Teaching for Change: Learning Partnerships and Epistemological Growth

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Educational practices developed to meet the needs of a burgeoning industrial-age society are proving inadequate to prepare students for the challenges of the information society in which they will live (Bransford, Brown, & Cocking, 2000; Gilbert, 2005). Over the last two decades an unprecedented number of high-profile reports and publications have called for radical reform of higher education and, in particular, a significant rethinking of the general education structures on which collegiate education is founded (American Association for the Advancement of Science, 1990; Association of American Colleges and Universities [AAC&U], 2002, 2007; Bartlett, 2004; Bok, 2006; Project Kaleidoscope, 2002; Ratcliff, Johnson, & Gaff, 2004). Critics argue for greater emphasis on problem-solving and communication skills fundamental to functioning in a complex, rapidly changing environment and emphasize the potentially disastrous consequences of our inability to recruit and educate students into science, math, and engineering disciplines. Large research universities that struggle to balance economic efficiency with educational effectiveness have received particularly pointed criticism (Bok, 2006; Ratcliff et al., 2004; Slaughter & Rhodes, 2004).

While questions have been raised about the efficacy of experiential, discovery, and other constructivist-based pedagogies (Kirschner, Sweller, & Clark, 2006; Talburt & Boyles, 2005), the evidence suggests that constructivist methods do promote greater comprehension, enhanced metacognition, deeper

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critical-thinking skills, and better school achievement (e.g., Hofer, 2004; Hofer & Pintrich, 1997; Klaczynski, 2000; Kuhn, 1999; Schommer, 1993; Schraw, 2001; Trautwein & Ludtke, 2007). Despite these findings, transmission models of teaching common in the 1970s and 1980s still predominate in today's introductory college classroom (Baxter Magolda, 2004a, 2004b; Hofer, 2001; McInerney, 2005).

This article reports on a comprehensive longitudinal evaluation of an experimental general education curriculum based on constructivist principles conducted at a large public research university. The new curriculum, centered on the theme of earth sustainability, is an integrated two-year, twenty-credit course series that (1) redefines faculty and student course-related roles and responsibilities, (2) emphasizes the role of peers through collaborative learning, and (3) reduces the fragmentation of the traditional general education experience with a fully interdisciplinary curriculum (Bekken & Marie, 2007). What distinguishes our model for general education from other constructivist or learning community–based models is its reliance on the principles and assumptions of Baxter Magolda's (1992, 2001, 2004a, 2004b) Learning Partnerships model and Theory of Epistemological Reflection as foundational to the design. A particular strength of the Learning Partnerships model is that it integrates a variety of pedagogical innovations into a meaningful whole, working to promote intellectual growth along a trajectory consistent with well-established theories of cognitive and epistemological development (Baxter Magolda, 1992, 2004a, 2004b; Bendixon & Rule, 2004; King & Kitchener, 2004; Kitchener & King, 1981; Kuhn, 1999; Perry, 1970). Using this approach, *students' understanding of the nature of knowledge and knowing is explicitly recognized within the learning environment* using principles of support and challenge designed to promote epistemological growth (Baxter Magolda, 2001, 2004a, 2004b; Hofer, 2004). The goal is not to produce one specific type of thinking or learning skill but, rather, a deep-seated set of conceptions or beliefs about knowledge, knowers, and knowing that will support deeper engagement in learning, greater intellectual flexibility, and more complex thinking generally. As Baxter Magolda (2004c) explains, "Epistemological transformation is a shift to a more complex set of epistemological assumptions rather than the acquisition of particular learning strategies or skills" (p. 31).

Theories of Epistemological Development and Beliefs

According to reviews provided by Hofer and Pintrich (1997) and Hofer (2001, 2002, 2004), the field of personal epistemology has been largely guided by two theoretical branches: (1) *stage-based developmental theories*, founded primarily on

qualitative data such as interviews and open-ended instruments, which construe epistemology as a coherent set of assumptions about knowledge and knowing, and (2) *belief-based theories*, founded primarily on quantitative methods using survey instruments and questionnaires, which conceptualize personal epistemology as a set of independent beliefs about the structure and boundaries of knowledge. Developmental studies that use small, select samples have been criticized because they are largely unconcerned with issues related to establishing internal reliability or external validity. Belief-based theories that view epistemology in a less contextualized, less interdependent, and more trait-like fashion are better suited to using survey measures to capture the dimensions of the belief system as separate constructs and statistically investigate relationships with other cognitive and academic variables of theoretical and practical significance. Despite their recent ascendance in the literature, however, belief-based models have been plagued by serious psychometric problems with scales assessing beliefs about the certainty, source, and stability of knowledge often failing to exhibit acceptable levels of internal reliability (DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008).

The present study is grounded in *stage-based developmental theory* because we believe that the substantial convergence of findings across studies (Hofer & Pintrich, 2002) supporting a roughly equivalent trajectory from absolutist to postrelativist constructions of learning and knowing attests to the value of this approach. In addition, we explore a basic point of disagreement between developmental and belief-based epistemological models—the level of the relative interdependence of components or dimensions of personal epistemology. More generally, cognitive-developmental theories have increasingly accounted for a horizontal decalage of uneven development across stages (King & Kitchener, 2002). Given these observations, we explore whether some dimensions of knowledge, knowing, and learning systematically advanced before others over the course of the two years of the study.

While theoretical formulations of personal epistemology vary, they share foundational principles stemming from their roots in the cognitive tradition of Piaget (Hofer & Pintrich, 1997). First and foremost is the notion that *people make meaning*, that is, that meaning is constructed rather than derived directly from experience. Second is that intellectual development comes about through interaction with the environment and through the processes of assimilation and accommodation. From these basic premises, epistemological development emerges as an intellectual transformation in which assumptions about the certainty, complexity, and source of knowledge change (Hofer, 2001; Kuhn, Cheney, & Weinstock, 2000). Students move from a state of naive empiricism with a belief in knowledge as a veridical representation of reality (mastered by experts and authorities), to an almost nihilist subjectivism in which all views

are equally valid, to a dialectical blending of the two. In this latter stage of development, the limits of knowledge are recognized, while ideas and theories are endorsed as better or worse based on evidence and argument, completeness, and integration. Right answers are replaced by right thinking. In her Theory of Epistemological Reflection, Baxter Magolda (1992) describes four stages of epistemological development that she terms absolute knowing, transitional knowing, independent knowing, and contextual knowing. Contextual knowing, the highest stage, signals that individuals respect and incorporate the views of others while accepting the prerogatives and responsibilities attendant to their own central role in the sense-making process; they value the perspectives of others without apology for having a viewpoint of their own. Baxter Magolda's (2004c) Theory of Epistemological Reflection is particularly germane to efforts to reform higher education as it construes beliefs about self, learning, and classroom instruction as intertwined with epistemological assumptions.

