Recommendations for Interdisciplinary Environmental and Sustainability Programs

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1. Context
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- In 1990, there were roughly 500 ESPs [environmental sustainability programs] (Vincent & Mulkey, 2015).

- By 2012, there were 1,859 (Vincent & Dutton, 2015).

These include, for example:

- interdisciplinary environmental programs, environmental science, environmental studies, environmental education, environmental health sciences, environmental biology, broadly focused programs in natural resources, broadly focused programs in sustainability
1. Context

- Sherburne Abbott, chief international officer at the American Institute for the Advancement of Science, identifies five periods of the environmental movement (Ginsberg, 2004)


  - The Fifth Wave: 1990 through Present
1. Context

Defining Environmentalism and Sustainability

- Parker (2010) sums up the four commonly held aspects of sustainability (dividing one of the three pillars, society, in two)
  - Culture: understanding values
  - Society: understanding social institutions and their role
  - Environment: an awareness of the resources and fragility of the physical environment
  - Economy: a sensitivity to the limits and potential of economic growth
2. Challenges to ESPs
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A Lack of Rigor*

- Soulé and Press (1998): the field has become too popular and its implementation diffuse, leading to a lack of rigor and a crises of curricular vision

- Clark et al. (2011a): with inadequate training in the physical sciences, ESPs can’t “educate ecologically literate” citizens

- Bursztyn and Drummond (2014): identified “the stigma of generality” (2014, p. 321)
2. Challenges to ESPs

An Unclear Mission

- Worry that the “lack of consensus on an environmental canon and core principles* poses a threat to the legitimacy of environmental programs” (Vincent & Focht, 2009, p. 165)

- A lack of actual interdisciplinarity (ID) leads to “muddled goals,” “disciplinary hodgepodge” and “curricular smorgasbord” (Clark et al., 2011a, p. 703) and will leave students with segmented skills

- Hull (2009): employers and the graduates themselves find they often lack the necessary knowledge and skills for the job
2. Challenges to ESPs

Challenges Operating Within the University Structure

- The nature of higher ed. institutions leads to entrenched separation between disciplines and departments, ESPs struggle to overcome this (O’Byrne et al., 2015)

- ESPs tend to exist at the margins, be subsumed within disciplinary departments, lack resources and self-direction (Vincent & Dutton, 2015)

- Bursztyn and Drummond (2014) identified an arrogance and defensiveness against new and other fields
Challenges Operating Within the University Structure (cont.)

• Most institutions are not designed or prepared to value or measure interdisciplinary work; hiring can also be a challenge (Aboelela et al., 2007; Bursztyn & Drummond, 2014)

• “Opportunistic members of academia” (Bursztyn & Drummond, p. 320) might:
  • not be committed to ID (Clark et al., 2011a)
  • hide their deficiencies within ID programs
  • Invite “characters attempting to ‘find their herd’ among a heterodox audience” (Bursztyn & Drummond, p. 320)
3. Addressing the Challenges
3. Addressing the Challenges

Interdisciplinarity: From Limited to Wide-Ranging

• Soulé and Press (1998): to promote diversity between but limit it within programs propose:
  • ecology and environmental policy analysis
  • literature and philosophy
  • social criticism and critical theory
• O’Byrne et al. (2015) argue that graduate ESPs should include more natural sciences (in addition to more Sociology, Anthropology, and Psychology), while undergraduate programs need to include more Arts & Humanities, Sociology, Anthropology, and Psychology
3. Addressing the Challenges

Interdisciplinarity: From Limited to Wide-Ranging

- Maniates and Whissel (2000) found that 70% of ESPs they studied address ID illiteracy through at least one of these:
  - environmental studies across the curriculum*
  - foundation study plus an applied, multidisciplinary focus*
  - explicitly multidisciplinary, extensive-breadth programs*
  - concentration programs
  - in-depth programs that foster a self-reinforcing understanding of natural science analysis
  - umbrella programs

* was much more common in smaller, undergraduate institutions

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3. Addressing the Challenges

Comprehensive NCSE studies show that a “substantial consensus... exists that all [ESPs] must embrace interdisciplinarity” (Vincent & Focht, 2010, p. 83)

So what is interdisciplinarity?
3. Addressing the Challenges

What is Interdisciplinarity?

- Bursztyn and Drummond (2014): the integration of knowledge from various sources
- Aboelela et al. (2007): research that “integrates the analytical strengths of two or more often disparate scientific disciplines to solve a given biological problem” (p. 331).
- Steiner and Posch (2006): “a holistic view involving systems thinking” (p. 880)
3. Addressing the Challenges

What might interdisciplinarity look like?

