
The Campus as a Living Laboratory: Macalester College Case Study

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Abstract

All higher education campus buildings and grounds can be studied, analyzed and even manipulated for research and education. However, higher education faculty do not typically use their own campus as a living laboratory. At most institutions, a student's education does not link to the local context, and students are unaware of an institution's sustainability footprint. This paper analyzes the effectiveness of one living laboratory case study at Macalester College in St. Paul, Minnesota, USA. This paper describes Macalester College's living laboratory program and the classes, independent studies, and academic internships that have used the living laboratory approach. The schools' program strengths and weaknesses are analyzed by using the "Eight Elements to Building a Living Lab" framework identified by the Sustainability Education and Economic Development (SEED) Center's "The Campus as a Living Laboratory" guidebook. Recommendations to improve the living laboratory program are also included.

Keywords

Living laboratory · Campus-based learning · Education for sustainability · Campus sustainability · Macalester College

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1 Introduction

At most higher educational institutions, education does not link to the local environmental context, and students are unaware of their institution's sustainability footprint. Typically, the campus buildings and grounds are a backdrop for the education that happens inside the classrooms. However, a growing number of schools are using their campus buildings and grounds as explicit educational tools for sustainability education; this concept is increasingly called "using the campus as a living laboratory." At the smallest scale, an instructor can illustrate a concept during a lecture by using a campus example. At a much larger scale, a multi-year interdisciplinary project could be undertaken with facilities management staff to have students research and design a new campus building with environmentally beneficial components. At any scale, the campus can act as a teaching lab where students can see the local, concrete links to theoretical concepts. The living laboratory concept can also be extended to include the community where the educational institution resides.

The living laboratory concept originally started as an outgrowth of the green building focus in architecture. One of the early examples of a higher education building used as a living laboratory in the United States is Oberlin College's Adam Joseph Lewis Center, built in 2000. It was one of the first green buildings to specifically use the building as a teaching tool. The building has over 150 sensors that give real-time feedback about energy and material flows (<http://new.oberlin.edu/office/environmental-sustainability/progress/buildings.dot>). Using new education buildings as living laboratories is relatively common in the architecture field. Many schools at all levels have been intentionally developed as teaching tools using the Leadership in Energy and Environmental Design (LEED) Green Building Rating System. The Center for Green Schools showcases many of these examples on their website (<http://www.centerforgreenschools.org/>).

A growing number of higher educational institutions are also creating living laboratory programs that use their campuses as a living laboratory, even without a new building. At Portland State University, an early leader in this area, the "Living Lab" is a partnership between the Campus Sustainability Office and the Institute for Sustainable Solutions. The program matches faculty and students with university staff, and the program meets operational needs while providing students with hands-on educational opportunities (<http://www.pdx.edu/sustainability/living-lab>). Another example is Penn State University, which includes an explicit mention of living laboratories in their Sustainability Strategic Plan. In addition, Princeton University recently developed a comprehensive living laboratory website (<https://sustain.princeton.edu/lab>) where academic research opportunities are listed, projects are archived and sustainability efforts are noted.

Organizations that assist schools with campus sustainability, such as the Association for the Advancement of Sustainability in Higher Education (AASHE) in the United States, also promote the use of buildings and grounds as living laboratories. In AASHE's Sustainability Tracking, Assessment and Rating System (STARS),

which is used to rate sustainability efforts in higher education, points are given for using the campus as a living laboratory. The rationale for credit states,

This credit recognizes institutions that utilize their infrastructure and operations as living environments for multidisciplinary learning, applied research and practical work that advances sustainability on campus. Students that actively participate in making their campuses more sustainable are well prepared to continue that work in their careers and communities after graduation (AASHE 2014).

As of January, 2016, 110 out of 178 schools participating in the STARS program have a 4-star rating in this credit, which means approximately 62 % of colleges answering this question in STARS have the highest rating possible.