Subsequently, Baxter Magolda (1999, 2001, 2004a, 2004b, 2004c) expanded the scope of her inquiry beyond students' cognitive development and explored intrapersonal and interpersonal domains emphasizing the contribution each makes to students' development of *self-authorship*. Self-authorship "is simultaneously an ability to construct knowledge in a contextual world, an ability to construct an internal identity separate from external influences, and an ability to engage in relationships without losing one's internal identity" (Baxter Magolda, 1999, p. 12). It is important to note that while we recognize the interrelatedness of the three developmental domains and have seen evidence of both intra- and interpersonal development in subjects, this study focuses *specifically* on the cognitive aspect of students' epistemological development and uses measures and protocols developed and validated by Baxter Magolda (1992) for that purpose.

Epistemological Development in College

In her review of the literature, Hofer (2001) suggests that while "college has some small but measurable impact on epistemological development . . . advanced epistemological thinking may occur infrequently in the U.S. adult population, the exception being those with graduate education" (p. 369). Thus, collegiate-level instruction appears to correlate with only modest epistemological growth. Moreover, the contribution to epistemological development from higher educational experiences in comparison with life experiences has yet to be sorted out, thus it is difficult to assess the specific impact of higher education on advancing epistemological thinking (Pascarella & Terenzini, 2005; Schraw, 2001). In her work with one hundred students from Miami of Ohio in the 1980s, Baxter Magolda (1992) found that students moved from more absolutist "black and

white" forms of thinking to more relativistic "I'm ok, you're ok" modes by the end of college. Her (2001, 2002) continued longitudinal study showed more salutary effects of graduate education or professional employment. Nonetheless, subjects were more likely to progress to more advanced independent and contextual knowing stages only as they grappled with the defining issues of career and family in the crucible of early adulthood. Baxter Magolda notes that postbaccalaureate respondents were highly critical of their education, maintaining that it did not prepare them for the challenges they faced as adults. Thus, her findings confirm rather than refute critics' concerns over the mismatch between the education offered and the education needed for students to become successful professionals, family members, and citizens. As Skipper (2005) points out, the first two years of college are likely to be a watershed period in developing students' "disposition to think critically." If early college experiences do not expose students to "challenging questions and new ideas and provide adequate support for working towards solutions and assimilating new information" (p. 64), development over the next two years of college will have a significantly lower trajectory.

Description of the Earth Sustainability Curricular Foundation

The Earth Sustainability (ES) four-semester curriculum was developed in 2003 and initially offered during the 2004–6 academic years with the primary goal of instantiating Baxter Magolda's Learning Partnerships model at the general education program level. Bekken and Marie (2007) describe the curricular design and initial challenges of offering this radically different interdisciplinary approach to general education. During the first two cohorts, the ES series and companion composition/communications courses met all but the quantitative reasoning component of the university's general education requirements (which was incorporated into later versions of the curriculum).

According to the Learning Partnerships model, a constructivist learning environment both supports and challenges students. Students are supported by the environment (1) validating learners' capacity to know, (2) situating learning in the learners' experience, and (3) defining learning as mutually constructing meaning. Students are challenged by the environment (1) portraying knowledge as complex and socially constructed, (2) conveying that the self is central to knowledge construction, and (3) ensuring that authority and expertise are shared in the mutual construction of knowledge among peers (Baxter Magolda, 2001, 2004a, 2004b). These principles of support and challenge are foundational to the design of the Earth Sustainability series and are incorporated into the *course content*, *curricular structure*, and *pedagogy* (Table 1).

TABLE 1 Implementing Baxter Magolda's (2004a) Learning Partnerships (LP) model in a two-year thematic general education curriculum: incorporating features of challenge and support into course series content, pedagogy, and curricular structure

LP Model: Challenge Feature	Two-Year Thematic General Education Curriculum for a Learning Partnership			LP Model: Support Feature
	***Content*: Timely/relevant interdisciplinary theme informed by a wide range of disciplines**	***Pedagogy*: Learning community cohort of faculty and students that meets over four semesters**	***Structure*: Curricular spiral uses disciplinary methods to investigate increasingly complex topics**	
Knowledge is complex and socially constructed	*Challenge*: Learners investigate interdisciplinary problems using disciplinary methods and assumptions; complexity arises as disciplinary results/truths differ.	*Challenge*: The community does not perform effectively unless every member participates in/contributes to the co-construction process on all levels; faculty are learners, too.	*Challenge*: Learners are challenged to become increasingly sophisticated in their application and transfer of discipline-specific content and methodology.	Validate learners' capacity to know
	Support: Learners are inherently interested in relevant, interdisciplinary theme; they already "know" about it based on personal/school experience.	*Support*: All voices are essential to a creating a functional learning community. Every member is invited to identify his or her strengths and contribute to the community.	*Support*: Learners use familiar disciplinary content, methods, assumptions, and cultural norms to investigate familiar interdisciplinary topics and problems.	
The self is central to knowledge construction	*Challenge*: Learners are challenged to negotiate their "common" knowledge with new information by engaging with progressively more complex interdisciplinary topics and multidisciplinary content materials.	*Challenge*: Each learner accepts responsibility/ownership for his or her learning and for supporting and being supported by the community by sharing expertise, abilities, and needs; the learner recognizes that his or her learning process is dynamic.	*Challenge*: Learners are exposed to new information but repeated disciplinary methodologies; they revisit and revise conceptions by honing disciplinary skills and discovering methodological commonalities between disciplines.	Situate learning in learners' experiences

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	Support: Learners self-select the theme; developmentally appropriate and relevant content materials encourage and support growth.	*Support*: Learners bring and share their expertise on learning and knowing within the community; the community determines policies for engagement.	*Support*: With each spiral, learners are supported and encouraged to incorporate new information into their existing worldviews.	
Authority and expertise are shared in the mutual construction of knowledge among peers	*Challenge*: Interdisciplinary inquiry requires using varied disciplinary methods and assumptions while appreciating the varied perspectives/ worldviews of informed others.	*Challenge*: Students and instructors incrementally redefine roles; instructors share control, and students accept responsibility for learning, to support the mutual knowledge construction process.	*Challenge*: The curricular spiral challenges learners to become increasingly sophisticated knowers by interacting with increasingly complex methods and issues.	Define learning as mutually constructing meaning
	Support: Using multidisciplinary methodologies and perspectives encourages each student to bring and share expertise from his or her chosen discipline, interest, or background.	*Support*: Learning community members use familiar forums of lecture, discussion, and lab in novel interdependent ways to mutually construct meaning; learners are active participants in this process.	*Support*: The curricular spiral supports the negotiation of old beliefs with new information by revisiting disciplinary methods and perspectives repeatedly with new issues.	

Several researchers have suggested that interdisciplinary content promotes epistemological growth (e.g., Drezek & Olsen, 2008; Ivanitskaya, Clark, Montgomery, & Primeau, 2002), thus we have closely coupled *course content* with interdisciplinary exploration. Further, many authors indicate that topical or content relevance increases motivation (National Research Council, 2003). While several broadly interdisciplinary themes could have been selected to focus content information, the recent increase in environmental awareness, coupled with mounting evidence that the planet's systems are significantly strained, makes the earth sustainability theme an ideal one for engaging all students, especially those disenfranchised from science, technology, engineering, and mathematics disciplines. Students are more likely to engage with content if it is embedded in the context of contemporary political, social, and environmental problems to which they can relate (Lattuca, Voigt, & Faith, 2004). In the ES series, students are exposed to many different disciplinary lenses through which they explore not only the world's natural resources and ecosystems but also the economic and political systems that govern their use; the social and cultural impact of uneven distribution of those resources and systems; the resulting interface between human-made and natural environments, including the ways in which this interface is managed; and the roles and responsibilities of individuals, communities, nations, and international entities in a both local and global world.

