

Integrating ePortfolios into Sustainability Education

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Given the importance of applied learning and skills needed in sustainability education, this study sought to explore how electronic portfolios enable students to provide a range of evidence to demonstrate their sustainability learning. Michigan State University developed an undergraduate minor on sustainability that required students to provide portfolio evidence of learning in eight required competency areas. Analysis of portfolio contents during 2011-2013 demonstrates that students most frequently addressed Ecological Integrity and Civic Engagement competencies and least often submitted evidence that addresses Personal Awareness and Aesthetic Understanding. In terms of sources of evidence, students most often submitted evidence from their required sustainability capstone and practicum courses, followed by elective academic courses and the required introductory course. Students least often provided evidence from non-curricular experiences. A major drawback to the approach was a student tendency to wait until the final semester to work on the portfolio. Given the change in pedagogy and approach from the standard institutional practice, students would have benefitted from a more structured and formal portfolio orientation program.

Education for Sustainability

Education for Sustainable Development, a global movement, has as its central concept the aim of facilitating the acquisition of knowledge, skills, and values to enable people to participate in local and global decision-making that will improve the quality of life now and not damage the planet for the future. (Glover, Jones, Claricoates, Morgan, & Peters, 2012, p. 76)

The United Nations designated 2005 to 2014 as the Decade of Education for Sustainable Development (ESD), which “aims to help people to develop the attitudes, skills and knowledge to make informed decisions for the benefit of themselves and others, now and in the future, and to act upon these decisions” (United Nations Education Science and Cultural Organization, 2012, para. 1). The United Nations ESD effort strives to: (a) foster monitoring and evaluation; (b) encourage a research agenda and serve as a forum for relevant research on ESD; and (c) share good ESD practices. Given the need to design, test, document, assess, and improve the knowledge and performance of education for sustainability programs (Barth & Thomas, 2012), as presented in the U.N. Decade of Education for Sustainable Development, this study sought to explore how electronic portfolios enable students to provide a range of evidence to demonstrate their sustainability learning.

To foster education for sustainable development effectively, higher education programs need to address the problematics and promise of sustainability within institutions by incorporating interactive approaches, engaged discourse, systemic learning, and whole systems design (Corcoran & Wals, 2004). Education for Sustainable Development shifts the focus from a

traditional educational emphasis on teaching and inputs toward achieving competencies (Anderberg, Nordén, & Hansso, 2009; Barth & Michelesen, 2013): “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” (Mochizuki & Zinaida Fadeeva, 2010, p. 392). A difference exists between the concept of a competency viewed in terms of a learning outcome or skill and the concept of competence viewed as an accomplished level of proficiency capable of high performance. This paper discusses the former and not the latter.

Several efforts identify a range of important competencies that sustainability education programs should consider as learning outcomes (Anderberg et al., 2009; Barth & Michelesen, 2013; Higher Education Partnership for Sustainability [HEPS], 2004; Mochizuki & Zinaida Fadeeva, 2010). However, such synthetic compilations address neither how to infuse such process dimensions into the curriculum nor how to assess the competency of those learning about sustainability (Glover et al., 2012; Karlin, Davis, & Matthew, 2013; McKeown, 2011; Yousey-Elsemer, Keith, & Ripkey, 2010), as Sterling (2010) notes: “To date, a sustainable education paradigm has been infrequently practised, particularly in mainstream formal education” (p. 525). This occurs despite an admonition to utilize a learner-centered approach in sustainability education (HEPS, 2004). Similarly, a recent call has encouraged education for sustainability researchers to develop a more focused synthetic agenda, as reflected in two overarching questions: first, “how is sustainability implemented in the curriculum, and second, how and under what circumstances do students develop the necessary capabilities to contribute to a more sustainable future?” (Barth & Thomas, 2012, p. 9). Despite the growth of

sustainability programs, a lack of program assessment appears in the literature (Glover et al., 2012; Karlin et al., 2013; McKeown, 2011; Sterling, 2010; Yousey-Elsemer et al., 2010).

ePortfolio Assessment

The rise in sustainability education efforts falls within the larger context of United States higher education, which includes greater attention to accountability and assessment in higher education (Arum & Roksa, 2010; Hacker & Dreifus, 2011; Schneider, 2012). To provide more effective assessment-centered environments, educational programs should provide frequent and ongoing feedback in order to expose students' thinking and understanding in a variety of modes.