As the living laboratory concept gained popularity, resources have been developed for campuses interested in utilizing the living laboratory approach. The most comprehensive resource specifically for living laboratory programs is *“The Campus as a Living Laboratory: Using the Built Environment to Revitalize College Education”* (Cohen and Lovell 2013). This guidebook, created by the Sustainability Education and Economic Development (SEED) Center, is designed as a resource for community colleges but is useful for all types of higher education institutions. In addition, the United States Green Building Council (USGBC) also hosts the Center for Green Schools that specifically looks at ways to connect education and buildings, particularly Leadership in Energy and Environmental Design (LEED) buildings. Their *“Roadmap to a Green Campus”* resource includes a chapter on campuses as living laboratories (Humblet et al. 2010). Finally, the Science Education Resource Center hosts a recently updated *“Campus Living Laboratory”* web module developed for geoscience faculty who want to develop a living laboratory project in their class (Hansen et al. 2015).

Using a university or college buildings and grounds as sustainability education tools is one approach to Education for Sustainable Development. According to the United Nations, “Education for Sustainable Development (ESD) allows every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future” (UNESCO 2016). ESD involves adding key sustainable development issues into teaching and learning and requires participatory methods that empower learners to change their behavior and take action for sustainable development (UNESCO 2016). Using the campus as a living laboratory is a tool for ESD. Some of the living laboratory projects may lead to behavior change by individual and institutions; these projects give students an opportunity to take action in support of sustainable development.

Using the campus as a living lab is a type of service-learning. Service-learning is a combination of community service and academic learning where students work on community volunteer projects as part of their educational experience. The use of service-learning has shown to improve academic learning and student satisfaction (Astin et al. 2000; Eyler et al. 2001).

Using the campus as a living lab also promotes civic engagement. Many colleges and universities are beginning to emphasize educating society about civic responsibilities as a crucial element, if not the purpose, of education (Boyte and

Hollander 1999; Kellogg Commission on the Future of State and Land-Grant Universities 2000). If the students recommend action or use their study to improve the environment on the campus, the students have the opportunity to become engaged in the civic activity of the college or university.

This paper analyzes the effectiveness of one living laboratory case study at Macalester College in St. Paul, Minnesota, USA. This paper describes Macalester College's living laboratory program and the classes, independent studies, and academic internships that have used the living laboratory approach. The schools' program strengths and challenges are analyzed by using the "Eight Elements to Building a Living Lab" identified in the SEED Center's "*The Campus as a Living Laboratory*" guidebook (Cohen and Lovell 2013). Recommendations to improve the living laboratory program are also included.

2 Methodology

This paper analyzes the living laboratory approach to sustainability education at Macalester College by analyzing how well the efforts fit with the SEED Center framework. First, the Sustainability Manager listed the classes and academic projects using a living laboratory approach. For each project or class, the department, activity type, topic and a note on how the project started is noted. The topics were grouped by type: climate change-related, zero waste, communication, sustainability assessments, landscaping/stormwater, and food. Next, the Sustainability Manager analyzed the how well the program fares under each of the eight elements identified by the SEED center by describing the effort in that area and assigning a numeric score. The scores were plotted on a spider graph to highlight the strong and weak areas of the program.

3 Macalester College Living Laboratory Case Study

Macalester College is a small liberal arts college located in an urban residential area of St. Paul, Minnesota, USA. The college enrolls approximately 2000 students, and employs 180 faculty and 390 staff. In 2007, the college president signed the American College and University Presidents' Climate Commitment, committing the college to achieving climate neutrality. As a result, the Sustainability Office was established with the hiring of the first Sustainability Manager in 2008. The Sustainability Office handles reporting for sustainability commitments, manages the campus-wide Sustainability Plan, and works with students, staff and faculty to improve the sustainability of the campus. The Sustainability Plan came about through a participatory strategic planning process and a class project (Hansen et al. 2011).

As the Sustainability Manager had a specific interest in using the campus as a living laboratory, one of the focuses of the Sustainability Office has been supporting the use of the campus as a living laboratory. The Sustainability Manager teaches classes and supervises independent studies and internships. In addition the office supports faculty with campus sustainability course projects, archives student projects, facilitates data accessibility, and follows up on student recommendations. The Sustainability Office also hosts a data and reports archive on the Sustainability Office website to make campus data available to faculty and students. In addition, the office developed a list of campus sustainability-related field trip locations, campus sustainability data sets and reports. The office also posted a “potential student projects list” on the office website to connect interested faculty and students with sustainability projects on campus.