Bruner's (1960) concept of a curricular spiral is as relevant today as it was when he first proposed it and is central to the organization and delivery of the Earth Sustainability curriculum. This particularly appropriate vehicle for the *curricular structure* organizes and accommodates content, skill development, and increasingly sophisticated ways of thinking, knowing, and learning as it spirals from established ideas, skills, and concepts to new ones. New ideas and concepts are linked directly to familiar ones through the curricular spiral but require increasing levels of sophistication to master, thereby encouraging self-reflection and intellectual growth. Importantly, the spiraling curriculum provides a useful curricular rubric not only for organizing multidisciplinary inquiry but also for scaffolding the kind of deep-seated intellectual development that is the primary goal of the ES series.

Finally, incorporating a learner-centered, community-based *pedagogy* (e.g., Weimer, 2002) becomes a cornerstone for any course or set of courses developed to instantiate the Learning Partnership model. Extensive class discussion, group work, and conscious self-reflection are used to help learners recognize the limits of their own knowledge as well as the value and validity of others' diverse information and complex perspectives. By learning within a community over a sustained period of time, not only are students able to explore the differences in their beliefs and values, but they also start to articulate why they think the way they do. Over time, they begin to ground their thinking in evidence, to

evaluate and synthesize the evidence, and thus to contextualize the basis for their viewpoint as well as that of others. This increasingly sophisticated process for learning and knowing creates opportunities for connecting seemingly disparate perspectives into a greater whole of mutually constructed knowledge that transcends the boundaries of what any one student or teacher can know individually.

To further encourage epistemological growth, the series unfolds over two years, providing the time essential for students to practice and acquire new habits of mind. As King and Kitchener (2004) note, when it comes to developmental change, "slow steady progress is a . . . reasonable expectation" (p. 16).

Methods

Research Questions

In the present study, we conduct a mixed-methods assessment of the Earth Sustainability course series to examine whether students in a Learning Partnership–based curriculum: (1) demonstrated significantly greater epistemological development at the end of their sophomore year than as entering first-year students and (2) demonstrated significantly greater epistemological development at the end of their sophomore year relative to a comparison group of students in a traditional curriculum measured over the same time period. As part of this investigation, we evaluated delivery of the course series through interviews with faculty and students and through direct observations of class sessions. Finally, we address an issue raised by Schommer-Aikins (2002), Hofer (2000, 2001), and others who question whether the dimensions of one's personal epistemology are uni- or multidimensional and whether they are highly interrelated or independent. In other words, do students' concepts of instructors, peers, and themselves as learners all proceed apace along with a more general conception of knowledge and knowing? Or do students rethink some dimensions of learning and knowing before others? In the present study, we explore possible developmental differences longitudinally to evaluate whether significant differences could be found within and between quantitative and qualitative measures of epistemological development. Our findings have direct implications for instruction as well as course and program design and can inform those seeking to optimize student thinking and accelerate cognitive-epistemological development.

Participants

Fifty entering first-year students were recruited during summer orientation 2004, at which time twenty-three students enrolled in the Earth Sustainability series. Scheduling conflicts prevented the remaining twenty-seven from enrolling, but sixteen of these students agreed to participate in a comparison group. Thus,

students in both the ES course series and the comparison group had expressed an interest in ES. Demographic and academic data were collected on ES and comparison students, including sex, race/ethnicity, state residency status, high school size, SAT score, high school GPA, first-semester college GPA, and entering major (Table 2). Chi-square tests were conducted on the demographics, and no significant differences were found for ethnicity or residency, but sex differences approached significance, with more women in the ES group ($X^2[4, N = 39] = 3.63$, $p = .06$). *T*-tests on high school GPAs and SAT scores indicated that there were no significant differences between the two groups. Nonetheless, comparison students had somewhat higher mean quantitative and verbal SAT scores as well as higher mean high school GPAs (Table 3).

TABLE 2 Demographic information on Earth Sustainability and comparison groups

	Earth Sustainability Class		Comparison		Total	
Variable	***N***	***%***	***N***	***%***	***N***	***%***
Sex						
Female	17	73.91	7	43.75	24	82.76
Male	6	26.09	9	56.25	15	51.72
Ethnicity						
Unknown	3	13.04	2	12.50	5	17.24
Asian	3	13.04	1	6.25	4	13.79
Hispanic	1	4.35	0	0.00	1	3.45
White	16	69.57	12	75.00	28	96.55
Nonresident alien	0	0.00	1	6.25	1	3.45
State residency status						
In state	15	65.22	12	75.00	27	93.10
Out of state	7	30.43	4	25.00	11	37.93

TABLE 3 High school and college academic variables for Earth Sustainability and comparison groups

	Earth Sustainability Class		Comparison		Total	
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
SAT—Verbal	585.71	67.57	623.33	60.67	601.39	66.6
SAT—Math	583.33	56.07	608.00	74.18	593.61	64.42
High school GPA	3.52	0.34	3.73	0.25	3.60	0.32

All students were paid $20.00 per hour for approximately seven hours each year for their participation in the project. Despite this, we experienced greater attrition than anticipated in the comparison group, with the comparison cohort dwindling from sixteen to eleven by the end of the second year. To address this issue, we recruited a subsample of nine students who were matched demographically and academically to the students lost through attrition. While these students could not be used in longitudinal analyses, they did help us assess how much comparison students' responses were affected by attrition.

Measures

Observations on the Delivery of the Learning Partnerships Model. Baxter Magolda evaluated how well the ES course series followed the tenets of the Learning Partnerships model during three campus visits over the two years of the pilot study. She observed the class directly in fall 2004 and spring 2006. During all three visits, she spoke at length with the team of ES instructors who taught all four semesters of the series. Two additional expert reviewers from the campus's Center for Excellence in Undergraduate Teaching and the Graduate Education and Development Institute met with ES instructional faculty several times each semester. These experts submitted written observations of faculty responses to the new teaching and learning paradigm.

Measures of Epistemological Development. Epistemological development was measured using Baxter Magolda's (1992) Measure of Epistemological Reflection (MER). The MER is well established in the literature and has been an important tool in the empirical work describing and documenting changes in college student thinking (Baxter Magolda, 1992, 2001, 2002, 2004a, 2004b; Meszaros, 2007). It is a semistructured protocol that probes students' construction of the college learning environment and the specific roles of different actors and dynamics within that environment (see the Appendix). Students are queried about how peers, instructors, and they themselves participate in the learning process (prerogatives and responsibilities), the nature of the knowledge construction process, and how learning should be evaluated.

