***The Earth Sustainability Liberal Education Program: An experiment in integrative learning***

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*What is the Earth Sustainability program in liberal education?*

The Earth Sustainability (ES) program is an integrative and STEM-saturated experiment in liberal education that debuted at Virginia Tech from 2004 to 2010. Over the span of four consecutive semesters, students fulfill their general education requirements through this thematic and interdisciplinary alternative to the traditional distribution-based general education model. From our knowledge, the Earth Sustainability liberal education program is unique in that it was designed with the specific goal of accelerating students’ epistemological and social development. During the first two college years, students participate in four consecutive five-credit semester courses through which they investigate eight interdisciplinary themes beginning with *worldviews & water* in the first semester and continuing onto *energy & shelter*, *agriculture & food*, and *waste, health, & pathways to the future* in the subsequent three semesters. Using Baxter Magolda’s (2004) Learning Partnerships Model, the ES social constructivist curriculum challenges and supports students to develop more sophisticated ways of knowing, learning, conceptualizing, and approaching unstructured interdisciplinary problems (Bekken and Marie, 2007). As such, the series not only meets general education goals, but also instantiates the structures and pedagogies advisory groups advocate are critical to learning and to developing a scientifically literate society (AAC&U, 2007; AAC&U, 2005; National Center for Public Policy in Higher Education, 2004; AAC&U, 2002; AAHE, ACPA & NASPA, 1998; AAAS, 1989). Three cohorts of students and faculty have completed the ES series: Cohort 1 (2004-2006): 23 students started, 19 finished for an 83% retention rate; Cohort 2 (2006-2008): 67 students started, 48 finished for a 72% retention rate, and Cohort 3 (2008-2010): 121 students started, 72 finished for a 60% retention rate.

*What is valuable about the Earth Sustainability program and what has it accomplished?*

Assessment data were collected longitudinally from all three cohorts of students and faculty and from a matched comparison group of students in the general education curriculum. Results demonstrated that:

1. In contrast to students in the general education comparison group, non-STEM majors developed a neutral to positive view of both the value and ability of STEM disciplinary knowledge and practices to inform current and societally relevant problems;
2. ES students’ epistemological development, beliefs about learning, and intrinsic motivation were significantly advanced in comparison with students in traditional programs (Olsen et al., 2011);
3. Students’ advanced epistemological positions, learning beliefs, and intrinsic motivation correlated with their development of more effective strategies for learning;
4. Student self-reports indicated that the STEM-saturated interdisciplinary design of the ES series positively impacted students’ ability to embrace complexity, grasp interdisciplinary issues through multiple disciplinary lenses, broaden their “useful” knowledge base, support transfer, respect diverse intellectual, social, and professional perspectives, and develop into more self-directed and self-efficacious creative and critical thinkers;
5. More than half of the graduating seniors who participated in the ES program in their first- and second-years cited the ES experience as the most valuable learning experience of their undergraduate experience. ES students were also twice as likely to have formulated specific career goals or educational trajectories just prior to graduation.

*What key lessons were learned from longitudinal assessment of student learning over three cohorts?*

* *Epistemological beliefs*. After two years, ES students held more sophisticated conceptions of the nature of knowledge than non-ES students. ES students were also less likely to be confused by unstructured knowledge or to hold naïve beliefs about the certainty of knowledge.
* *Learning beliefs*. ES students: 1) were more likely to believe that they could produce a desired learning result, 2) held more sophisticated beliefs about learning, and 3) were less likely to believe that “learning is quick” than non-ES students.
* *Motivation*. Although students in the ES group entered the program with higher intrinsic goal orientation on average, over time intrinsic goal orientation grew in comparison to non-ES students, even while holding constant students' epistemic beliefs. Thus, participating in the ES program had a positive and direct effect on students' motivation to learn.
* *Interdisciplinarity.*  Using the interdisciplinary writing rubric of Boix Mansilla et al. (2009), ES students’ ability to use two or more disciplinary lenses to inform an interdisciplinary problem had, on average, advanced from naïve to apprentice levels over the two year ES program. Exit interviews with ES students indicated that most had developed confidence in their ability to integrate and transfer content knowledge within and between disciplinary areas and had gained an appreciation for the value of multi-disciplinary ways of knowing (well outside their majors). The vast majority of those interviewed attributed their experiences in the ES learning community to development of these skills. This finding also was observed during exit interviews with graduating seniors who had completed the ES series two years earlier.
* *STEM education.* Exit interviews of ES students showed that the majority of non-STEM majors had shifted their positions on their inherent “interest in science” from largely unfavorable to largely favorable over the course of the program.

*What were the greatest challenges to offering the Earth Sustainability program?*

After six years of university funding, a parallel NSF-supported study, and considerable documented learning gains, funding for the ES program was cut during the budget crises of the 2010-2011 academic year. As an interdisciplinary program, Earth Sustainability had no collegiate or departmental “home” and, as a result, no advocates willing to fund it. Given the tremendous learning gains demonstrated by the ES program assessment, we were disheartened but not surprised by this outcome because there is little room to experiment in the shrinking budgetary landscape of disciplinary driven funding structures. In essence, to support interdisciplinary programming in the long term, it needs to be institutionalized. As a community of scholars, we need to encourage administrative faculty to re-envision both the administrative and budgetary structures that restrict funding to traditional silos, thereby choking the development of interdisciplinary, cross-disciplinary, multi-disciplinary and trans-disciplinary programming, wherein, as we have documented, student-learning gains can be acute. Our data demonstrate the value of interdisciplinary programming to build knowledge structures, facilitate transfer, and encourage cognitive and social development. We need to act constructively to ensure that STEM-based interdisciplinary programs have secure homes and futures.

*How does interdisciplinary and integrative programming prepare students for careers?*

 To determine what affect the ES program may have add on preparing students for careers, we interviewed graduating seniors from both the ES program and the comparison group about their career visions, goals, and strategies for achieving those goals. We found significant differences between the two groups of students. Over each of the three summers between freshman and senior years, ES students were half again as likely to report working in jobs that were relevant to their future career goals in comparison to students in the traditional general education programming. Graduating ES students were almost twice as likely to have identified focused long-term professional and personal goals than graduating seniors in the comparison group. Further, all ES students with definite plans to continue their education could articulate a professional argument for why further graduate education was necessary. This finding contrasts with more than half of the comparison students who cited vague reasons for continuing their education. While these results are based on a small number of students (n=37), they are suggestive that the developmental gains made by students in the ES series influence their choice of summer jobs and internships and stimulate greater clarity around their professional plans and goals.

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