Many of the classes that are part of the living laboratory program are Environmental Studies classes. The Environmental Studies Department faculty also advises the EcoHouse student residence. The EcoHouse is a small campus house that was renovated using sustainability criteria and was designed as a living learning laboratory by and for students (Wells et al. 2009).

Other departments with a role in the living laboratory program include the Jan Serie Center for Scholarship and Teaching (Serie Center) and the Institute for Global Citizenship (IGC). Sustainability education topics are occasionally included in regular faculty development workshops and lunches at the Serie Center. The IGC hosts a grant funded Educating Sustainability Ambassadors program that offers faculty development, international sustainability faculty trips, and student sustainability conversations. One of the additional programs of the IGC, the Civic Engagement Center, also connects faculty with community partners for service-learning projects and volunteer activities.

4 Living Laboratory Academic Projects

Table 1 lists academic living laboratory projects by academic experience, department, activity type, topic, project and how the project started. Routinely offered classes are given in bold. Note that the table only lists the projects known to the Sustainability Office. Other classes and student papers may have been completed, but they were not part of the Sustainability Office’s living laboratory program.

A total of 23 academic experiences were identified as living laboratory projects; five are regularly offered classes. The academic experiences range from full senior seminar classes to small class papers. In addition to classes, living laboratory projects were part of academic internships and independent study classes. The list includes a significant number of research projects. Many of these research projects were part of required senior seminar classes, particularly environmental studies

Table 1 Living laboratory academic projects at Macalester College

Academic experience	Department	Activity type	Topic	Project	How project started
Senior Seminar Class	Environmental Studies	Major class project	Climate change	Calculated campus greenhouse gas emissions	Sustainability Manager co-taught class
Senior Seminar Class	Environmental Studies	Major class project	Climate change	Recommended actions for campus climate action plan	Sustainability Manager taught class
Senior Seminar Class	Environmental Studies	Major class project	Zero waste	Researched zero waste projects for campus, including composing	Sustainability Manager co-taught class
Senior Seminar Class	Environmental Studies	Major class project	Communication	Developed communications projects for campus field station	Instructor interest
Senior Seminar Class	Environmental Studies	Major class project	Communication	Developed campus Earth Day activities	Instructor interest
Senior Seminar Class	Environmental Studies	Major class project	Climate change	Researched renewable energy for campus	Students found topic in the Sustainability Plan
Senior Seminar Class	Geography	Major class project	Climate change	Recommended ways to more effectively calculate airline travel emissions as well as how to reduce travel	Students found topic in the Sustainability Plan

(continued)

Table 1 (continued)

Academic experience	Department	Activity type	Topic	Project	How project started
Sustainability and the Campus Class	Environmental Studies	Major class project	Sustainability assessment (climate change, zero waste, communication)	Recommended actions for the Center for Religious and Spiritual Life	Sustainability Manager taught class
				Researched solar options for campus-owned buildings	
				Developed sustainable special events guide	
				Developed sustainability education materials for campus language houses	
Cities, Sustainability and the Campus Class	Environmental Studies	Major class project	Communication	Developed campus signage for Earth Day	Sustainability Manager taught class
			Zero waste	Analyzed sustainability efforts in the Athletics Department	
				Recommended compostable dishware for the dining hall	
Cycling the Urban Landscape Class	Environmental Studies	Class project	Climate change	Recommended actions for improving bicycling infrastructure on campus	Faculty interest
Environmental Science Class	Environmental Studies	Class project	Landscaping/Storm water	Analyzed the potential for a green roof on a dormitory	Facilities Director recommended project
Psychology for Sustainable Behavior Class	Psychology/Environmental Studies	Class project	Climate change Zero waste	Developed recommendations for campus energy and waste projects	Faculty interest