Students write their answers to the MER questions and are then interviewed verbally to help clarify the interviewer's understanding of the students' perspective. We administered the written version of the MER to ES and comparison groups at the beginning and end of their freshman year and at the end of their sophomore year. Each student wrote responses to the MER online and was then interviewed using a similar but less structured set of questions to allow for clarification, expansion, and redirection. Verbal interviews were largely helpful for setting context.

Coding of students' written MERs was based on the following epistemological dimensions: (1) role of self in the learning process, (2) role of peer, (3) role of instructor, (4) role of evaluation, and (5) nature of knowledge. Transcripts were scored using the coding scheme developed by Baxter Magolda (1992) and modified and used by Pizzolato (2007b). Pizzolato (2007b) added a fifth stage to the four stages of Baxter Magolda (1992). Similarly, we employed a fifth stage in the coding scheme. Scores for each of the five dimensions ranged from 1 to 5, reflecting five stages from least to most developed: (1) absolute or dualistic thinking, (2) transitional from dualistic to independent or relativistic knowing, (3) independent knowing, (4) transitional from independent to contextual knowing, and (5) contextual knowing. This fifth stage helps the coder systematically identify two discrete stages previously encompassed in the long, complex final stage of contextual knowing. Respondents appeared to transition gradually from a position of independent knowing in which "students remained individual in their approach to knowing; . . . plac[ing] their views at the center of the learning process" to a position of contextual knowing in which "knowers' believed that some views were more valid than others, depending upon the available evidence" and that "evidence came from experts . . . who had gained expertise in a particular context" (Baxter Magolda, 1992, pp. 165, 170, 175). Thus, in the fourth stage, learners view knowledge as both uncertain and grounded or rooted in evidence. They begin to look beyond themselves as knowers *in some contexts* and to acknowledge that experts and expertise exist and can be evaluated based on an interdependent set of values and codes. In this stage, learners are more likely to look for evidence to support a previously held position in contrast with seeking evidence from multiple perspectives to determine a position (Table 4). (For a detailed description of coding criteria for all five stages, please contact the authors.)

Coders were not aware of whether interviewees were participants in the ES series. Codes for the five stages were derived through consensus and stabilized as a formal rubric when the coders working independently were able to reach 90 percent agreement across all five dimensions of the MER for a subset of five students, at all three time points. Reliability of the rubric was demonstrated when a third newly trained coder achieved 90 percent agreement recoding transcripts for eight students, or 20 percent of the sample. Overall-stage scores were created by summing across the ratings assigned to the five different dimensions. Thus, if a student was coded at the highest stage possible across all five dimensions, his or her score would be 25 and his or her stage would be stage five, contextual knowing. It is important to note that stages are broad categorizations, placing students at relative points along a long and complex continuum of intellectual reconceptualization and

TABLE 4 Coding scheme overview for rating epistemological development

Absolute Knowing (External formulas)	Transition to Independent Knowing (Recognition of relativism)	Independent Knowing (Relativism)	Transition to Contextual Knowing (Recognition of context)	Contextual Knowing (Internal formulas)
Views knowledge as certain and knowable	Views knowledge as mostly certain but beginning to accept uncertainty	Views knowledge as increasingly uncertain; dissatisfied but lacks confidence in evaluating competing knowledge claims	Views knowledge as increasingly dependent on context; increasing confidence in evaluating knowledge claims	Views knowledge as contextual and is confident in ability to navigate different knowledge sources
Relies on select authorities as source of knowledge (instructors, parents, environment, deity, fate)	Yields to wider range of authorities as source of varied knowledge	Yields partially to select authorities; challenges others	Seeks evidence to support position; concept of "expert" and "expertise" may be naive	Seeks evidence without agenda; consults experts to provide perspective
Lacks internal basis for evaluating knowledge claims	Begins developing internal basis for evaluating knowledge	Exercises voice as relativism is adopted	Evidence sought to support position	Weight of evidence determines position
Perspectives defined externally	Recognizes relativism as an option but not yet adopting concept as own	Unwilling to move forward but unable to revert to previous stages of knowing Relativistic thinking eclipses all other ways of reasoning, especially when evaluating conflicting claims	Adopts knowledge claims through increasingly sophisticated internal processes Reverts to relativism when outside the familiar or when evidence challenges previously held knowledge claims	Internal belief system well developed via constructing, evaluating, and interpreting claims based on available evidence If no evidence is available, refrains from judgment

Source: Modified from Baxter Magolda, 1992, 2004b; Kuhn & Dean, 2004.

attainment: "Developmental patterns [should be] taken as prevailing winds, chart[ing] overarching similarities yet remain[ing] open for particularities across individuals" (Baxter Magolda, 2004a, p. 36).

The MER was employed because it authentically reflects the theory and methods that support the Learning Partnerships model. Because it is a semistructured measure that allows for open-ended responses, it is also time-consuming and labor-intensive to use. In addition, work by Bendixon and Rule (2004), Schraw (2001), and Duell and Schommer-Aikins (2001) has underscored the need for epistemological research to employ multiple measures in the same study. Thus, we incorporated Pizzolato's (2007a) quantitative Self-Authorship Survey in conjunction with the MER; however, its use was precluded because of an inability to achieve adequate reliability. These results may be limited by sample size; further research is warranted.

Results

External Evaluation of Instructional Delivery

Baxter Magolda served as the external reviewer to the ES series. Excerpts from her fourth-semester final report review the implementation of the Learning Partnerships model in the delivery of the ES course series:

> The structure of the session worked extremely well to spark discussion and move it forward. The student facilitators played an important role once the discussion began by asking the key questions, handling the overheads, and mediating discussion. I was very impressed with the seriousness with which they took this role, their initiative, and their ability to manage their classmates' discussion.
>
> The dialogue during the class was very rich. Students brought their own experience (everything from personal experience to research) quickly to the discussion. They were invested in the discussion, open about sharing their thoughts, and willing to respectfully question each other. They picked up on each other's ideas and invited each other into the discussion. They raised important questions and made important connections. Comments expressing concern about people's mind-sets about the earth, the issue of having children, and American responsibility in global issues and problems revealed that they read carefully and were exploring the content deeply. They are aware of their responsibility to connect with others and educate others, despite their plea for reading "happier" books!

> The class dynamics made for a productive learning environment. Students' learning styles were all validated—the woman who always had page numbers to go with her comments, the man who was highly pessimistic, those who offered a primarily emotional response, and those who offered research experiences were all respected. All perspectives were welcomed and connected in the goal to increase understanding. The overall learning environment I witnessed conveyed respect, a passion for learning, and curiosity.
>
> Overall, I was very impressed with the structure, dialogue, and dynamics of the class. The learning partnerships model was clearly in place and is paying important dividends! Observing this in action was a refreshing experience.