• Many argue that a strong disciplinary foundation is required of students (Steiner & Posch, 2006; O’Byrne et al., 2015; Barth et al., 2007; Parker, 2010; Fortuin et al., 2013)

• Bursztyn and Drummond (2014): ESPs should position themselves as aggregations of disciplines through bridges
  • Successful bridging requires social as well as academic bonds
  • To achieve this, they propose the Star Model

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Figure 1. The ‘Star Model’.

Figure 2. The ‘Star Model’ – modes of engagement of faculty members in an interdisciplinary program offered within a major university.
3. Addressing the Challenges

What might interdisciplinarity look like?

- Steiner and Posch (2006) define “transdisciplinarity” as the interaction between academics and practitioners as equals.
- Calling it interdisciplinarity, Parker (2010) promotes inter-agency, inter-professional collaboration and partnerships.
- For Hull (2009), professors and employers must collaborate so that faculty teach knowledge and skills, while the workplace works to strengthen them.
- Bursztyn and Drummond (2014) suggest that ESPs emulate non-academic research institutions (NARIs) that build research groups based on need and expertise.
3. Addressing the Challenges

Experiential/Applied Learning

- Sipos et al. (2008) found it results “in profound changes in knowledge, skills and attitudes related to enhancing ecological, social and economic justice” (p. 74)
- It is characterized by (Barth et al., 2007):
  1. intellectual, sensory, and emotional involvement
  2. the active use of relevant life and learning experiences
  3. the reflection upon earlier experiences that lead to the evolution of thought and thus deeper understanding
- Steiner and Posch (2006) advise the use of well-designed, real-world case studies/problem-solving in an ES program
3. Addressing the Challenges

Experiential/Applied Learning: Brief Examples

- Barth et al. (2007) recommend facilitating informal learning opportunities with an increase on self-reliance and self-direction in students.
- Clark et al. (2011b) recommend a “policy sciences” approach suggesting ESPs use goal clarity, interdisciplinarity, and skill-based pedagogy for improved “balance between unity and fragmentation in purpose, methods, and pedagogical approaches” (p. 717).
- More examples will be discussed below in “5. Models and Proposals.”
3. Addressing the Challenges

Relevant Outcomes/Competencies

- Competencies are not acquired like knowledge—they can be learned through application and experience, but not taught (Barth et al., 2007)

- The UN’s world decade on sustainable development suggests the following: “skills for creative and critical thinking, oral and written communication, collaboration and cooperation, conflict management, decision-making, problem-solving and planning, using appropriate [information and communication technologies], and practical citizenship” (2004, p. 20)
3. Addressing the Challenges

Specific Competencies

- Federal programs in Germany developed competencies in education for sustainable development (de Haan, 2010). 
  Gestaltungskompetenz (i.e. shaping competence), includes twelve sub-competencies—here are five:
  1. Gather knowledge in a spirit of openness to the world, integrating new perspectives
  2. Think and act in a forward-looking manner
  3. Acquire knowledge and act in an interdisciplinary manner
  4. Deal with incomplete and overly complex information
  5. Co-operate in decision-making processes
3. Addressing the Challenges

Specific Competencies

- Fortuin and her colleagues (2013) argue that environmental systems analysis can provide the following competencies:
  1. Being able to “understand environmental issues in a holistic way, taking into account the interplay of biophysical and social dynamics” (p. 141).
  2. The ability to apply disciplinary theories within integrative frameworks “to analyze environmental problems and to devise possible solutions” (pp. 142).
  3. “Students should be able to... critically [assess and reflect on] the role of science in society” (p. 142)
3. Addressing the Challenges

Key Competencies

- Barth et al. (2007) specify that key competencies represent:
  
  “the interplay of cognitive [i.e. the construction of mental models] and non-cognitive [i.e. producing, reproducing, and communicating values] components” (p. 418).
3. Addressing the Challenges

Key Competencies

- Wiek et al. (2011) specify the following key competencies, suggesting students develop expertise in one or two then work in problem-solving teams that include them all*:
  1. Systems-thinking competence
  2. Future-thinking or anticipatory competence
  3. Value-thinking or normative competence
  4. Strategic competence
  5. Interpersonal competence
  6. Integrated problem-solving competence (specified in follow-up article; Wiek & Kay, 2015)
3. Addressing the Challenges

General Recommendations

- Wiek et al. (2011) recommend that ESP competencies be reflexively adapted based on student performance during and after graduation, experimentation with teaching and learning, and achievements and shortcomings.

