

## **Integrating Core Sustainability Meta-Competencies and SDGs Across the Silos in Curriculum and Professional Development**

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Abstract. Debra Rowe, president of the U.S. Partnership for Education for Sustainable Development, is known to challenge us to go beyond educating students with conceptual knowledge; to develop student capacities to become agents for systemic change. This means putting into the classroom the subject of values, attitudes, behavior, and ethics. Penn State University Sustainability Institute research findings propose five sustainability meta-competencies for sustainability: system thinking, temporal thinking, interpersonal literacy, ethical literacy and creativity/imagination. For the practitioner, this means experimenting and assessing different ways to integrate these proposed meta-competencies into curriculum. This presentation provides examples using guided inquiry with peer to peer learning with team wiki projects, case studies, SDGs, and reflection essays using Digication ePortfolio, Blackboard and self-assessment exercises and instruments. We present some interesting comparisons of the New Ecological Paradigm – Revised instrument metrics and the Sulitest Sustainability Literacy self-assessment before and after the course for classes and individuals. Limitations of these instruments and alternative quantitative and qualitative instruments will be discussed. A faculty development workshop template for sustainability across the curriculum with the sustainability meta-competencies and SDGs has been developed from this experience and an Association for the Advancement of Sustainability and Higher Education (AASHE) inter- and multi- disciplinary bioregion faculty development workshop template. Experience with a new pilot sustainability and SDG literacy workshop template for higher education nonfaculty staff professional development will also be presented for discussion and to exchange experience or participants with other initiatives.

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Debra Rowe, president of the U.S. Partnership for Education for Sustainable Development, is known to challenge us to go beyond educating students with conceptual knowledge to develop student capacities to become agents for systemic change. This means putting into the classroom the subject of values, attitudes, behavior, and ethics. Ideally, this involved activities that provide students with experience of self-efficacy and collective efficacy of systemic change. (Svanström, et al. 2008). Debra Rowe proclaimed at the New Jersey Higher Education Partnership for Sustainability workshop, that the last thing we need is to graduate more students with extensive knowledge of sustainability that do nothing about it.

The Association for the Advancement of Sustainability in Higher Education (AASHE) and Second Nature have identified curriculum as the weakest area of gains and systemic improvement on campus; operational concerns have made the greatest gains in AASHE's Sustainability Tracking and Assessment Reporting System (STARS) reports and Second Nature's University President's commitments to Climate Action Plans. Our Northeast Campus Sustainability Consortium meeting this year (2018) had few faculty members present, and no attention to curriculum.

The Sustainability Curriculum Consortium (SCC) was founded last year (2017) to address this gap and has had two working conferences. AASHE has established centers of excellence for sustainability across the curriculum to conduct regional faculty development workshops. The SCC met with the National Council for Science and the Environment (NCSE) to launch a collaborative process focusing on 'key competencies' in sustainability degree programs and are sponsoring a workshop at the AASHE 2018 conference in Pittsburgh in October.

Engle et al. (2016, 2017) identified in their research of existing classes and programs at Penn State five core meta-competencies: system thinking, temporal thinking, interpersonal literacy, ethical literacy, and creativity/imagination (see Table 1). Wiek et al. (2011a, 2011b, 2015) research group at Arizona State University has shifted in core categories, but emphasizes strategic thinking as key to student efficacy as a change agent, and Engle et al., considers the elevation of creativity/imagination as an important contribution to this literature.

We report here the author's experience in practice implementing the sustainability meta-competencies at John Jay College Sustainability and Environmental Justice program interdisciplinary classes, Fordham University Physical Science class for non-majors with a climate science curriculum developed by the American Meteorological Society Education Department, and a Biology Department course on Evolution at Saint Peter's University. We will also refer to an author's experience as a guest lecturer at the Arctic University at Svalbard, Norway (UNIS), a hands-on university with research experience the focus of all the courses. We also incorporated the United Nations Sustainable Development Goals in the curriculum to provide grounding and connections with other efforts. To learn from our experience, we incorporated assessment instruments, quantitative and qualitative, and reflective essays. The authors are involved in ongoing research of a cognitive approach to community engagement with ecosystem science in practice, with special attention on meta-cognition and self-awareness that also guide our practice of teaching.

