Abstract

In 2010 Michigan State University launched an undergraduate academic specialization (minor) in sustainability. Two distinct components mark this unique program: 1.) competency-based curriculum, and 2.) portfolio evidence and assessment. The program requires that students achieve wholeness and balance in terms of synthetic and integrative learning among the following eight competency areas, each denoted by a classification scheme: personal development, critical thinking, civic engagement, systems thinking, social equity, economic vitality, ecological integrity, and aesthetic understanding. Students must complete an introductory course, 11 elective credits, a practicum, and a portfolio capstone. The program illustrates how to embed accountability through the fostering and tracking of student learning outcomes (the learning paradigm) instead of using other metrics such as student enrollment, credit hours, and mere participation (instructional paradigm). Accordingly, the program represents calls for higher education institutions to embrace the learning paradigm approach.

Introduction

As evidenced by the growth of the Association for the Advancement of Sustainability in Higher Education (AASHE) and the number of journals publishing or focused on sustainability education, a steadily increasing number of colleges and universities offer programs and degrees in sustainability. However, little evidence exists of programs rooted in the learning paradigm that require students to achieve specific competencies evidenced through an electronic portfolio. In 2010 Michigan State University (MSU) launched an undergraduate academic specialization (minor) in sustainability. This article focuses on the implementation of this innovative undergraduate program in sustainability, which seeks to address calls to improve accountability in higher education learning outcomes.

Learning Paradigm

The U.S. National Academies' Division of Behavioral and Social Sciences and Education summarized the key factors in generating curricula that lead to valuable learning experiences: "an alternative metaphor for curriculum is to help students develop interconnected pathways within a discipline so that they 'learn their way around it' and not lose sight of where they are." This suggests that poor curriculum design produces knowledge and skills that are disconnected rather than organized into coherent wholes. While students might learn material from individual assignments and individual classes, they might fail to integrate the learning across assignments and classes. According to Bransford and co-authors,1 in order to succeed, a curriculum should include components that are learner-centered, assessment-centered, knowledge-centered, and community-centered.

Learner-centered environments provide opportunities for students to construct their own meanings based upon their understanding, beliefs, and cultural practices. The teacher provides bridging activities that lead from the student's past or current knowledge to new understanding. Such bridging activities can engage students in cognitive conflict that generates multiple viewpoints. Learner-centered environments shift the emphasis from teacher to learner and from teaching to learning.2 Institutions that embed this learning paradigm in their curricula can generate more emphasis, excitement, innovation and activity around learning by utilizing the following best practices:

- support students in pursuing their own goals,
- require frequent student performances,
- engage in frequent and ongoing feedback,
- assure a long time horizon for learning,
- provide for stable communities of practice, and
- align activities around the mission of producing student learning.3

Program Profile

Competency-Based Sustainability Specialization at Michigan State University

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Institutions, academic units (colleges, schools, departments), and programs committed to this learning paradigm would shift indicators from credits, grades, enrollment, and faculty time to learning indicators such as quantity and quality of learning outcomes and demonstrated knowledge and skills. Teachers within such programs would seek to foster every student’s competencies and talents.

To effectively foster education for sustainable development, higher education programs need to address the “problematics, promise, and practice” of sustainability within institutions by incorporating interactive approaches, engaged discourse, systemic learning, and whole-systems design. Education for Sustainable Development (ESD) shifts the focus from the traditional educational emphasis on teaching and inputs to achieving competencies. Competencies consist of discrete learning abilities, “simply put, competence can be defined as what the students will be more capable of doing after completing the learning activity. Competences are written as verbs, as the ability to do something” (p. 392). While some differences may exist in the structure and format of various efforts at fostering sustainability learning in higher education, many emerging efforts at synthesizing key sustainability competencies emphasize that “analytic skills should include systems thinking and synthesis in order to devise innovative solutions for pressing environmental problems.” For example, Wiek and Brundiers reviewed different sets of competencies in sustainability and grouped them into four categories: problem-oriented and conceptual knowledge, methodological knowledge, ability to “link knowledge to action, and interpersonal and collaborative skills.”