The two teaching experts established that faculty teaching the ES series had begun transitioning from teacher-centered to learner-centered practice. Their observations indicate that change in instructional practice is possible but challenging:

> I observed ES faculty move away from more traditional, banking method, stand-and-deliver teaching practices. The faculty began, tentatively at first, and then with more confidence and enthusiasm, to grasp the central tenets of learner-centered teaching. . . . [B]ecause the ES faculty instructors were so successful in employing learner-centered pedagogy, many of the ES students moved more quickly toward becoming self-reflexive, engaged, and independent learners. (expert #1)

> [I] observ[ed] that virtually everything the ES faculty did in their planning activity was in the service of giving more control and responsibility to students. . . . [A] number of times during these faculty discussions I was reminded . . . that implementing learner-centered pedagogy is harder than it looks. (expert #2)

Impact of ES on Epistemological Development and Differential Development of Dimensions

Year 1 Findings. Until the end of the ES students' second year of college, student responses on the MER yielded few significant differences between ES and comparison students on any of the five dimensions individually (role of learner, role of instructor, role of peer, evaluation of learning, and nature of knowledge) or overall (Tables 5 and 6). At Time 1 (fall term, beginning of

first year), entering first-year students in the ES group had an overall mean MER score of 10.15 (SD = 2.07), and those in the comparison group had a mean score of 9.61 (SD = 1.58), out of a possible score of 25 (t[17] = 0.92, n.s.). Inspection of ratings for the five dimensions shows a range of mean scores from 1.90 (SD = 0.42) to 2.15 (SD = 0.55) for the ES group and 1.73 (SD = 0.68) to 2.13 (SD = 0.50) for the comparison group (Table 6). Thus, despite some variation by dimension, scores for both groups at Time 1 hovered between stages 1 and 2 or between "absolute knowing" and "transitional to independent knowing." As such, this study replicates findings that indicate that students enter college with epistemologies that assume (1) the simplicity and consistency of factual knowledge and (2) authorities as the source of knowledge.

TABLE 5 Means, standard deviations, and standard errors for ratings of epistemological level on total Measure of Epistemological Reflection (MER) and individual dimensions for Earth Sustainability pilot and comparison group students

Epistemological Dimension	Collection Point	Comparison Group				Earth Sustainability Pilot Group			
		N	M[a]	SD	SE	*N*	M[a]	SD	SE
Role of Learner	Time 1	16.00	2.00	0.02	0.00	23.00	1.95	0.47	0.10
	Time 2	11.00	1.73	0.79	0.24	20.00	2.05	0.69	0.15
	Time 3	20.00	2.23	0.40	0.09	19.00	3.11	0.88	0.20
Role of Instructor	Time 1	16.00	1.87	0.34	0.09	23.00	1.90	0.42	0.09
	Time 2	11.00	1.64	0.92	0.28	20.00	2.00	0.56	0.13
	Time 3	20.00	1.89	0.55	0.12	19.00	2.68	0.75	0.17
Role of Peers	Time 1	16.00	1.87	0.50	0.12	23.00	2.15	0.55	0.11
	Time 2	11.00	1.64	0.81	0.24	20.00	2.15	0.49	0.11
	Time 3	20.00	1.72	0.63	0.14	19.00	2.63	0.68	0.16
Evaluation of Learning	Time 1	16.00	1.73	0.68	0.17	23.00	2.00	0.80	0.17
	Time 2	11.00	1.73	0.65	0.19	20.00	2.00	0.79	0.18
	Time 3	20.00	1.83	0.67	0.15	19.00	2.79	0.71	0.16
Nature of Knowledge	Time 1	16.00	2.13	0.50	0.12	23.00	2.15	0.62	0.13
	Time 2	11.00	2.45	0.82	0.25	20.00	2.15	0.75	0.17
	Time 3	20.00	2.28	0.63	0.14	19.00	2.95	0.85	0.19
Total MER	Time 1	16.00	9.61	1.58	0.40	23.00	10.15	2.07	0.43
	Time 2	11.00	9.18	3.52	1.06	20.00	10.35	2.72	0.61
	Time 3	20.00	9.95	2.19	0.49	19.00	14.16	3.15	0.72

[a]Based on a five-point developmental scale, with 1 = absolute knowing, 2 = transitioning to independent, 3 = independent knowing, 4 = transitioning to contextual, and 5 = contextual knowing.

TABLE 6 Independent-means *t*-tests on Earth Sustainability and comparison students' ratings on total Measure of Epistemological Reflection (MER) and by epistemological dimension

Epistemological Dimension	Collection Point	Mean		*t*	df
		Comparison	Earth Sustainability		
Role of Learner	Time 1	2.00	1.95	0.45	37
	Time 2	1.73	2.05	–1.19	29
	Time 3	2.23	3.11	–4.06**	37
Role of Instructor	Time 1	1.87	1.90	–0.23	37
	Time 2	1.64	2.00	–1.37	29
	Time 3	1.89	2.68	–3.79**	37
Role of Peers	Time 1	1.87	2.15	–1.65	37
	Time 2	1.64	2.15	–2.21*	29
	Time 3	1.72	2.63	–4.31**	37
Role of Evaluation	Time 1	1.73	2.00	–1.08	37
	Time 2	1.73	2.00	0.97	29
	Time 3	1.83	2.79	–4.43***	37
Nature of Knowledge	Time 1	2.13	2.15	0.09	37
	Time 2	2.45	2.15	1.05	29
	Time 3	2.28	2.95	–2.81**	37
Total MER	Time 1	9.61	10.15	0.88	37
	Time 2	9.18	10.35	1.03	29
	Time 3	9.95	14.16	–4.87***	37

* $p < .05$; ** $p < .01$; *** $p < .001$.

Uncertainty is tantamount to not knowing in this conception. As one entering first- year student explained, "I learn best in a class which focuses on factual information because I know that it is concrete information. I don't like walking into a class where the professor is teaching his opinion. I want the professor to be able to prove that what he is teaching is fact." Expanding on the role the instructor plays in the learning process, another responded, "You are always told to listen to your elders because they are wiser; and one might think, Who am I to question the professor?" Professors have authority because through years of experience they have learned the facts. After years of being taught that there are right and wrong answers on tests and assignments, entering students indicate

that they have internalized the message and are fully onboard to learn the correct answers from their expert instructors who can tell them what to learn.

Entering students also consistently indicated that in collegiate education, "learning is for getting a job." Thus, instructors and professors determine *what* students need to learn, while future career requirements determine *why* it is important to learn. It is not surprising that in this scenario entering students assume that as learners their responsibility is simply to march through a set of prescribed assignments. With so little sense of agency, students tend to believe that the evaluation of learning should reflect level of effort rather than performance. The following statement is representative of most first-year students we interviewed: "If you are working really hard and just having a hard time understanding the subject, you get bad grades; that isn't really your fault, so I think the time and effort you put into the course should be evaluated."

At Time 2 (spring term, end of first year), findings indicate that students' belief in the absolute certainty and stability of knowledge and of "expert" authorities as the source of knowledge remained largely intact. Means for the total MER scores were 10.35 (SD = 2.72) and 9.18 (SD = 3.52) for ES and comparison groups, respectively (Table 6). Independent-samples *t*-tests failed to show significant differences between the ES and comparison groups' overall scores (Table 6), and only one significant between-group difference was found on individual epistemological dimensions. By the end of the first year, differences between the ES and comparison groups' responses relating to the "role of peers" dimension did achieve significance, with ES students scoring significantly higher; however, this difference was due largely to a decrease in the comparison group's rating of role of peers from Time 1 to 2, rather than an increase in ES student scores (which had been somewhat higher than comparison groups' scores since the outset of the first year).