The authors believe that it is insufficient to teach sustainability solely in sustainability courses, that to graduate students that do not follow contravening unsustainable practices in the outside world, we must implement sustainability across the curriculum, as we have in the past in the areas of race, ethnicity and gender. We developed and implemented a faculty development workshop with the elements of big ideas, sustainability meta-competencies, and sustainable development goals. We are in the development process of an "Eco-literacy" workshop for non-faculty staff at John Jay College with the leadership of our Health and Safety Director who is also our Sustainability Council Chair, Lindsey Kayman. We are learning from the implementation experience of Engle et al. (2016) with non-faculty staff of the sustainability competencies.

Engle et al. (2016, 2017) found in their research that interpersonal literacy to be the biggest barrier to producing change agents, so we stressed in our curriculum communication and team work. We conveyed to students in their own class experience and through case studies the importance of understanding knowledge to be distributed, and contingent, with no one person having comprehensive and diverse expertise, and the importance of local and indigenous knowledge.

We refer students to the Shome et al. Guide to the Psychology of Climate Change Communication (2009) and other sources (e.g. Yale Climate Communication website) to use when doing exercises of communicating what they learn in class, or in action assignments. Team Wikis Blackboard and ePortfolio), podcasts (audio, video and animation) and art projects (e.g. eco-fashion and show) are effective activities to develop interpersonal literacy and creativity/imagination. Evaluation using blogs and reflection essays on exams provide further development of the meta, awareness of how they are learning and communicating, and developing their own competencies. Student individual work and team work are presented to the entire class to expand on the peer to peer learning, and to flip the audience of their work from instructor to students and the public. ePortfolio and voice-thread are exceptionally good platforms for students sharing and expanding their modes of expression from written to aural to visual. We use both class wiki ePortfolios and individual student ePortfolios.

System thinking and temporal thinking is taught explicitly and indirectly. We aim to provide students with many instances of complexity and how to be comfortable with uncertainty. A delphi study by Ruppert and Duncan (2017) found that an important big idea of ecosystem science is understanding that it is impossible to know all of the connections, relationships and importance of elements and boundaries of an ecosystem. By teaching ecological case studies (e.g. Walker & Salt, 2012; Healy et al. 2017; Seeds for Good Anthropocene) students learn the difficulties of human interventions and predicting impacts on ecosystems. Case studies and place based student activities teach students the contingency of knowledge and the importance of local and indigenous knowledge. The American Meteorological Society (AMS) course materials including eInvestigations where students find and evaluate real data, just as scientists do, and thereby gaining a better understanding of what is know, what is unknown, and levels of uncertainty. AMS offers a Climate Diversity Workshop that teaches non-climate scientists from all disciplines how to teach climate science, since the need cannot be fulfilled by the limited amount of teaching climate scientists. Bob Kerry, when President of the New School, stated it was the responsibility of everyone in academia to learn enough climate science to be able to communicate to decision makers, regardless of disciplinary training.

We employed the New Environmental/Ecological Paradigm – Revised instrument (Dunlap & Liere, 1978; Dunlap, 2009) as a self-assessment pre and post course since it is well established. The instrument consists of fifteen questions with no correct answers that can be used to score the degree the participant has the NEP-R viewpoint. Most students show an increase in total score pre and post, indicating a shift in values and attitudes. Ordinarily we do not expect to see larger shifts in values and attitudes in a single class, but aim to do so in a program or degree. The changes were not large, but what was most interesting is the student reflection on what questions students changed their responses and why. Also what was interesting was students understanding of the wide range of values and attitudes in their classmates by comparing their responses with

others. This is a learning outcome we aim for, an awareness and understanding of ones own values, others, and societal values. This is also taught in climate/sustainability communications directly, but it has greater impact when students become aware of it through the NEP-R. This stimulates further reflection on differences students had on Discussion Board and class discussion. Of interest is the few students that had a decline in score (one to three students per class). A common reflection in these cases was that the students didn't know how they felt about an answer before class, or that they were trying to give the answer expected or wanted by the instructor pre but had more confidence in expressing their values post. Some students critique some of the questions posing dichotomies, since they felt the issues to be more complex. Overall most students respond they are aware of their values and others, achieving our meta-cognitive objective. We are looking into other instruments for moral reasoning to use this coming fall.