The need for students to think critically and systematically about sustainability problems is reflected in a breadth of sustainability education competency formulation efforts in the United States, including AASHE,16-18 Ruffolo Curriculum at Harvard University,19 and the Sustainability Forum of the American Association for the Advancement of Science (AAAS).20-22 Previous work often includes the importance of process competencies such as critical thinking, systems thinking, and civic engagement involving actual problems and stakeholders. However, while such synthetic compilations do a great job of reviewing previous efforts, identifying commonalities, selecting and parsing the most salient and pertinent dimensions, the compilations neither address how to infuse such process dimensions in the curriculum nor how to assess the competency of those learning about sustainability as reflected by Sterling, “to date, a sustainable education paradigm has been infrequently practised, particularly in mainstream formal education” (p. 525).

Overview of the Sustainability Specialization

The April 2010 approval of a new undergraduate specialization in sustainability at MSU provided an opportunity to address the UN Education for Sustainable Development (ESD) objectives by designing a curriculum that incorporates the scholarship of teaching and learning. The MSU program differs from existing programs at other institutions in its focus on student achievement of explicit competencies, achieved through a learner-centered paradigm assessed through evidence stored in portfolios. This competency-based approach using portfolios was designed to meet the recommendations for effective learning environments.

The program requires that students achieve wholeness and balance in terms of synthetic and integrative learning among the following eight competency areas, each denoted by a classification scheme: Personal Development (1.0), Critical Thinking (2.0), Civic Engagement (3.0), Systems Thinking (4.0), Social Equity (5.0), Economic Vitality (6.0), Ecological Integrity (7.0), and Aesthetic Understanding (8.0). The specific configuration of the competency approach makes explicit the interdisciplinary nature of sustainability by including competencies that form the basis for other disciplines and majors (social equity, economic vitality, ecological integrity, and aesthetic understanding), and focusing on learning outcomes as well as development of learners by including more process competencies (personal development, critical thinking, civic engagement, systems thinking). Each competency contains seven to eight learning tasks, with higher numbering representing more complex tasks according to Bloom’s Taxonomy.

For example, critical thinking has seven associated tasks numbered 2.1-2.7. While task 2.1 requires students to simply “define and explain critical thinking and the indicators one can use to identify critical thinking in the works of others;” task 2.6 requires students to develop a higher order task; “propose a plan of action to mediate multiple stakeholder concerns.” Students acquire and demonstrate competency through a required introductory course (ACR 187); 11 elective credits; a required field project experience that addresses research, outreach, internship, or teaching (ACR 387); and a required final defense of an academic portfolio (ACR 487) to a panel of faculty, staff, and community members.

Students must compile evidence that demonstrates a basic level of two to three learning tasks in each of the eight competencies and must achieve a total of five learning tasks in each of the following competencies: personal development, critical thinking, civic engagement, and systems thinking. Students
must also achieve an intermediate level of proficiency by achieving five learning tasks in each of the following competencies: social equity, economic vitality, ecological integrity, or aesthetic understanding. Lastly, students must achieve exemplary level by achieving seven to eight learning tasks in one of the following competencies: personal development, critical thinking, civic engagement, and systems thinking; and in one of the remaining competencies: social equity, economic vitality, ecological integrity, or aesthetic understanding. Students identify their elective credits and distribution of competency achievement in a plan of study developed in conjunction with the program director (Table 1).

Although any student may enroll into the introductory course, enrollment in the specialization is limited to students with majors in one of the six colleges that financially support the operation of the program: Agriculture and Natural Resources; Arts and Letters; Business; Natural Science; Social Science; and James Madison College. Current and former students (27 total) represent a range of majors with a plurality from packaging (33 percent), with much smaller representation (<10 percent each) from environmental economics and policy, environmental studies and agriscience, interior design, general management, hospitality business management, earth science, psychology, and urban and regional planning (Table 2). Most of the students reside in the

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College of Agriculture and Natural Resources (59 percent). As of July 2012, eight students have completed the program.

Coursework

**ACR 187 Introduction to Sustainability**

The MSU sustainability program offers sections of Introduction to Sustainability (ACR 187) each semester. The course meets twice weekly for 80 minutes each period with an average of 25 students enrolled each semester. On average students in ACR 187 represent 16 different majors across six different colleges. During the first week of class, students receive voluntary consent forms to acknowledge use of course material for educational research purposes as approved by the institutional review board (project number 03-651).