To better address more holistic and authentic approaches to learning assessment, electronic portfolios have gained attention particularly within the Association of American Colleges and Universities (AAC&U). Terrel Rhodes (2010a), the Vice President for Quality, Curriculum, and Assessment for AAC&U, stated that the use of "electronic student portfolios recognizes that learning occurs in many places, takes many forms, and is exhibited through many modes of representation" (p. vi) and that "electronic portfolios have emerged as a powerful means for deepening student learning and for demonstrating achievement of the broad set of essential learning outcomes needed by today's students" (p. viii-ix). Importantly, ePortfolios "offer insight into the process by which students learn, rather than just an end product" (Chen & Penny Light, 2010, p. 3). In particular, a portfolio serves as an appropriate and unique assessment tool that "captures evidence of student learning over time—in multiple formats and contexts—documents practice, and includes a student's own reflection on his or her learning" (Chen & Penny Light, 2010, p. 1). Portfolios also encourage students to represent and integrate their formal and informal learning experiences (Chen & Penny Light, 2010; Peet et al., 2011; Richards-Schuster, Ruffolo, Nicoll, Distelrath, & Galura, 2014). This provides a much richer explanation of learning than grades, credit hours, and transcripts (Chen & Penny Light, 2010; Schneider, 2012; Tagg, 2003).

Academic Program Overview

To integrate best practices in portfolio learning and sustainability education and to enable assessment over a long temporal horizon (Tagg, 2003) and across multiple modalities, Michigan State University launched a 2010

minor in sustainability that centers assessment on the use of portfolios (Habron, 2012).

Learning Outcomes and Competencies

As suggested by best practice in curricular (Wiggins & McTighe, 1998) and portfolio design (Chen & Penny Light, 2010), the program is based on specific learning outcomes (Chun, 2010; Fink, 2009) in the form of competencies required for sustainability learning. The program requires that students achieve wholeness and balance in terms of synthetic and integrative learning among the following eight competency areas: (a) Personal Development, (b) Critical Thinking, (c) Civic Engagement, (d) Systems Thinking, (e) Social Equity, (f) Economic Vitality, (g) Ecological Integrity, and (h) Aesthetic Understanding (Habron, 2012; Michigan State University, 2014a). The specific configuration of the approach makes explicit the interdisciplinary nature of sustainability by including content-based competencies that form the basis for disciplines and majors (Social Equity, Economic Vitality, Ecological Integrity, and Aesthetic Understanding), the focus on learning outcomes, as well as development of learners in terms of more process-based competencies (Personal Development, Critical Thinking, Civic Engagement, Systems Thinking). The competencies represent a mix of outcomes across a range of domains (foundational knowledge, caring, application, integration, learning how to learn, human dimension) that provides greater likelihood of producing significant learning experiences in which students are engaged, in which student effort produces significant and lasting learning, and in which the learning produces added value (Fink, 2009).

The integrative learning required for sustainability (Karlin et al., 2013) and the specific sustainability program matches well the kinds of integrated knowledge assessment befitting a portfolio approach (Peet et al., 2011). Each competency contains seven to eight learning tasks, with higher numbering representing more complex tasks according to Bloom's Taxonomy (Michigan State University, 2014a). For example, critical thinking has seven associated tasks, numbered 1-7. While the first critical thinking task (CT-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," the sixth and more advanced critical thinking task (CT-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 Introduction to Sustainability), 11 elective credits, a required field project experience that addresses research, outreach,

internship, or teaching (ACR 387 Sustainability Practicum), and a required final defense of an academic portfolio to faculty, staff, students and community members (ACR 487 Sustainability Portfolio Capstone). Students can achieve program level outcomes through core courses and electives, as well as through non-curricular ways. As emphasized during student advising sessions, academic courses comprise just a subset of the total learning opportunity space.

Student Choice

To complete the program, 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 process competencies: Personal Development, Critical Thinking, Civic Engagement, and Systems Thinking. Students must achieve an intermediate level by achieving five learning tasks in one of the content competencies: Social Equity, Economic Vitality, Ecological Integrity, or Aesthetic Understanding. Lastly, students must achieve an exemplary level by achieving all seven to eight learning tasks in one of the following process competencies (Personal Development, Critical Thinking, Civic Engagement, and Systems Thinking) and one of the remaining content 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.

