

University of Michigan Ginsberg Center - Exercises that can be applied to many course topics in a variety of disciplines.

K-12 Curriculum Repositories

These are searchable collections of syllabi, assignments, and lesson plans for kindergarten through high school students, some of which could be adopted or adapted in introductory college courses.

Sustainability

All We Can Save - Lesson plans, discussion guides, and more on the climate crisis.

Beyond Benign - Curricular resources on green chemistry for K-higher education.

Climate Generation - Resources for K-12 and informal climate education.

Climate Change Teacher Resources - UCSD Scripps Institution of Oceanography resources, focused on oceans.

California Regional Environmental Education Community (CREEC) Network - A program of the California Department of Education. Use the statewide projects link and especially the regions links to find learning resources.

California Environmental Protection Agency (CalEPA) - Links to curricula and materials developed by state environmental agencies.

California Environmental Education Interagency Network - Links to environmental education curricula and resources offered by members and partner organizations.

EcoRise Environmental Justice Curriculum – for elementary through high school.

Environmental and Climate Change Literacy Projects (ECCLPs) – Soliciting curricular examples to build a curriculum hub now. Contribute your materials and watch their website for publication of the curriculum repository. See their projects and steps to get involved for more information.

North American Association for Environmental Education - EEPRO - A broad array of resources for environmental educators, mostly focused on K-12. See especially the NAAEE's K-12 Environmental Education: Guidelines for Excellence and A Framework for K–12 Science Education and College, Career, and Civic Life Standards.

Resource Center for Environmental and Climate Action Changemakers in TK-12 Schools and Solutionary Teaching and Learning Resources - Curricular resources developed or curated by Andra Yeghoian, educator and Chief Innovation Officer for Ten Strands.

Seeds to Solutions – Free lesson plans and instructional resources on climate change and environmental justice for K–12. Lessons address California environmental challenges, from food waste to water use to wildfire management. Lessons are designed to be age-appropriate and culturally relevant, and to foster collaboration, critical thinking, and problem-solving.

Teachers Pay Teachers - Large site for teachers to share lesson plans and assignments for micropayments. Search for resources for teaching environmental justice, sustainability, etc.

Ten Strands Education and Environment Curriculum Initiative - Guided by California's Environmental Principles and Concepts, the Education and the Environment Initiative (EEI) Curriculum consists of 85 engaging units that address core academic standards in science, history–social science, and English language arts.

Environmental Justice

Climate Justice Projects - Example projects developed by teachers in a Chicago Teachers Union professional development program for a variety of K-12 classes.

EcoRise Environmental Justice Curriculum – For elementary through high school, aligned with a variety of state standards. Contains some EJ materials.

Educators for Social Change (E4SC) - Environmental justice lessons, curricula, toolkits.

Environmental Justice: Solutions for a Healthier and Fairer California - Syllabus and slide decks for a short course on EJ problems and solutions in California. Designed for adult learners, but materials can be used and adapted to high school and above.

Equitable Sustainability Literacy Guide - Learning tools and resources for teaching introductory environmental justice, including environmental racism, Indigenous rights, ecofeminism, climate migration, and food justice aimed at both institutions and companies.

Global Oneness Project - Multimedia stories and lesson plans on ecology for grades 3-12.

Groundwork USA - Introductory EJ curriculum for high school students.

G-WOW Changing Climate, Changing Culture Curriculum - Resources and activities that incorporate Indigenous Traditional Ecological Knowledge and culturally relevant teaching, using place-based education.

Online Learning Opportunities: A Guide to Digital Environmental Justice Education in the Age of COVID-19 - Created by West Harlem Environmental Action, this guide includes lessons for grades 9-12.

Protect Juristac - Created by the Amah Mutson Tribal Band, includes lesson plans and resources for teaching about the campaign to save sacred lands south of San Jose, CA from a proposed sand and gravel mine.

SCU Environmental Justice and the Common Good Initiative - including a guide and example programs of community-driven research for environmental justice (on food, water, climate, law and advocacy, youth). Standing Up For Environmental Justice Now - statements on the connections between racial and environmental justice for Black, Asian, Latinx, and disabled people, with links to current resources, organizations, and actions. (You could assign your students to research and write additional statements, and share them with the Initiative.)

Teaching Environmental Communication - A zine that describes and links to curricula and teaching resources, including lessons for K-12 on climate histories; and arsenic, water, and EJ in North America.

Zinn Education Project - Teach Climate Justice Campaign - Classroom-tested environmental justice lessons, a climate crisis timeline, other teaching resources, workshops, and a sample school board climate justice resolution (for elementary through high school).