- O’Byrne et al. (2015): recommend reflectivity about the disciplinary content in sustainability degrees.

- Redman (2013): “evaluation and major refinements of its program [continue] up to the present” (p. 231).
3. Addressing the Challenges

General Recommendations

- Mochizuki & Fadeeva (2010): all stakeholders must have a hand in the ongoing development of ESP competencies and universities must integrate sustainability into conventional disciplines with incremental changes over time.

- O’Byrne et al. (2015) suggest that ESPs as a whole might gain coherence from having a reading canon (to some degree) and recommend “The Ruffolo Curriculum on Sustainability Science.”
4. Existing Programs
4. Existing Programs

Assessing 57 graduate and undergraduate ESPs, O’Byrne, Dripps, and Nicholas (2015) found:
- all of the undergraduate programs were comprised of at least 50% core credits, 30% required core courses alone
- 24% of the required courses were in natural sciences, 23% in general sustainability, 15% in social sciences, and 10% in methods
- 96% of the programs had core courses in natural sciences (only 44% of graduate programs did), 93% in general sustainability, 85% in the social sciences, and 56% in the arts and humanities (graduate programs had 22%).
4. Existing Programs

Summarizing findings from two studies from the NCSE on how ESPs prepare graduates, Vincent and Focht (2010) identified three types of student preparation. They are combined here into two (based on a study they cite by Roorda and Martens):

1. Environmental Integrators: combining the environmental citizen—focused on awareness, literacy, and advocacy; and the environmental problem solver—focused on problem solving, systems thinking, and disciplinary synthesis)

2. Environmental Scientists: focused on disciplinary strength and interdisciplinary communication skills
4. Existing Programs

At Germany’s University of Lüneburg, Barth, Godemann, Rieckmann, and Stoltenberg (2007) analyzed two student groups: one that completed a formal (i.e. typical) program and another who participated in informal campus projects:

- The formal group demonstrated that interdisciplinary cooperation and socio-communicative competencies were important in their programs
- Important with the informal group were: voluntariness and individual responsibility; learning with an ethical orientation in meaningful situations; unintentional, but conscious learning; and interdisciplinary collaboration
4. Existing Programs

Applying systematic review and content analysis to 2513 studies published between 2000 and 2015, Viegas et al. (2016) identified 15 attributes across four categories in ESPs:

- **Foundational Assets**: includes Philosophy, Epistemology, Interdisciplinarity, and Transdisciplinarity
- **Knowledge Assets**: includes Pedagogy, Literacy, Learning, and Teaching
- **Personal Assets**: includes Values, Beliefs, Attitudes, Behavior
- **Integrative Assets**: includes Constructivism, Complexity, and Holistic Thinking
4. Existing Programs

Vincent and Dutton (2015) reviewed the findings of a number of studies performed for the Center for Environmental Education Research (CEER) and the NCSE between 2003 and 2013. They discovered a number of commonly held views regarding ESPs:

- The goal of preparing sustainability-oriented problem solvers
- A focus on coupled human-nature systems
- A holistic educational approach with a focus on interdisciplinary knowledge, systems approaches, and diverse epistemological viewpoints
- Key competencies, including: “disciplinary synthesis and systems-thinking cognitive skills” among others (p. 407)
4. Existing Programs

Vincent and Dutton (2015) categorized the ESPs into three approaches to “ideal curriculum design” and identified their predominant knowledge and skills components:

1. Natural Systems (34% of programs): physical and life sciences (knowledge), lab & field research (skills); the “majority of... degrees are BS degrees in environmental science(s)” (p. 417)

2. Social Systems (29% of programs): social sciences, followed by sustainability and humanities (knowledge), collaborative engagement (skills); the “majority of degrees... are BA degrees in environmental studies, policy or sustainability” (p. 417)
4. Existing Programs

3. Sustainability Solutions, emphasizing “a systems-oriented approach that encompasses a broad range of knowledge and skills” (p. 409, 37% of programs): physical and life sciences, social sciences, sustainability, humanities, systems, and built environment (knowledge); lab & field research, collaborative engagement, informatics, project management, systems thinking, technical communication, and personnel management (skills)
4. Existing Programs

Within the Sustainability Solutions Emphasis:

- There was a 60:40 balance between BS and BA degrees
- Degrees are more likely to require fieldwork and a project
- There was a more balanced focus on the natural and social sciences
- Leadership is more likely to emphasize external support and partnerships
5. Models and Proposals
5. Models and Proposals

To train students in cognitive interdisciplinary skills, Fortuin et al. (2013) recommend the systems approach:

1. “formulating the problem
2. identifying, designing, and screening possible alternatives
3. forecasting future contexts or states of the world
4. building and using models for predicting the consequences
5. comparing and ranking the alternatives
6. communicating the results.” (p. 148)
5. Models and Proposals

They specifically recommend the RAINS model as it highlights “the conflicting interests of people and the organization of politics” (p. 149). The environmental systems analysis tools they use at Wageningen University (the Netherlands) in applying RAINS are:

1. conceptual models
2. environmental indicators
3. scenario analysis
4. life cycle assessment
5. stakeholder analysis
6. multicriteria analysis
7. cost effectiveness analysis
8. ecosystem services analysis
9. environmental impact assessment
10. integrated assessment models

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5. Models and Proposals

Case studies can serve as the “vessel” that embodies Steiner and Posch’s (2006) principles of interdisciplinarity, transdisciplinarity, and self-regulated learning sustainability education. These require:

- An ID academic case study team works with stakeholders to provide solutions as well as outline and define problems
- Integrated practitioners (stakeholders) share knowledge and experience with students and researchers
- Integrated researchers instruct and tutor students
5. Models and Proposals

Students at ASU develop key competencies through solution-oriented sustainability learning (SOSL; Wiek & Kay, 2015), where “solutions are conceptualized as evidence-supported strategies” (pp. 29-30) suited to complex problems. It:

1. “familiarizes students with real-world” issues
2. “trains students in evidence-supported problem-solving”
3. “trains students in teamwork and stakeholder engagement” (p. 30)
4. “is self-guided and supported training” (p. 30)
5. is facilitated by instructors who serve as coaches and facilitators that pre-structure course-work
Clark et al. (2011b) recommend that ESP curricula be skill-based and train students in problem orientation. They outline:

1. “a four-semester program wherein students are required to take one course a semester” (p. 722) to learn and apply the policy sciences framework
2. teaching with an active/applied learning approach
3. venues that include courses, workshops, field trips, applied appraisals, experiential education, studies abroad, and apprenticeships
4. organization and governance with an interdisciplinarity champion high in the program’s hierarchy
5. Models and Proposals

- For Shephard (2008), the trans-disciplinary case study (TCS) approach is central to developing affective outcomes, which can be useful given the complex nature of ESP goals.

- TCS is based on two approaches: “functional socio-cultural constructivism and project-based learning” (p. 93). She suggests four key aspects to effectively incorporating affective outcomes in sustainable education:
  - Assessment and evaluation, Credit for attaining affective outcomes, Key roles for role models, and Developing different affective domains (to develop values, not entrench them).
5. Models and Proposals

Sipos, Battisti, and Grimm (2008) use the “framework of transformative sustainability learning (TSL) and the organizing principle of head, hands and heart” (p. 69) as a tool to “to explicitly unite and embody the theories, practices and heartbeats of sustainability within academic and applied fields” (p. 81).

- head (engagement, i.e. “learning through readings, lecture, discussion; includes critical thinking,” p. 75)
- hands (enactment, i.e. “painting a fence,” p. 75)
- heart (enablement, i.e. “experiencing connection; reflecting upon values,” p. 75),
6. Moving the Field Forward
6. Moving the Field Forward

- Wiek, Withycombe, and Redman (2011) see five critical issues and gaps regarding ESP competencies that must be addressed:
  - Establishing links between ES and traditional academic competencies
  - Gaining more evidence, depth, and rigor in analyses of the competencies as well as their theoretical justification
  - Identifying the ideological aspects within these competencies that may cause conflict
  - Integrating key competencies into unified competence in sustainability research and problem-solving
  - Assessing the requirements and challenges students will face on the path to acquiring this full set of competencies

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6. Moving the Field Forward

- Fortuin, Koppen, and Kroeze (2013) argue that ESPs need to find ways to better deliver on the promise of case-studies:
  - Few students realized the model was a flexible tool
  - The systems approach helped only started to make improvements in students’ ability to assess the role that science and other paradigms play in society

- Proctor et al (2018) argue that students and practitioners engage in a “global cosmopolitics” establishing deep and meaningful dialogue in ever larger circles: starting first with ES community, then out to the university, then the country, and finally the world
6. Moving the Field Forward