Year 2 Findings. The effects of the ES program largely emerged over the course of the second year. Independent-means *t*-tests conducted on ratings of ES and comparison students' epistemological stage indicate significant differences at the end of Time 3 (spring term, end of second year), with ES students outperforming comparison students on the overall measure and on all five individual dimensions (Table 6). Mean ratings for ES students' MER responses indicate that ES students were between stage 2 and stage 3 in terms of epistemological development; means ranged from 2.63 (SD = 0.68) to 3.11 (SD = 0.88) over the five individual dimensions, with a mean total score of 14.16 (SD = 3.15; Table 5). ES students were now largely "independent knowers," marking a transition to higher-order relativism. At the end of their second year, mean ratings for the comparison students ranged from 1.72 (SD = 0.63) to 2.28 (SD = 0.63)

on individual epistemological dimensions, with a total mean score of 9.95 (SD = 2.19). Means suggest that comparison students' epistemological constructions still reflected their reliance on external formulas, with only more nascent forms of relativism appearing, that is, "transitional to independent knowing."

It is possible that differences found at the end of the second year were due to differences in the comparison group at Time 3, with the addition of nine matched replacements. To assess this possibility, we repeated independent-means *t*-tests on Time 3 data including only those eleven comparison subjects who had been with the project since the beginning. With this longitudinal subset, significant differences were found between ES and comparison groups, with ES students again demonstrating higher levels of epistemological reasoning ($t[29] = 2.81$, $p < .01$). In summary, independent-mean *t*-tests were conducted on ES and comparison group ratings at three points in time: Time 1 = beginning of fall term, first year of college; Time 2 = end of spring term, first year of college; and Time 3 = end of spring term, second year of college. ES students' mean ratings of epistemological thinking were significantly higher only at Time 3.

To further investigate the possibility of developmental differences, we again restricted analyses to those students with complete data for all three data-collection time periods and conducted repeated-measures analyses of variance on each of the five MER dimensions and the overall MER score (Table 7). Time (or development) was the within-subjects factor, and Group (comparison group or ES, dummy coded as 0 and 1, respectively) was the between-subjects factor. The interaction of Group by Time was of particular interest, as a positive interaction of the two factors would suggest that the ES series had a greater effect on epistemological development than the traditional general education curriculum taken by comparison students.

Results show a significant main effect of Time (or development) on the repeated measures for all five dimensions and the total MER ($p \leq .001$). The only main effect found for Group was for "role of peers" ($p \leq .01$), a finding consistent with earlier *t*-tests. Significant Group-by-Time interactions were found for "role of learner" ($p \leq .001$), "evaluation of learning" ($p \leq .006$), "nature of knowledge" ($p \leq .003$), and total MER score ($p \leq .001$), with ES students attaining a significantly higher level of epistemological development in their second year than comparison students. Whether findings are examined longitudinally or as a series of *t*-tests on independent means, the pattern of findings remains the same and indicates, albeit with a relatively small sample, the positive effects of the ES curriculum and pedagogy on epistemological growth.

While quantitative analyses confirm the impact of the ES curriculum and pedagogy on students' epistemology, it is informative to hear what ES

TABLE 7 Repeated-measures analyses of variance on effects of development (time) and group (Earth Sustainability/comparison) on students' ratings of epistemological development

Epistemological Dimension	Within-Subjects Factor—Time				Between-Subjects Factor—Group				Interaction—Time × Group			
	SS	*F*	df	Significance	SS	*F*	df	Sig.	SS	*F*	df	Significance
Role of Learner	9.81	24.42	2, 29	$p \leq .001$	3.07	3.76	1, 29	n.s.	3.79	8.88	2, 29	$p \leq .001$
Role of Instructor	4.75	10.27	2, 29	$p \leq .001$	2.94	3.89	1, 29	n.s.	1.28	2.78	2, 29	n.s.
Role of Peer	2.11	5.51	2, 29	$p \leq .007$	5.83	6.84	1, 29	$p \leq .01$	0.51	1.33	2, 29	n.s.
Evaluation of Learning	5.06	16.38	2, 29	$p \leq .001$	2.19	1.54	1, 29	n.s.	1.73	5.59	2, 29	$p \leq .006$
Nature of Knowledge	4.01	10.56	2, 29	$p \leq .001$	0.00[a]	0.002	1, 29	n.s.	2.5	6.78	2, 29	$p \leq .003$
Total Measure of Epistemological Reflection	118.49	29.79	2, 29	$p \leq .001$	54.66	2.95	1, 29	n.s.	41.69	10.48	2, 29	$p \leq .001$

[a]Value less than 0.01.

students say. The developmental progression we observed quantitatively is also captured with transcript data from interviews. In the second year, changes in epistemology could be heard in the distinction students began to make between knowing and knower and the assumption of a less authoritarian, more relativistic perspective on the knowledge construction process. In the emerging relativism of second-year students' worldviews, the instructor's absolute claim on knowledge diminishes and access to knowledge is shared:

> It's all relative. We learn things in different ways and have different beliefs. Obviously in some subjects, there is a fair amount of certainty, while in others there's much room for debate. The professor might not even necessarily believe what he or she is teaching but, rather, is giving a different perspective.

> I think that can all be a matter of opinion. None of us were alive in the 1700s, so no one can be fully sure of what happened. One professor may lean more on believing an unpopular view of history, but as a student you have to know for his exam to write what he wants to hear.

Faculty retain some privilege over knowledge, but their authority is now derived from outside sources such as the "certainty" of the disciplinary area, pedagogical practice, or simply being the one who gives the tests.

As students moved on, they referenced the greater logic of one argument over another or the preponderance of the evidence on one side of an argument as *criteria for greater knowledge*. As one comparison student put it, "The explanation I would believe is the one that is most closely related to my understanding. In a physics class, we were discussing string theory. The instructor provided a different understanding than one of the well-versed students. Since the student's reasoning seemed more logical, I followed his understanding to arrive at the common theory." Another student from the comparison group articulated the importance of supporting evidence: "If all scientific evidence backs up one person's view and another totally has no support, one can be sure that the reason the evidence backs up one view is because it is the truth, and the other is false and therefore does not need to be weighed when accepting the first explanation."

As the quantitative findings indicate, it is at this juncture that ES and comparison students part ways epistemologically. Analysis of student responses suggests that having distinguished between knower and knowing, ES students began to conceptualize a more organic relationship between the two, viewing them as co-evolving. In this scenario, the role of learner is quite different; it is

more self-conscious and empowered, challenged by the constraints of knowledge rather than limited by them:

> I, by no means a scientist, was able to gather . . . data to update my knowledge regarding the latest research on polyvinyl chlorides. While the results of the research regarding potential effect were disturbing, I was empowered by the fact that I now know the impacts of the chemical rather than being a blind consumer. Writing the chemical report showed me that I did not have to rely on Steingraber's account but, rather, could create my own. I once felt limited and helpless in my ability to obtain information, yet I now feel truly empowered and compelled to be a responsible and informed consumer.
>
> Some information is more reliable or empirically proven. Some people are guided more by emotions, values, and/or past experiences. These kinds of influences on interpreting information are important to acknowledge and understand. However, value-based information can be extremely biased, and analysis of information will give a clearer picture. I'd check out the resources at the library. I know how to navigate a few of the databases. I know how to find peer-reviewed papers in a number of different fields. I was curious about the consequences of using birth control and checked out some papers from Medline. I understand that a lot of research is constantly changing and restructuring conclusions. I keep my eyes and ears open . . . and a grain of salt handy. Look at as many peer-reviewed sources as possible. As my great grandfather always said, "Only fools are positive."