Catholic Education

21 Day Catholic Enviro Justice Challenge - Lessons and links on EJ and integral ecology, incorporating spiritual exercises, created by the Ignatian Solidarity Network. Can be used in a course or in informal learning contexts, such as student or faculty/staff organizations.

California Catholic Conference Environmental Literacy Hub - Includes curricula for 4th, 7th, and 11th grades, many lesson plans, and links to environmental education organizations in California. Great place to find community partners for CA schools also.

Green Ninja - Middle School curricula for California and Texas aligned with the encyclical *Laudato Si'* learning goals. Paid registration required.

Healing Earth: An Interdisciplinary Environmental Science Textbook – Developed by and for Catholic secondary and higher education, this is a free-access online textbook in integral ecology–a method of teaching and learning biodiversity, natural resources, energy, water, food, and global climate change from the perspectives of science, ethics, spirituality, and action.

Laudato Si' High School Resource Guide - Created by the Catholic Climate Covenant & Ignatian Solidarity Network.

Laudato Si' Interdisciplinary Secondary School Curriculum - An example of the integration of *Laudato Si'* in grades 9-12 curriculum by the Carmelite NGO. Disciplines include Environmental Science, Theology 1 & 2, Humanities, and Social Studies.

Spiritual Ecology Course at Bishop O'Dowd High School - A religious studies class at Bishop O'Dowd High School. This course provides students with both a conceptual and applied understanding of spiritual ecology, and introduces multiple faith traditions.

Teachers Pay Teachers - Large site for teachers to share lesson plans and assignments for micropayments. Search for resources for teaching Laudato Si', etc.

Wholemakers Curriculum - A 10-session curriculum on integral ecology for use in young adult ministry. Created by young adults for young adults, it weaves together the latest in climate science with insights from Catholic tradition in 3 tracks focusing on Spirituality & Ecology, Sustainability & Simple Living, and Social Action & Civic Love.

Appendix C. Sustainability Competencies and Pedagogies Handout

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Competency	Definition	Example Pedagogies
Systems thinking	UNESCO: The ability to recognize and understand relationships, to analyze complex systems, to think of how systems are embedded within different domains and different scales, and to deal with uncertainty. KCSF: The ability to collectively analyze complex systems across different domains (society, environment, economy, etc.) and across different spatial and temporal scales (local to global; past, present, future), thereby considering change agents, cause-effect structures, cascading effects, inertia, feedback loops, and interdependencies as well as other systemic features related to sustainability issues.	• **Games, simulations, and models** to explore patterns, cause and effect, and change under different circumstances. • **Case studies or current news stories** to identify transparent and hidden connections. Local and global examples to highlight the interconnectedness. • **Institutional analysis** to review existing practices, mechanisms, and procedures. • **Group discussions** to identify hidden and visible flows.
Anticipatory thinking Futures thinking	UNESCO: The ability to understand and evaluate multiple futures – possible, probable, and desirable; to create visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes. KCSF: The ability to collectively explore future developments and states, specifically to anticipate how sustainability problems might evolve or occur over time (scenarios), considering concepts such as inertia, path dependencies, and triggering events. It also includes the ability to collectively analyze, evaluate, and craft rich "pictures" of future visions, which provide a foundation for researching evidence-supported alternative development pathways.	• **Journaling** to reflect on the consequences associated with certain choices. • **Scenarios** to develop alternative ends or map out possible outcomes. Scenarios can be written, visual, auditory, embodied, kinesthetic, and/or verbal. • **Macrohistory** to seek patterns of change or consider historical trends.
Normative Values thinking	UNESCO: The ability to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge, and contradictions. KCSF: The ability to collectively identify values and to map, analyze, and specify values, as well as the ability to apply, reconcile, and negotiate sustainability values, principles, goals, and targets, as well as trade-offs. As sustainability is an inherently normative concept centered on intra- and intergenerational justice and equity among people and between people and the environment, values-thinking competency includes engaging principles and practices emphasizing justice, equity, diversity, and inclusion.	• **Modeling good practice** to demonstrate a strong sense of fairness and social justice in the classroom for performance beyond the classroom. • **Debates and group discussions** to ask questions, clarify and analyze their values, and explore others' values in a safe space. • **Active listening/participation and role-play** to understand another person's perspective. • **Culturally responsive teaching** to ensure topics are appropriate for the grade level, culture, and community. • **Diversity/global learning*** to explore cultures, life experiences, and different worldviews.