Each semester focuses on a class theme (for example, campus recycling or campus energy use) and partners with campus entities for student civic engagement projects. These projects require students to provide evidence of achievement of specific systems thinking and civic engagement competency such as:

- **Systems Thinking 4.7**: diagnose a problem, create an intervention/alternative system to address the problem; or, delineate alternative initial conditions that could lead toward a more sustainable state.
- **Civic Engagement 3.5**: Engage with a community, agency, or organization to work in collaborative and reciprocal ways for the common good through shared goals, resources, and expertise.

Projects must also involve an integration of all eight competencies. The project sequence involves visiting a campus site, developing an initial systems diagram based on the site visit, revising the diagram to include the student’s own social networks, conducting a subsequent whole class hands-on experience, developing a grant proposal that addresses the theme, and developing project materials and actions that contribute to addressing the theme. Students can work alone or in teams on the civic engagement project. Students present their ideas to project partners during the final exam portion of the course and submit written materials to the instructor for assessment.

In terms of student competency learning, every class assignment requires students to present evidence that addresses specific competency tasks among the eight competency areas. In sum, ACR 187 exposes students to 67 percent of the competency tasks required for the specialization. Upon faculty review of each assignment, each student receives feedback using a grading sheet that scores each competency task on a range from fails to meet expectation (0), approaches expectation (1), meets expectation (2), to exceeds expectation (3). Analysis of the assign-
ment scoring sheets enabled assessment of student competency learning.

**ACR 387 Sustainability Practicum**

Students must engage in a project in which they implement sustainability through research, outreach/service, teaching, internship, or creative performance. Regardless of the dimension, students must develop an initial project outline and a detailed project plan that includes a logic model and a description of how the project will address aspects of all eight competencies. Students do not meet in a classroom setting, but must provide weekly updates in the online class discussion board.

Through three semesters, students undertook a range of projects that addressed competency through corresponding learning tasks in which they conducted research in collaboration with MSU faculty related to: campus carpooling (Systems Thinking 4.3: Describe the role of leverage points and drivers in a specific system), Habitat for Humanity’s use of green building (Social Equity 5.4: Explain relationships between technology, environment, place, and time regarding social justice and equity), and consumer perceptions of sustainable packaging (Economic Vitality 6.2: Describe opportunity costs and trade-offs related to sustainability). Some students engaged in internships involving working with community gardens through the local food bank (Social Equity 5.2: Identify examples of both historically significant and current social justice issues and describe their relevance to sustainability), residential energy conservation with the local utility (Personal Development 1.3: Articulate one’s relationships with the local and global sustainability communities), software development for reducing greenhouse gases with a pharmaceutical company (Ecological Integrity 7.3: Describe a range of commonly used indicators of ecosystem integrity), and fair trade with a local retailer (Critical Thinking 2.4: Analyze the legitimacy claims of various stakeholders in a current sustainability issue). One student developed and helped implement a curriculum with a local elementary school teacher (Civic Engagement 3.5: Engage with a community, agency, or organization to work in collaborative and reciprocal ways for the common good through shared goals, resources, and expertise), while another designed and built a sculpture out of surplus materials (Aesthetic Understanding 8.6: Construct a sustainability project that is shaped by aesthetic values.). A list of students projects in 2011-2012 includes:

**Spring 2011**
- Recycling Awareness – MSU Surplus & Recycling Center (MSU Operations; intern)
- Sustainable Packaging Tool - GlaxoSmithKline (intern)
- Middle School Sustainability (Module)
- Recycled Materials (Sculpture)

**Fall 2011**
- Sustainable Hospitality Business Management Curriculum (faculty research)
- Sustainable Metroparks
- MSU Building Retrofit (MSU Office of Campus Sustainability grant application)
- EcoUnity Carbon Tracking and Offset System
- Consumer Perceptions of Sustainable Packaging (faculty research)
- Habitat for Humanity and Leadership in Energy and Environmental Design (LEED) Homeowner Education

**Spring 2012**
- Increasing Carpooling at MSU (faculty research)
- The Garden Project – Greater Lansing Food Bank (internship)
- Corporate Use of Tools for Sustainable Packaging
- MSU Residence Hall Water Conservation (MSU Operations) and Geocognition Research (faculty research)
- Board of Water and Light – Energy Optimization and Renewable Energy Project (outreach; intern)
- Kirabo Fair Trade Store
- Sustainable Supply Chain Solutions