Students can choose portfolio material from their core sustainability classes, the electives they list on their plan of study, courses from their major field of study, other courses, or other experiences. Many students choose to develop materials within their ACR 487 Sustainability Portfolio Capstone course experience itself. A student may submit one specific artifact (e.g., ACR 187 Introduction to Sustainability weekly assignment) for one specific competency task (e.g., Civic Engagement-1). A student may submit multiple pieces of evidence (ACR 187 Introduction to Sustainability weekly assignment; ACR 387 Sustainability Practicum power point presentation) for one specific competency task (e.g., Social Equity-1). However, a single piece of evidence (ACR 187 Introduction to Sustainability weekly assignment) might qualify for multiple competencies (e.g., CE-1 and SE-1).

Based on the work of Marie Eaton at Western Washington University, students must provide reflections on each piece of evidence and each competency that discusses how the evidence meets the competency and describes the learning experience in

four domains: intellectual development, skill building, affective development, and integration/judgment.

Methods

While multiple components of the ePortfolio process exist (nature of learners, external uses of evidence, role of stakeholders, etc.), this article seeks to focus on exploring the nature of the evidence that students use. This aligns with the belief that portfolio assessment should explore the many places, forms, and modes of learning that students utilize (Rhodes, 2010a).

Participants

Thirteen students (nine female, four male) completed the program as graduating seniors during 2011 to 2013. While six students majored in Packaging, the remaining seven students were evenly distributed across Earth Science, Environmental Studies and Applications, Geography, General Management, Hospitality Business, Psychology, and Technology Systems. Participants all stated that they were 18 years or older, and protocols were established through the Michigan State University Institutional Review Board, where the study was declared exempt (IRB# x03-651).

Research Design

The portfolio analysis addressed the following research questions:

1. Which competencies were most frequently addressed in the ePortfolios?
2. What sources of learning evidence did students utilize in their ePortfolios?
3. What kinds of evidence of learning did students submit in their ePortfolios?

The program director tracked each student submission using electronic review spreadsheets. Data included the target competency, whether the competency was required or in the student's plan, the source of evidence submitted for review, submission date, assessment date, pass/fail status of submission source of evidence, and program director feedback.

Measures

The program director assessed student achievement of competency tasks by utilizing rubrics based on the Critical Thinking Value Rubric produced and developed by the Association of American Colleges and Universities (2014; Rhodes, 2010b). The rubric utilized five criteria for assessing critical thinking in terms of suitable and sufficient evidence, explanation,

context and assumptions, student position, and conclusion. Students were required to meet the capstone level on each criterion to achieve successfully the competency learning task. The capstone rubric descriptors are as follows:

- Explanation: Issue/problem to be considered critically is stated clearly and described comprehensively, delivering all relevant information necessary for full understanding.
- Evidence: Information is taken from source(s) with enough interpretation/evaluation to develop a comprehensive analysis or synthesis. Viewpoints of experts are questioned thoroughly.
- Influence of context and assumptions: Thoroughly (systematically and methodically) analyzes own and others' assumptions and carefully evaluates the relevance of contexts when presenting a position.
- Student's position (perspective, thesis/hypothesis): Specific position (perspective, thesis/hypothesis) is imaginative, taking into account the complexities of an issue. Limits of position (perspective, thesis/hypothesis) are acknowledged. Others' points of view are synthesized within position (perspective, thesis/hypothesis).
- Conclusions and related outcomes (implications and consequences). Conclusions and related outcomes (consequences and implications) are logical and reflect student's informed evaluation and ability to place evidence and perspectives discussed in priority order.

Procedure

Students submitted portfolio evidence for each corresponding competency through an online course management system or an electronic portfolio platform. Students received a rubric score and feedback on each submission (Figure 1). Students were able to revise and resubmit until their submission met the capstone level for all five critical thinking criteria for each competency task they sought to achieve. Every submission was included regardless of whether the submission achieved a passing status.

Data were collected by reviewing and summarizing the portfolio review sheets for each student. Counts were made of the source of the evidence and the kind of evidence utilized. Categories of curricular sources of evidence included the three required program courses, a student's major field of study, elective courses, and study abroad. Non-curricular sources of evidence

emerged from participation in student organizations, work, community service, or career preparation materials such as resumes, cover letters, and graduate school applications. Because students could submit more than one piece of evidence for each competency or could use one piece of evidence to address multiple competencies, depending on the variable, data were analyzed either in terms of number or percent of individual student submissions, or in terms of the total number of submissions (regardless of student). This descriptive content-analysis study provides no statistical analysis and makes no claims of generalizability beyond the program.

Results

Research Question 1: Which Competencies Were Addressed Most Frequently in the ePortfolios?