The Sustainability Literacy Test (SuLiTest) of the Higher Education Sustainability Initiative (HESI) is a UN SDG partner and a work in progress. On the individual student level its greatest value is as a learning instrument of the wide scope of sustainability. When students get the wrong answer, they are shown the "expected" answer with an explanation and a reference. On the course level, the pre and post scores are important for benchmarking and seeing the gains in overall score. But what is most significant is the change pre and post of three different types of students, the students that score highest and lowest in pre course assessment, and the students that have the greatest gains. The reflection essays provide the instructor with the self-understanding of the scores of the students. Generally, the students with the higher scores do not change as much as others. Only one or two students with low scores pre have similar low scores post.

One interesting case, is a B- student on midterm and final of the climate science test bank exams, she was very disappointed after receiving her final test bank exam grade I was surprised too, as she did extremely well on a team video project, interviews of participants in a March for Science, demonstrating she met many of the learning objectives and competencies of the course. However she had a 37% increase in her SuLiTest score, indicating she had learned a lot in the course. I noticed there were quite a few B students that did not change much on conceptual knowledge in climate science from midterm and final, but did on the SuLiTest. This was most surprising, since although the climate science students were exposed to a few SDGs, the SuLiTest has very few science questions. However, the gains in sustainability competencies evident in their projects and reflection essays must have provided the intuition to have more correct answers on the SuLiTest.

Many students had a similar critique, that the SuLiTest asks too specific subdomain data questions, and not enough key concept or science questions. This is an impression some of the authors also had from taking the SuLiTest myself. This is a problem with the validity of the SuLiTest, and/or the large scope of sustainability.

The results for the competencies and SDGs were erratic in many cases going down while others went up. This implies the total score is more accurate than the breakdown. For instance a breakdown category may have one to four questions per test. This is too small of a sample to assess a breakdown category for an individual student. This results in puzzlement of many students in their final reflection essay, they can't understand how they declined in a particular area.

The Sustainability Across the Curriculum faculty development workshop we designed made use of MacGregor et al (2014) template matching big ideas of a course in a discipline with sustainability concepts to develop a fundamental course activity and learning objective. We added to this template sustainability core competencies and SDGs. Faculty easily integrate the big idea, competency and SDG in the course. We are doing something similar with an Eco-Literacy workshop for non-faculty, but using what they care about in the world or at work, instead of big ideas.

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Note: Presentation Slides will showcase student work and provide evidence of sustainability competencies.

Table 1. Sustainability key competencies, descriptions and justifications (Engle et al. 2016.)

<b>Competency</b>	<b>Description</b>	<b>Justification</b>
<b>Systems Thinking</b>	Ability to analyze complex systems across multiple domains and at different scales.	Necessary for understanding complexity of sustainability concepts; ubiquitous in sustainability competencies literature.
<b>Temporal Thinking</b>	Ability to draw upon and anticipate states and narratives of past and future societies and environments.	Emphasizes the ability to extract and apply lessons from the past and to envision the needs of people in the future and the effects of current actions on those needs.
<b>Interpersonal Literacy</b>	Ability to comprehend, motivate, enable, relate to, and communicate across diverse individuals, political systems and organizations.	The societal and policy changes necessary to deal with issues of sustainability require that individual sustainability advocates have the skills to negotiate complex personalities, networks, assumptions and political/power systems.
<b>Ethical Literacy</b>	Ability to identify and assess ethical issues and controversies (related to sustainability), and to discuss, respond to, and reconcile them, applying personal and societal values and goals.	Sustainability issues are inherently value-laden and must be analyzed through an understanding of ethics.
<b>Creativity (Imagination)</b>	Ability to envision, develop and apply innovative and strategic solutions, frameworks, etc. in order to adapt to changing and challenging situations.	Identified by research participants as necessary for addressing unforeseen outcomes and scenarios; not addressed in other categories.
<b>Foundational Competencies</b>	<i>Expected capabilities based on education and adaptation.</i>	<i>These baseline abilities are needed in order to further develop meta-competencies.</i>