**ACR 487 Sustainability Portfolio Capstone**

As with the Sustainability Practicum class, students do not meet in a classroom but submit their work online. Students must address a selection of 39 learning tasks (1.1, 2.2, 3.2, 4.1, etc.) across the eight competencies that they identify in their plan of study (Figure 1). Students can choose course material from their core sustainability classes, the electives they list on their plan of study, other courses, or other experiences. Many students choose to develop materials within their ACR 487 course experience itself. A student may submit one specific artifact (ACR 187 weekly assignment) for one specific competency task (e.g., 3.1). A student may submit multiple pieces of evidence (ACR 187 weekly assignment; ACR 387 power point presentation) for one specific competency task (e.g., 5.1). However, a single piece of evidence (ACR 187 weekly assignment) might qualify to submit for multiple competencies (e.g., 3.1 and 5.1).

For example one assignment in ACR 187 requires students to bring in an actual consumer product (or representation of a product such as an advertisement or photo) that reflects sustainability (positive or negative) and discuss the challenges of corporate sustainability efforts. One student discussed attempts at reducing the bulk in a particular medical packaging product. The evidence addressed issues of economic vitality and aesthetic understanding. Another student submitted a paper written about Monet’s painting *Waterloo Bridge*. The student reflected on the piece regarding the aesthetics of the coal pollution in London that was captured in the painting.

**Students must engage in a project in which they implement sustainability through research, outreach/service, teaching, internship, or creative performance.**
Beyond traditional course assignments students have submitted other informal learning artifacts. One student who served in the marching band submitted two videos of band performance contrasting two different bands and explaining how they illustrated Aesthetic Understanding 8.1 (Describe some common indicators of aesthetic quality). Another student submitted a video of diversity awareness training conducted while a mentor in the residence halls, which addressed both Personal Development 1.1 (Describe one's self, identity(ies), values, and worldview) and Social Equity 5.1 (Identify and describe key examples of how individuals and social groups experience inequality). For more advanced competency tasks students have submitted software programs developed to track greenhouse gas emissions while working on a pharmaceutical company internship (Systems Thinking 4.7: Diagnose a problem, create an intervention/alternative system to address the problem, or, delineate alternative initial conditions that could lead toward a more sustainable state; and Ecological Integrity 7.7: Propose a plan to address the roles of an actual threat to ecological integrity). Another student developed a business plan for a company to track voluntary individuals, carbon footprint and charge them as an offset for their emissions, as occurs when some people make airline reservations. The company would then use the fees to fund local carbon mitigation efforts in the community where the individual resides (Economic Vitality 6.8: Develop a plan to address a specific sustainability issue that demonstrates multiple perspectives of economic vitality and how they affect resource allocation.) As with each required course, students conclude their capstone with a campus presentation.

Conclusion

The MSU sustainability specialization represents the learning paradigm by focusing on concrete evidence of students’ learning as represented by the eight competencies and their corresponding learning tasks. Students have the freedom to submit their choice of artifact in their preferred medium and also to determine which learning task to correlate with their selected artifact. To complete the specialization students can submit their evidence for review at any time; there is no limit on the frequency of submission upon receipt of faculty feedback. This approach opens space for a larger range of evidence that confirms learning and a broader selection of artifacts that can be used to substantiate sustainability topics. In addition to meeting the principles of the learning paradigm, the program also represents the new set of assumptions for the education sector based on sustainable living systems suggested by Gould:27

1. Generative-centered learning allows for the development of the intrinsic interest of students.
2. Learning is based on the diversity of intelligence and styles.
3. Understanding is manifested through demonstration rather than obtaining the right answer on a static test.
4. Conversations are inclusive among all who are involved in the learning process.
5. Education is a vital part of the web of social relationships that link people and communities together.
6. Information technologies can be utilized to enhance the development of new relationships among different disciplines, leading to the development of a sense of one’s place within the ecosystem.

While our assessment of the current program is the subject for another article, we invite readers to utilize the competencies and the corresponding learning tasks and share with us their experiences in fostering sustainability learning across a range of academic and nonacademic sustainability education programs.

References


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