ES students were able to articulate that as learners they had to be "accountable" for their own learning. Moreover, ES students were able to reflect on the kinds of changes that had taken place; they were aware of the active role they needed to take as learner. For example, ES students talked about "cross-referencing knowledge from different courses and feeling more connected and intrigued as a result." Consistent with this observation, we saw a change in students' perceptions of how learning should be evaluated and the very nature of knowledge. ES students now indicated that their work should be evaluated by some combination of individual, peer and faculty assessments and that together they should decide whether their work was "up to par." They indicated that evaluation should encourage students to continue to learn and improve and not simply reflect hard work and completion of assignments.

Additionally, ES students became more comfortable with knowledge as fundamentally dynamic and uncertain but not unattainable. They recognized

that attaining knowledge and becoming a knower required a substantial commitment on their part and that their role in a community of learners was integral to that process. As one student put it, "Proof does not exist, only different levels of confidence. Therefore, acceptance is only tentative in all cases. If levels of confidence with regard to information change, then one's acceptance of that information should change as well." Finally, the ES students began to see that the ephemeral nature of knowledge should not be used as a rationale for the kind of intellectual agnosticism expressed at the earliest phases of relativistic epistemology. Just as the learners must assume responsibility for finding evidence and weighing arguments, they must be able to commit to the validity of some ideas and values over others: "If enough peer-reviewed articles and respected scholars say something is so, it's probably safe to agree. However, I understand that sometimes even the really, really, really, really smart people of the world can be wrong—and lots of them can be wrong together. It's important to question everything, but it is necessary to believe in something once in a while."

Student Retention

Student retention is a critical outcome in any study of major curricular change and most especially in freshman and sophomore years, when attrition is highest. Students in the ES series are more likely to stay in school than their counterparts. Of the twenty-three first-year students enrolled in the first cohort in fall 2004, nineteen completed the series in spring 2006 (83%). By spring 2008, all twenty-three students who began the series had graduated from university, compared with a 78 percent graduation rate overall.

Discussion

The present study contributes to a growing body of literature suggesting that it is possible to reshape general education according to more constructivist principles and practices and that these practices encourage epistemological development. In our evaluation of the Earth Sustainability course series we were able to demonstrate that (1) a general education experience based on the constructivist Learning Partnerships model can be effectively delivered, even at a large, public research university; (2) a general education program founded on the Learning Partnerships model does, in fact, enhance epistemological growth in the first two years of college; and (3) some dimensions of epistemological development advance before others. The significance of these findings is supported by the findings of other researchers who show that higher levels of epistemological

development are associated with more complex and effective metacognitive skills, with critical and scientific thinking, and with school achievement (e.g., Hofer, 2004; Hofer & Pintrich, 1997; Klaczynski, 2000; Kuhn, 1999; Schommer, 1993; Schraw, 2001; Trautwein & Ludtke, 2007).

The ES course series redefined the goals of general education to make epistemological growth foundational to the attainment of more specific thinking skills and content mastery. This meant that the curriculum and pedagogy were intentionally designed to make students self-conscious about their learning and to promote better learning skills or "learning to learn." In so doing, students and instructors had to abandon transmission-based models of course delivery and redefine the roles of student-learner, peer-learner, and instructor-facilitator in the learning process. By comparing students in the interdisciplinary ES program with students participating in the traditional distribution-based general education program, we were better able to separate out educational and developmental effects and show that a spiraling curriculum and constructivist pedagogy can accelerate the rate of epistemological development beyond the small but measurable impact that college typically produces (Hofer, 2001).

This study found a significant main effect of Time (or development) on students' epistemological growth overall and across all five dimensions, regardless of group status. Thus, epistemological change seems to be fundamental to the metamorphosis most college students undergo. However, a significant Time-by-Group interaction on the overall Measure of Epistemological Reflection indicates a significant difference in the two groups' epistemologies by the end of the second year. Significant Time-by-Group interactions on three of the five epistemological dimensions suggest that development may be uneven and some epistemological assumptions may precede others.

It was not until the second year that the ES group appeared to show the differential effects of their experience and moved to more sophisticated levels of relativism. As documented in previous studies (Baxter Magolda, 1992; Belenky, Clinchy, Goldberger, & Tarule, 1986; Kitchener & King, 1981; Kuhn, 1999), as students begin to recognize that knowledge is constructed, they conclude that each person is therefore entitled to construct knowledge along whatever lines he or she sees fit, with each individual's ideas as good as another's. They cannot yet integrate differing perspectives into a new whole but, instead, tend to use other's views as a touchstone to strengthen weaknesses in their own arguments and opinions. With time, ES students moved from mere tolerance of different viewpoints to an appreciation with some assimilation of them. At this stage, students recognize that knowledge is constructed through the contributions of

many people but still assume personal responsibility for seeking the view that most broadly and coherently explains the available evidence.

By dividing the last stage of contextual development in two, we were able to better distinguish specific changes in developmental thinking structures and more accurately calibrate the advance that ES students demonstrated relative to both the comparison group and their own earlier epistemology. Having said this, it is important to note that there was a full stage difference in the epistemologies of ES and comparison students. Thus, between-group developmental differences did not depend on modifications in the coding scale made here but were robust by either a four- or a five-point metric. More specifically, students in the ES group experienced significantly more growth than comparison group students on three of the five epistemological dimensions: the role of the learner, evaluation of learning, and the nature of knowledge. No significant differences were found for the role of peers or the role of instructor. It is not surprising that students would begin to redefine their own role as learner before revising ideas about the role of others in the learning process. This is especially true given that the ES series required students to assume increasing responsibility for course administration and for specific course content. ES students were asked to actively reflect on their learning in assignments and discussion and explicitly tasked with finding and making connections among interdisciplinary materials. Thus, the students' pivotal role in constructing knowledge was underscored throughout the course series in a set of activities and procedures that departed radically from the traditional general education experience, whether core- or distribution-based.

Beliefs about how one knows and the nature of knowing would seem equally fundamental to other dimensions of epistemological change and the most immediate complement of reformulating one's identity as a knower. It is more difficult to explain why ES students would show slightly greater change in their ideas about how learning should be evaluated than in their construction of the "role of the instructor"—as the two would seem to go hand in hand given a teacher's role in student evaluation. In the case of "role of peers," there was a significant main effect of Group for this one epistemological dimension. That is, ES students were more likely to see peers as integral to the learning process at all three time points. While this suggests that there were some differences between the two groups a priori, the fact that ES and comparison groups did not differ on the other four epistemological dimensions until the end of the second year of college argues against attributing the developmental changes found simply to group bias. Nonetheless, it is possible that the greater openness of ES students to peer input may have interacted with the educational innovations in

the ES series. This possibility will need to be investigated in a future evaluation with a larger cohort of entering first-year students.