As indicated in Table 1, students most frequently chose to submit more evidence for the highest levels of Ecological Integrity (7/13 students) and Civic Engagement (6/13) and were less likely to submit evidence for higher levels of Personal Awareness and Development (1/13) and Aesthetic Understanding (1/13). Very little variation occurred at the highest level among the process competencies (Personal Development, Critical Thinking, Civic Engagement, and Systems Thinking), with only Personal Development serving as an infrequent submission. However, submissions appeared more skewed among the content competencies (Social Equity, Economic Vitality, Ecological Integrity, and Aesthetic Understanding), with Ecological Integrity serving notably as a very high frequency submission at the highest level.

Research Question 2: What Sources of Learning Evidence Did Students Utilize in Their ePortfolios?

Of the 13 students completing the sustainability minor, students most often populated their portfolios with evidence from academic rather than non-academic sources (Tables 2 and 3). As indicated in Table 2, students most frequently utilized evidence from their ACR 487 Sustainability Portfolio Capstone class (13/13 students), ACR 387 sustainability practicum (12/13), other electives (11/13), or ACR 187 Introduction to Sustainability (9/13). An example of capstone coursework materials includes an analysis of the gender representation in a student's professional field that was inspired by an internship. Another student submitted a conceptual graphic from the student's practicum experience developing sustainable packaging materials at a corporation that described the balance needed between economic cost and environmental gain from developing more sustainable packaging systems. A minority of students (6/13) submitted evidence from their academic majors.

Figure 1
Example of Completed Rubric Score

Assessment:

	Benchmark 1	Milestone 2	Milestone 3	Capstone 4
Explanation of issues Value: 3.00	Issue/ problem to be considered critically is stated without clarification or description.	Issue/ problem to be considered critically is stated but description leaves some terms undefined, ambiguities unexplored, boundaries undetermined, and/ or backgrounds unknown.	Issue/ problem to be considered critically is stated, described, and clarified so that understanding is not seriously impeded by omissions.	Issue/ problem to be considered critically is stated clearly and described comprehensively, delivering all relevant information necessary for full understanding.
Evidence - Selecting and using information to investigate a point of view or conclusion Value: 3.00	Information is taken from source(s) without any interpretation/ evaluation. Viewpoints of experts are taken as fact, without question.	Information is taken from source(s) with some interpretation/ evaluation, but not enough to develop a coherent analysis or synthesis. Viewpoints of experts are taken as mostly fact, with little questioning.	Information is taken from source(s) with enough interpretation/ evaluation to develop a coherent analysis or synthesis. Viewpoints of experts are subject to questioning.	Information is taken from source(s) with enough interpretation/ evaluation to develop a comprehensive analysis or synthesis. Viewpoints of experts are questioned thoroughly.
Influence of context and assumptions Value: 3.00	Shows an emerging awareness of present assumptions (sometimes labels assertions as	Questions some assumptions. Identifies several relevant contexts when presenting a position. May be more aware of	Identifies own and others' assumptions and several relevant contexts when presenting a position.	Thoroughly (systematically and methodically) analyzes own and others' assumptions and carefully evaluates the relevance of contexts

Comment:

Good, but you need to provide some Evidence for each of the systems thinking competencies (4.4-4.7) in terms of how community gardens operate as depicted in your diagram are explained. So provide some evidence for pests, for irrigation as leverage, etc. Perhaps a web page or a reference is all you need.

Comments

Comments may be used to provide additional feedback and suggestions.

Table 1
Frequency of Students that Addressed Each Level (1-8) of Each Competency

Level	Personal	Critical	Civic	Systems	Social	Economic	Ecological	Aesthetic
1	13	11	12	13	13	10	12	13
2	12	13	12	12	12	12	11	13
3	12	12	12	11	8	10	13	7
4	11	12	11	12	6	1	8	8
5	12	12	13	12	5	2	8	1
6	1	4	6	4	2	3	8	1
7	1	4	6	3	2	2	7	--
8	--	--	--	--	--	1	--	--

Table 2
The Percentage (%) of Portfolio Submissions by Curricular Source for Each Student

Student	ACR 187	ACR 387	ACR 487	Major	Elective	Study abroad
1	0	10	24	5	59	0
2	21	0	29	18 ^a	13	0
3	0	79	21	0	0	0
4	30	22	9	0 ^a	36	2
5	12	15	36	0	22	15
6	13	4	53	7	7	2
7	0	40	36	0 ^a	8	0
8	0	24	58	3 ^a	15	0
9	5	49	17	15	5	5
10	6	40	8	0	33	0
11	58	27	4	0 ^a	11	0
12	20	18	2	7 ^a	41	0
13	5	59	23	0	0	0
#Students	9	12	13	6	11	4
Mean %	13	30	35	4	19	2

Note. ^aStudents shared at least one major.