Viegas et al. (2016) argue that ESPs must consider the following:

1. ESPs should promote “deep conceptual understanding” of what’s involved in the integration of knowledge
2. Context is crucial to the Foundational and Knowledge assets
3. Creativity is important to the Foundational and Personal assets
4. Programs need to overcome challenges to new ways of thinking in terms of the Foundational and Integrative assets
5. Resilience and vision are essential to Knowledge and Personal
6. There is a “paradox of deconstruction and affective lessons” (p. 269)—it’s impossible to give structure to chaos
7. Values, beliefs, attitudes, and behaviors need to be reassessed in their relationships to one another
7. The Big Picture
The Big Picture

• The dominance of rationalism has led higher education to “fragment knowledge into disciplines” (Sipos, Battisti, & Grimm, 2008, p. 70) at the expense of macroscopic, holistic perspectives (Brand & Karvonen, 2007).

• Fragmentation and over-specialization, a boon to industrialization, hampers the professional’s ability to see the big picture and have led to the unsustainability of contemporary civilization (Rojas, 2009).

• A related challenge for ESPs is the division between two predominant strains in ESPs and the value they place on positivist versus constructivist thinking (Soulé and Press, 1998; Maniates & Whissel, 2000; Clark et al., 2011a).
7. The Big Picture

Most, if not all, of the recommendations for ESPs involve creating a new learning culture that is grounded in an open-minded and participative process.

Such a culture is required to develop an enabling-oriented, self-organized, competence-focused education that promotes personal development and the tools to manage complex situations, benefit from reflection, make decisions, consider ethics, and judge consequences (Barth et al., 2007).
7. The Big Picture

- Sipos et al. (2008) propose a university structure that allows “critically reflective, inter/transdisciplinary, experiential and place-based learning to emerge” (p. 71)

- Mochizuki and Fadeeva (2010) call for the “challenging of structural conventions and questioning of the taken-for-granted modernist dualisms underpinning the modern education system” (p. 395)

- Vincent and Mulkey (2015) find that many ESP leaders agree that there is a need to break down the barriers to inter- and transdisciplinary, collaborative education.
7. The Big Picture

- Rojas (2009) argues that a revised educational system must rely on both rationality and the personal/emotional/poetic experience. He suggests an “ecology of knowledge,” where program content and the learning process are bound together.

- Wiek and Kay (2015) argue that ESPs focus on “learning while transforming” (p. 30): teaching students how to think rather than what to think.

- For Redman (2013), based on his experience at ASU, sustainability education requires “a sharp break with the traditional way of conducting research and problem solving” (p. 238).
8. New Research
9. Conclusions
9. Conclusions

- Vincent and Dutton (2015) found that the longer a program has been in existence, the more:
  - prominence it has
  - autonomous it is
  - likely it is to “have curricula that align[s] with the Sustainability Solutions Emphasis” (p. 416)

- They also found that ESPs would prefer the Sustainability Solutions Emphasis approach if they had equal standing with other programs
9. Conclusions

- If ESPs are to achieve their unique missions, Vincent and Dutton’s (2015) findings suggest that they must be provided with the autonomy and resources to do so.

- While a gradual intensification of current interdisciplinary approaches within the existing university structure *can* yield effective ESPs, the consensus seems to be that it will likely require a radical transformation at the university.
9. Conclusions

- ESPs should begin by training students to be discipline experts first and focus on interdisciplinarity later, to become either:
  - Interdisciplinary Coordinators/Environmental Integrators
  - or Multidisciplinary Team Members/Environmental Scientists

- Students should participate in experiential/project-based/applied learning toward the end of their program

- ESPs must be autonomous, adequately funded, and respected
9. Conclusions

Engagement, whether in the context of environmental well-being or a host of other current issues, may well be both the greatest challenge and the greatest opportunity of our times. Let us, then, start by engaging with each other in the ESS community, then let us reach out on our campuses, across the country, and beyond. Engaging across these expanding and interconnected circles, we can be the environmental leadership that is so plainly missing and desperately needed to produce meaningful change. (Proctor et al, 2018, “The challenge and the opportunity” Section, paras. 3-4)


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Vincent, S., Bunn, S., & Stevens, S. (2012). Interdisciplinary Environmental and Sustainability Education: Results from the 2012 Census of U.S. Four Year Colleges and Universities Council of Environmental Deans and Directors.


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Additional/Newer References