Conclusions

Amid calls for radical reform of higher education from outside the academy, there has been healthy skepticism from within regarding the feasibility and the educational effectiveness of constructivist-based pedagogies and curricula. Despite the study's limitation of sample size, its findings are significant and constitute a solid foundation for further inquiry. Additionally, the longitudinal nature of the data and the inclusion of a comparison group help argue that our findings provide an important "proof of concept" for the viability of alternative forms of general education—even at large public research universities with scarce dollars and entrenched disciplinary structures. We document the successful delivery of an interdisciplinary, two-year general education program based on the Learning Partnerships model—and with its delivery, greater epistemological development or the ability to "learn with understanding," which many now believe is the sine qua non of twenty-first-century education.

The two-year time frame was critical; it allowed students the time and practice necessary to coalesce the graduated learning experiences designed around a curricular spiral into a more meaningful whole. As might be expected, there were many logistical obstacles to crossing disciplinary and academic year boundaries and many cultural inhibitions to implementing a less didactic pedagogy, including the perceived cost of the program. There is also evidence that these barriers are surmountable and worth surmounting. This resonates with current national-level thinking around general education best practices, in particular those practices currently advanced in the literature by such respected organizations as the AAC&U (2007). Recent research conducted under the auspices of AAC&U identified ten high-impact educational practices (Kuh, 2008) that promote increased student retention and engagement in the undergraduate experience. That said, the author notes, "On almost all campuses, utilization of active learning practices is unsystematic, to the detriment of student learning" (Kuh, 2008, p. 9).

Arguably, Earth Sustainability incorporates several of these high-impact practices. It is a *learning community* that provides a *common intellectual experience* centered on a broad theme that combines several curricular and co-curricular options for students. Though not advertised as such, it serves as a *first-year experience* for students, one that places "a strong emphasis on critical inquiry, frequent writing, information literacy, collaborative learning, and other skills that develop students' intellectual and practical competencies"

(Kuh, 2008, p. 9). It incorporates activities such as *collaborative assignments and projects*, *service learning*, and aspects of *undergraduate research* projects in meaningful ways. Future research is needed to link the epistemological developments reported here to other aspects of cognitive growth and academic performance. In the interim, the current work suggests that innovations in general education can encourage students to become more reflective, active, and autonomous thinkers and learners.

While not insensitive to issues associated with the costs of programs like Earth Sustainability, we—to paraphrase Albert Einstein—question the efficacy of doing general education the same way over and over again while expecting different results for student learning. However, issues of cost overshadow the educational enterprise as never before and pose the all-important question of how we can afford to implement innovations that would seem to stress limited resources even further. In response, we cite the recommendations of AAC&U (2007) and others who argue that the cost of stagnation and ineffective practice in collegiate education is greater than the cost of change. This may be especially true as our student population continues to diversify with each passing year. Research into the efficacy of high-impact practices like Earth Sustainability demonstrates that such curricular innovations may help "level the playing field" (Kuh, 2008, p. 22) for first-generation, low-income, and historically underserved student populations. Too often, however, such programs are restricted by either policy or tradition to the select few (e.g., honors students) instead of the larger student population. For undergraduate education to have value beyond the student loan debt many if not most students now incur, it is incumbent upon colleges and universities to rethink existing curricula and course delivery mechanisms. It is always difficult to reshape long-standing institutional structures and traditions, but paradoxically the same fiscal stresses that challenge collegiate reform may ultimately help promote it, as shortfalls in current practice reveal its true costs.

Appendix

Measure of Epistemological Reflection (Baxter Magolda, 1992)

INSTRUCTIONS: The questionnaire that follows has to do with your perspective on learning in college. Each of the questions on the following pages asks for your opinion or choice on a given subject and the REASONS why you have that particular perspective or opinion. We are interested in understanding your perspective as fully as possible. Please give as much detail as you can to describe how you feel about each question. Thank you!

Today's Date:
Name:
Age:
Sex: Male Female
College Major:
Class Rank:
Father's Job:
Highest degree attained by father:
Mother's Job:
Highest degree attained by mother:

1. Think about a major decision you made in the last year about your education. What was the nature of the decision?
   1a. What alternatives were available to you?
   1b. How did you go about choosing among the alternatives?
   1c. What were the most important considerations in making your choice? Please give details.

2. As you begin your college career, it is appropriate to reflect on your past educational experiences. Thinking about all your courses, what is the *most effective learning experience* you have had in a college course in the last year? Be as specific as you can in describing this experience.
   2a. What did you learn that you will take away from the class?
   2b. Can you describe the instructor's teaching method and his or her style of interaction with students? Please be specific about the instructional methods and how they affected you as a learner.
   2c. What did these methods motivate you to do or not do?
   2d. Did these instructional methods change the way you learn in other classes or how you think more generally?
   2e. What part did you play in this learning experience?
   2f. How did your peers contribute to the learning experience?

3. Now think about the *least effective learning experience* you have had. Again, please be as specific as you can in describing this experience—
   3a. Can you describe the instructor's teaching method and his or her style of interaction with students? Please be specific about the instructional methods and how they affected you as a learner.
   3b. What did these methods motivate you to do or not do?
   3c. Did these methods change the way you learn in other classes or how you think more generally?
   3d. What part did you play in this learning experience?
   3e. What role did your peers play?

4. Some people think that hard work and effort will result in good grades in school. Others think that hard work and effort are not a basis for high grades. Do you share either of these opinions, or do you have another explanation for how people get high grades?
   4a. Ideally what do you think should be used as a basis for evaluating your work in college courses?
   4b. Who should be involved in the evaluation of student work? Why?
5. Sometimes different instructors give different explanations for historical events or scientific phenomenon. When two instructors explain the same thing differently, can one be more correct than the other?
   5a. When two different explanations are given for the same situation, how would you go about deciding which explanation to accept? Please give details and examples.
   5b. Can one ever be sure of which explanation to accept, and if so, how?
6. Students engaged in a class discussion discover soon after they start talking that they fundamentally disagree about the issue being discussed. At this point, what should the instructor do? Why?
   6a. What should the students do? Why?
7. If you could give advice to anyone on how best to succeed in college coursework, what kind of advice would you give him or her? Talk about what *you* believe is the key to doing well in college.
   7a. To what extent do you feel you can now act on your own advice?
8. Have you ever had to participate in a collaborative (i.e., group) project working with other students?
   8a. If yes, describe the most positive aspect of the *collaboration* on that project.
   8b. Describe the most difficult aspect of the *collaboration* and how you dealt with it.
   8c. In retrospect, would you do anything differently if you could do the project all over again?
9. Suppose you and a friend have strong but opposing religious convictions. Would you try and avoid the contentious issues or discuss them with your friend? Why or why not?

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