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Strategic Strategic thinking	UNESCO: the ability to collectively develop and implement innovative actions that further sustainability at the local level and further afield. KCSF: The ability to collectively design and plan to implement transformational (systemic) interventions, transitions, and transformative governance strategies toward sustainability while accounting for strategic leverage points, power dynamics, uncertainty, surprises, and social and organizational learning in navigating these strategies.	• **Inquiry- and project-based instruction,** such as designing, evaluating, and adapting policies, programs, action plans. • **Place-based learning** to address real-world problems and solutions. • **Reflections** to evaluate personal and group progress. • **Games and puzzles** to analyze and test strategies and contingency plans for unintended consequences. • **Mapping** intervention strategies to build the necessary knowledge and skills to create change.
Collaboration Interpersonal	UNESCO: The ability to learn from others; to understand and respect the needs, perspectives, and actions of others (empathy); to understand, relate to, and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem-solving. KCSF: The ability to motivate, enable, and facilitate collaborative and participatory sustainability research and collective problem-solving processes. Additionally, interpersonal competency is the ability to facilitate collective and inclusive co-production of knowledge and collaboration across academic disciplines (interdisciplinary collaboration), between academic and societal communities (transdisciplinary collaboration), and across diverse ways of knowing (epistemologies) and being (ontologies).	• **Collaborative assignments and projects*** to learn how to work with others to analyze and solve problems. • **Intensive writing*** to produce and revise various forms of writing for different audiences in different disciplines. • **Community-Based Learning*** to provide direct experience with issues, apply what learning in real-world settings, analyze and solve community problems, and reflect.
Critical thinking	UNESCO: The ability to question norms, practices, and opinions; to reflect on one's values, perceptions, and actions; and to take a position in the sustainability discourse.	• **Stimulus activities**, such as viewing or making creative works, initiating reflection or discussion. • **Critical reading and writing** to analyze viewpoints, futures, and values. • **Fieldwork** to link theory to real-world examples.
Self-awareness Intrapersonal	UNESCO: The ability to reflect on one's role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires. KCSF: The ability to consciously and proactively engage as a change agent for sustainability. This involves being aware of one's own emotions, desires, thoughts, and behaviors, as well as one's positionality in society and one's role in the local community and (global) society. Building on this, intrapersonal competency involves the ability to reflect and act on that self-awareness and to regulate, motivate, and continually evaluate one's actions and improve oneself, drawing on competencies of emotional intelligence.	• **Critical incidences** to consider personal perspectives and actions in light of an ethical dilemma. • **Reflexive accounts** to consider personal roles, attitudes, and responsibilities concerning sustainability issues. • **Personal development planning (PDP)** to reflect on learning, performance, and achievement and to plan for personal, educational, and career development. • **ePortfolios*** to electronically compile work, reflect on growth, and share items with professors, advisors, and potential employers.

Competency	Definition	Example Pedagogies
Integrated problem-solving	UNESCO: The ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive, and equitable solution options that promote sustainable development, integrating the other competencies. KCSF: The ability to select an appropriate problem-solving framework developed for complex sustainability problems and to apply the selected framework to collective approaches that jointly develop viable solution options as a result of meaningfully integrating problem analysis, sustainability assessment, visioning, and strategy-building and to jointly plan to implement the co-created solution options on the ground.	• **Problem-based learning** to research issues, develop action plans and evaluate processes. • **Undergraduate research*** to involve students in addressing contested topics, empirical observation, technology development, and excitement from working to answer important questions.
Implementation	KCSF: The ability to collectively carry out and realize (on the ground) a planned solution over time, working toward a sustainability-informed vision. This involves collaborating with others to monitor and evaluate the realization process and address emerging challenges (adjustments), recognizing that sustainability problem-solving is a long-term, iterative process between planning, realization, adjustment, and evaluation.	• **Capstone projects***, such as a research paper, a performance, or an art exhibit, to integrate and apply previous learning. • **Internships*** to provide students with direct work experience and to give them the benefit of supervision and coaching from professionals. • **Social action projects** that provide students with opportunities to advance a plan of action they developed on campus, in a community, or in local, state, national, or global policy arenas.

Notes. UNESCO definitions of competencies are adapted from UNESCO (2017). Key Competencies in Sustainability Framework (KCSF) definitions of competencies are from Brundiers et al. (2023); see also Brundiers et al. (2021), de Haan (2010), Rieckmann (2012), Wiek et al. (2011), and Wiek et al. (2016).

Pedagogies are adapted from AAC&U (n.d.), Cotton & Winter (2010), Daffron & Caffarella (2021), and Warren et al. (2014).

* Denotes high-impact learning practices identified by AAC&U (n.d.).

An online tutorial on the KCSF sustainability competencies for instructors and students is at sites.google.com/asu.edu/gcselevel1/home and an introductory portal is at keycompentencies.sustedu.org/#