Table 3
The Percentage (%) of Portfolio Submissions by Non-Curricular Source

Student	Student organization	Work	Service	Career prep
1	2	0	0	0
2 ^a	5	3	3	0
3	0	0	0	2
4 ^a	0	0	0	0
5	0	3	0	2
6	9	2	2	2
7 ^a	6	10	0	0
8 ^a	21	0	0	0
9	2	0	0	0
10	0	0	2	0
11 ^a	0	0	0	0
12 ^a	4	7	0	0
13	3	10	0	0
Students	8	6	3	3
Mean %	4	3	0.5	0.5

In terms of distribution across academic sources, six students (1, 3, 6, 8, 11, and 13) utilized one source that comprised at least 50% of the submissions (Table 2). Two students (2 and 5) displayed a more even distribution of portfolio sources, with no source exceeding 36%. The results display a large diversity in the distributional assemblage of sources across students. Two students drew mainly from the practicum course, ACR 387 Sustainability Practicum, and two students drew mainly from the capstone course. Every student drew upon ACR 487 Sustainability Portfolio Capstone, all but one drew from ACR 387 Sustainability Practicum, 11/13 utilized electives, while 9/13 used Introduction to Sustainability. Students 3 and 13 drew from no more than 3/7 possible curricular sources. Students 4, 5, and 12 drew from five sources, while students 6 and 9 drew from six academic sources. Only one student drew from study away, and that comprised 40% of that student's submissions (not included in table to protect student confidentiality).

The most common non-academic sources (Table 3) included student organization involvement (8/13 students) and work/internship experiences (6/13). For example, a student submitted the job description for executive officers as evidence of civic engagement competencies in terms of the leadership and facilitation roles and requirements of serving as a president of a student professional organization. Only student 6 (Table 3) drew from all four of the most common non-curricular sources, which leads to the greatest breadth among the portfolios. Student 2 drew upon three-quarters of the most common non-curricular sources. Students 4 and 11 used none of the most common non-curricular sources. Student 8 drew heavily (21%) from student organization experience. In terms of less frequent non-curricular submissions, one student used 6% from graduate school application essays. Another student drew 5% from professional conference participation. Overall, students 2, 5, and 6 had the most diverse portfolios, either in terms of breadth and/or in terms of equal distribution of sources.

Research Question 3: What Kinds of Learning Evidence Did Students Submit in Their ePortfolios?

Students most often submitted written manifestations of competency learning that were mostly associated with existing academic formats, such as formal papers, lab reports, and homework assignments. Some of the formal academic evidence included such non-traditional (depending on major) formats as maps, geographic information systems analysis, and student journals. One student provided required class videos used to document public speaking ability over time, along with a corresponding reflection about improvement. One student also provided a class video

project produced for a foreign language class. Students also submitted PowerPoint presentations and photographs.

The greatest range and diversity of evidence emerged from the ACR 387 Sustainability Practicum class. Student output included a life-sized sculpture made of materials drawn from the campus surplus and recycling center, elementary school art and posters depicting students' visions of sustainability, several business plans, websites, curricula, statistical output/reports, focus group summaries, and management recommendations. For more advanced competency tasks, one student submitted software programs developed to track greenhouse gas emissions for a pharmaceutical company internship (Systems Thinking-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: 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 consumer carbon footprint and use the fees to fund local carbon mitigation efforts (Economic Vitality-8: Develop a plan to address a specific sustainability issue that demonstrates multiple perspectives of economic vitality and how they affect resource allocation).

Beyond traditional course assignments, students have submitted other non-formal learning artifacts. One student from the marching band submitted two videos of band performances, contrasting the aesthetic attributes of two different bands (Aesthetic Understanding-1: Describe some common indicators of aesthetic quality). Another student submitted a video of diversity awareness training conducted while serving as a mentor in the residence halls (Personal Development-1: Describe ones self, identity(ies), values, and worldview; and Social Equity-1: Identify and describe key examples of how individuals and social groups experience inequality). Another student submitted photos and a journal of international travel conditions compiled while on vacation (Personal Development-7: Synthesize personal experiences, values, and thinking with external opinions and evidence into a coherent statement related to current and envisioned goals for one's sustainability journey.)