(continued)

Table 1 (continued)

Academic experience	Department	Activity type	Topic	Project	How project started
Hydrology Class	Geology	Class project	Landscaping/Storm water	Calculated runoff from different campus areas	Sustainability Manager recommended project
Science of Renewable Energy Class	Physics/Environmental Studies	Class activity	Climate change	Analyzed the effectiveness of campus wind turbine	Faculty interest
Social Science Inquiry Class	Sociology/Political Science	Class project	Communication	Surveyed attitudes about sustainability, composting, energy	Sustainability Manager recommended project
Architecture, Sustainability and Place-Making Class	Environmental Studies	Major class project	Green building	Envisioned the architecture of a college field station	Sustainability Manager recommended project
Introduction to Statistical Modeling Class	Math, Statistics and Computer Science	Major class project	Climate change Zero waste	Analyzed commuter data Analyzed composting data	Faculty interest Student interest
Honors Thesis	Math, Statistics and Computer Science	Thesis	Climate change	Analyze energy use in all college dormitories	Student interest
EcoHouse Research Project	Environmental Studies	Independent study	Zero waste	Documented and analyzed all waste from a campus house	Student interest

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Table 1 (continued)

Academic experience	Department	Activity type	Topic	Project	How project started
EcoHouse Research Project	Environmental Studies	Independent study	Climate change	Analyzed the different energy use in two campus houses	Sustainability Manager recommended project
EcoHouse Research Project	Environmental Studies	Internship	Food	Developed student guide to Eating Sustainably on a Budget	Student interest
Markim Hall Research Project	Partnership with Dakota County Technical College	Internship	Green building	Summarized documentation for a LEED platinum building	Sustainability Manager recommended project
				Developed community guide to green building materials for EcoHouse	
Research Project	Partnership with University of Minnesota Landscape Architecture Class	Class project	Landscaping/Storm water	Designed possible new green roof designs	Faculty interest

senior seminar classes. A math, statistics and computer science student also used a living laboratory approach to an honors thesis. Students also used the EcoHouse student residence as an independent study or internship research project.

The most common topic for the academic experiences using a living laboratory approach was climate change with 10 living laboratory projects listed. The second most common topic was zero waste with five living laboratory projects. Many of these zero waste projects focused on composting. Other topic areas included communications (three listed), sustainability assessments (three listed), landscaping/storm water (three listed) and food (one listed).

Environmental studies is the most common department using the living laboratory approach. Other departments listed include the following: geology, sociology/political science, math/statistics/computer science, geography, psychology, physics, and architecture. Almost all of the classes are from Macalester College. However, the class listing includes one University of Minnesota landscape architecture class that uses Macalester College as a case study site location. In addition, a student at Dakota County Technical College used Macalester College as an academic internship site.

Many of the living laboratory projects started because the Sustainability Manager taught or co-taught the class, suggested the topic, or students found the topic in the Sustainability Plan. Classes also included projects because the topic was already a research interest of the instructor.

5 Analysis

The most comprehensive resource for colleges interested in developing a living laboratory is *“The Campus as a Living Laboratory: Using the Built Environment to Revitalize College Education,”* developed by the SEED center (Cohen and Lovell 2013). The guidebook describes “Eight Elements to Building a Campus Living Laboratory” as: Engage the right campus participants, ID key collegiate programs, Build credibility through engagement and data, Integrate into curriculum, Expand beyond individual programs of study, Build partnerships with industry, Engage support beyond campus, and Open your labs to the community.

Macalester College’s living laboratory program was evaluated for the purposes of this paper using these eight elements. The Sustainability Manager scored how well Macalester College’s living laboratory program fits the SEED Center elements on a zero-to-three scale: 0, no work in this area; 1, minor work in this area; 2, some work in this area; 3, significant amount of work in this area. Scoring was self-reported by the Sustainability Manager.

6 Eight Elements to Building a Campus Living Lab and Macalester College

1. Engage the right campus participants

According to the SEED Center, key participants include the course instructor, Division Chair, Academic Dean, Facilities Director, and Human Resources Director. By including the right participants, a campus can move a living laboratory program from a single course to a strategic initiative (Cohen and Lovell 2013).