Discussion

The results represent an attempt at addressing the goals of the U.N. Decade of Education for Sustainable Development in terms of (a) monitoring and evaluation, (b) encouraging a research agenda and serving as a forum for relevant research on ESD, and (c) sharing good ESD practices (United Nations Education Science and Cultural Organization, 2014). The study also

addresses research needs by describing how sustainability is implanted in the curriculum and how, and under what circumstances, students develop the necessary capabilities to contribute to a more sustainable future (Barth & Thomas, 2012).

Research Question 1: Which Competencies Were Addressed Most Frequently in the ePortfolios?

Expected results. The frequent submission of portfolio evidence for Ecological Integrity and Civic Engagement (Table 1) reflects common understandings and manifestation of sustainability in the public sphere, as well as in sustainability education (Karlin et al., 2013). Unfortunately, sustainability has come to mean the narrow equivalent of environmental or green practices. What is surprising is that Ecological Integrity is not stressed in the introductory class as much as Systems Thinking and Civic Engagement. Furthermore, the core rubric for every portfolio submission requires students to address Critical Thinking, as articulated by the Association of American Colleges and Universities. This might provide an example of the powerful role of incoming student assumptions and how those assumptions affect student learning (Bransford, Brown, & Cocking, 2000). Despite the multidimensional, eight competency design, students might still cling to the primacy of the ecological domain that they displayed upon entering the program (Karlin et al., 2013).

A possible curricular explanation for the frequency of Ecological Integrity is that the majority of students (8/13) pursued majors within the College of Agriculture and Natural Resources, although only one pursued an explicitly environmental major, with most pursuing Packaging. Students in other colleges pursued environmentally related majors, including Earth Science or Geography, while the remainder pursued business or psychology. Given that ten students hold majors in Packaging or business-related fields and will work in the corporate arena, one would expect that more than one student would have pursued advanced levels of Economic Vitality (Table 1). Perhaps that reflects the lack of attention given to the economic, financial, or business aspects of sustainability in students' curricula outside of the sustainability program.

The focus on Civic Engagement makes sense, given the great effort made to develop campus-based civic engagement projects in the introductory course, as well as the frequent environmental activism of students and affiliated student organizations. Furthermore, many students chose to submit evidence from the practicum course, which frequently involves working with partners through internships, either on or off-campus.

As expected, students gave less attention to Aesthetic Understanding, reflecting the lesser degree of

emphasis on this area in sustainability education (e.g., see the June 2013 special issue of *Sustainability: The Journal of Record* at <http://online.liebertpub.com/toc/sus/6/3>). This is exacerbated by the inattention given to the arts within the students' majors, despite a university requirement that students earn two courses in Integrated Arts and Humanities.

Unexpected results. Lack of attention to advanced Personal Development competencies is somewhat surprising, given the personal nature of electronic portfolios and claim of advocates that "e-portfolios can be used to support student success, intellectual growth, and individual development within higher education and beyond" (Chen & Light, 2010, p. 1). So while ePortfolios might foster personal development overall (Richards-Schuster et al., 2014), students failed to pursue more advanced level personal development competencies as part of their portfolios. While the program was built around enabling students to demonstrate both the delivered and the experienced curriculum (Chen & Penny Light, 2010; Yancey, 1998) or the hidden curriculum (Winter & Cotton, 2012), students more often drew upon the standard delivered curriculum. This also reflects the reduced priority given to explicit Personal Development competencies in the introductory course. So while students may end up gaining intermediate level aspects of Personal Development by the nature of the pedagogy of the program, they more frequently identify advanced levels of other process competencies (Critical Thinking, Civic Engagement, or Systems Thinking) as components of their sustainability portfolios.

Research Question 2: What Sources of Learning Evidence Did Students Utilize in Their ePortfolios?

Expected results. Students did provide a range of portfolio evidence, though sources from formal academic, credit-bearing experiences dominated the portfolios. Little overlap in sources of evidence (Tables 2 and 3) among the portfolios indicates that students selected a range of portfolio sources to meet the same competency expectations. This holds true even with the six students that shared a similar major. The diversity in approaches meets program design expectations built around the learning paradigm (Barr & Tagg, 1995; Tagg, 2003) and learner-centered education (Blumberg, 2009; Blumberg & Pontiggia, 2011; Mostrom & Blumberg, 2012; Weimer, 2002). Students displayed choice in both the range of competencies they chose and the range of evidence they chose to meet the competency. This echoes calls in the ePortfolio community to ensure a good balance between program structure and student flexibility and choice (Richards-Schuster et al., 2014).

Unexpected results. However, some of the patterns yielded surprises. Despite the predominance of students in sustainability-related majors, a minority of students submitted evidence from their major, as compared to elective courses (Table 2). This provides support for the idea that the program, sustainability itself, and the portfolio process (Peet et al., 2011) contribute to both integrative learning and liberal learning. The competencies provided an opportunity for students to apply learning from electives in a coherent, logical fashion. Some of the electives related to major fields of study, while others related to the MSU liberal learning design requiring credits in integrative studies in arts and humanities, biological or physical science, and social science. The lack of use of major coursework perhaps represents the lack of major tie to, or emphasis on, sustainability. However, that is surprising, given the kinds of majors, such as Environmental Studies and Agriscience, Geography and Packaging, the latter of which focuses heavily on concepts such as life-cycle assessment and recycling.

The lack of study abroad proves surprising, given the campus's emphasis on and data about student participation in study abroad. Michigan State University displays a long history of international engagement and, for the last six years, has led the nation in study-abroad participation among public universities. It runs over 275 programs, across 60 countries, involving close to 3,000 students each year (Michigan State University, 2014b). Only a minority of students (4/13) submitted study-abroad evidence, and only one used such evidence for more than 10% of the portfolio. One would expect a higher use of study-abroad material in conjunction with competencies such as Personal Development, Critical Thinking, and Social Equity, as these represent frequent hallmarks of the rationale for study abroad.

At Michigan State University, student registrations for community service opportunities reached 17,892 in 2010-2011 and 18,889 in 2011-2012 (Michigan State University, 2012). Despite those figures, however, only three students submitted service experiences, and those comprised a very small portion (2-3%) of the overall portfolio materials (Table 3). The lack of service experiences represents an overall lack of non-curricular sources of evidence, despite the strengths of a portfolio in valuing non-academic experiences and learning (Chen & Penny Light, 2010) and the program's emphasis on and recognition of the critical importance of learning in community (Bransford et al., 2000). Students in the program receive advising that emphasizes how courses provide only a subset of the possible learning spaces in their portfolios. Adding to the surprise, the program includes two competencies, Personal Development/Awareness and Civic Engagement, in which non-curricular opportunities

might provide the best and richest learning opportunities, especially in terms of leadership (Missimer & Connell, 2012). The program design and choice of competencies reflects a programmatic value on whole-person development that aims to facilitate student journeys toward self-authorship (Bekken & Marie, 2007; King & Baxter Magolda, 2005), in which students are comfortable making their own meaning of concepts situated within a larger whole and recognize a range of other understandings and meanings. Part of the explanation might lie in the application of typically non-curricular kinds of civic engagement experiences in the practicum class.

Research Question 3. What Kinds of Learning Evidence Did Students Submit in Their ePortfolios?

Expected results. While advocates of ePortfolios identify them as conducive to review of multiple forms of evidence (Chen & Penny Light, 2010), the sustainability minor portfolios displayed a mixed set of results. While a range of evidence certainly exists, students most often relied on written textual materials, either derived from traditional academic assignments or summarizing non-academic experiences. This certainly represents the path of least resistance, as one would expect students to have the greatest experience and comfort in submitting traditional written assignments. It also reflects perhaps the standard assignments requested by faculty teaching students in traditional classes.

Unexpected results. Interestingly, while the Introduction to Sustainability course utilizes a range of assignments and evidence modalities, a minority of students (6/13) utilized a substantial amount (>10%) of evidence from that course. One would expect a range of evidence types because of both the nature of the formal program design and also of the students' multiple intelligences (Gardner, 1983, 2006). The concept of multiple intelligences suggests that individuals may have varying ranges for the kinds of learning domains, including: verbal-linguistic, bodily-kinesthetic, interpersonal, intrapersonal, naturalistic, spatio-visual, musical-rhythmic, and logical-mathematical (Gardner, 1983,2006). A lesson for the program is to highlight such different forms of evidence with existing students so that they can see what is possible and acceptable.

Education for Sustainability

The portfolio evidence reflects the calls for applied project work to convey sustainability learning (Barth & Michelesen, 2013; Brundiers & Wiek, 2011; Karlin et al., 2013; Sterling, 2010; Stupans, Scutter, & Pearce, 2010; Thomas, 2009). Students drew from projects in ACR 187 Introduction to Sustainability, ACR 387 Sustainability Practicum and work/internships, and

student organization activity. Students often drew upon their practicum course (Table 2), which reflects an emphasis on the applied, project-based kind of learning that is considered critical for sustainability learning. Students also focused on competencies related to civic engagement (Table 1), which also satisfies much of the discourse surrounding education for sustainability (Anderberg et al., 2009; Barth & Michelesen, 2013; HEPS, 2004; Mochizuki & Zinaida Fadeeva, 2010). Most important, the results describe one of the few assessments and descriptions of a learner-centric approach to sustainability education that several scholars have identified as a need (Glover et al., 2012; HEPS, 2004; McKeown, 2011; Yousey-Elsener et al., 2010). The results further utilize portfolios to assess applied-project performance related to competencies commonly identified as crucial for effective sustainability education.

Portfolio Program Assessment

The portfolio assessment identified student approaches to providing evidence of “knowing what, how, why and when” (Shavelson & Huang, 2003). However, the review also identified gaps and needs. While portfolios enable students to provide a range of evidence (Chen & Penny Light, 2010), a majority of the evidence was derived from curricular activity (electives and core courses), and a minority of students utilized curricular material from their major coursework. The results support the claims that “electronic student portfolios recognize that learning occurs in many places, takes many forms, and is exhibited through many modes of representation” (Rhodes, 2010a, p. vi). The student portfolios also illustrate the application of the learning paradigm (Barr & Tagg, 1995; Tagg, 2003) and learner-centered education (Blumberg, 2009; Blumberg & Pontiggia, 2011; Mostrom & Blumberg, 2012; Weimer, 2002), as displayed in the distribution of portfolio evidence by students (Tables 1 through 3). Students used a variety of evidence, though not all students used the same range of sources for evidence.

Portfolios provide the kind of platform to facilitate integrative learning (Chen & Penny Light, 2010; Peet et al., 2011; Richards-Schuster et al., 2014) that educational scholars advocate for helping students make sense of their overall educational experiences (Bekken & Marie, 2007; Bransford et al., 2000; Haynes et al., 2010; King & Baxter Magolda, 2005). However, results indicate that adopting a more formal approach might yield more robust portfolios, as students often struggle with integrative learning (Peet et al., 2011). This struggle occurs despite the fact that Michigan State

University requires a sequence of integrative learning within the areas of Arts and Humanities, Social Science, and Biological and Physical Sciences. While those courses might encourage integration within related fields, they may not facilitate a more focused attention on integrated learning itself that would enable students to better integrate common outcomes across a range of courses and experiences, both in and out of the classroom, as well as across a range of modalities.

Limitations

While analyzing every artifact and source for every student portfolio provides a level of depth and rigor, the participation of only 13 students prevents the use of statistical analysis and generalization of findings beyond the scope of the program. Only one person (the program director and author) analyzed ePortfolio contents, which could threaten validity in terms of categorization of the kinds of artifacts students submitted.

Conclusions

Given the need to design, test, document, assess, and improve the knowledge and performance of education for sustainability programs (Barth & Thomas, 2012), as presented in the U.N. Decade of Education for Sustainable Development, this study demonstrates how electronic portfolios enable students to provide a range of evidence to demonstrate their sustainability learning. This approach reflects the learning paradigm (Barr & Tagg, 1995; Tagg, 2003) by focusing on student learning regardless of modality (source or type of learning evidence). It also fits the learning-centered approach (Blumberg, 2009; Blumberg & Pontiggia, 2011; Mostrom & Blumberg, 2012; Weimer, 2002) by enabling student choice and reflection. While students successfully submit evidence, however, they often find themselves starting and completing the portfolio in their final 15-week term. That delay runs counter to the design of effective portfolio-based education (Chen & Penny Light, 2010) in that students have difficulty demonstrating the range of their learning. The delay in commencing their portfolios prevents students from effectively building and scaffolding learning as they proceed, instead of having to make such connections retrospectively. Richards-Schuster et al. (2014) reach a similar conclusion regarding using ePortfolios for their interdisciplinary minor. Hopefully, this study provides the impetus for other sustainability programs to embark on ePortfolio use.

Postscript

Unfortunately, after two years of implementation the sustainability minor program was eliminated in fall 2013

due to concerns with low enrollment. The unique and divergent emphasis on competency-based performance and ePortfolios beyond the typical courses and credits approach seemed to deter both student enrollment and the willingness of faculty and staff, beyond the program director, to review portfolios and apply rubrics. This may reflect the large range of other voluntary and required curricular options available that reflect a more standard approach to higher education and sustainability learning. While the program arose during an institutional reform initiative called Boldness by Design, perhaps the program design proved too bold for its own good. As others have learned, embarking on ePortfolio efforts provides enough challenge for institutional adoption.

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