(Score 1: Minor work in this area) Of the key participants listed, only the course instructor and the Facilities Director have been engaged in living laboratory projects at Macalester College. However, the core of the living laboratory program is facilitated by the Sustainability Office and sustainability staff is not included in the SEED center list. At Macalester College, the living laboratory program is also not well connected to other potential areas that could be allies, such as the Serie Center and the IGC.

2. ID key collegiate programs

The SEED Center highlights the following academic programs as good fits for living laboratory programs: agriculture, business and accounting, engineering, environmental science, physics, and psychology (Cohen and Lovell 2013).

(Score 3: Significant amount of work in this area) All of the key collegiate programs that Macalester College offers are on the SEED Center list. The classes at Macalester College that use a living laboratory approach have been in environmental studies, physics, psychology and geography. As a small liberal arts college, Macalester does not offer agriculture, business, or engineering classes in the curriculum. Macalester's living laboratory program has been used in some departments not listed above: geography, geology, and math, statistics and computer science.

3. Build credibility through engagement and data

The SEED Center notes that "early wins are essential to build momentum" with institutional change projects. In the SEED Center examples, student projects showed significant cost savings, engaged a wide number of partners, quantified the impact on students, and brought in additional money (Cohen and Lovell 2013).

(Score 1: Minor work in this area) At Macalester College, student projects have often been able to highlight an issue or change a practice on campus. For example, student data from a composting project provided the needed support for adding composting campus-wide. Data from the EcoHouse energy efficiency independent study project also saved the college money by identifying a basement dehumidifier left running continually in the winter.

The Sustainability Office collects student papers when these papers are available, and the environmental studies program archives student projects on the website. However, there has not been a systematic collection or sharing of the specific cost savings or impacts of the student work with upper level administrators.

4. Integrate into curriculum

The SEED center notes that, at minimum, instructors need to include the following in the syllabus: a full description of the project, including the topic's connection to the college's broader sustainability goals, student learning outcomes, where and when the work will take place, expectations for on-site behavior, safety issues to keep in mind, and student work expectations (Cohen and Lovell 2013).

(Score 2: Some work in this area) At Macalester College, instructors typically include in their syllabi project descriptions, learning outcomes, logistics, safety guidelines and student work expectations. However, instructors do not necessarily include the topic's connection to the college's broader sustainability goals.

5. Expand beyond individual programs of study

The SEED center recommends starting with small projects within a single course. More experienced instructors could collaborate with faculty and staff on interdisciplinary projects that can build students' system thinking skills (Cohen and Lovell 2013).

(Score 0: No work in this area) At Macalester College, all of the projects have been individual courses, independent studies or internships. Many of the courses that were co-taught by the Sustainability Manager were co-taught by an environmental studies professor. The classes may have an interdisciplinary focus, but no efforts have been made to team teach across classes in other disciplines or to teach across multiple classes.

6. Build partnerships with industry

The SEED Center noted that the successful living laboratory programs typically have an industry partner involved (Cohen and Lovell 2013).

(Score 3: Significant amount of work in this area) Macalester College has partnered with industry partners on living laboratory projects. First, the local utility, Xcel Energy, supported EcoHouse outreach efforts through a grant. In addition, TRANE donated equipment for metering the EcoHouse. Recently, MAMAC Systems partnered with the college to install energy meters and test the effectiveness of real-time data communication feedback. MAMAC donated some of the equipment and supported student research.

7. Engage support beyond campus

The SEED Center recommends finding partnerships in the local community where students can work on sustainability efforts though using the community as a living laboratory (Cohen and Lovell 2013).

(Score 1: Minor work in this area) At Macalester College, the Civic Engagement Center connects instructors to community partners with service learning projects and volunteer activities. However, these projects are not typically seen as part of the campus sustainability efforts or as an extension of the living laboratory program. The Civic Engagement Center works off-campus exclusively while the campus sustainability office specifically works on campus. However, both programs have similar goals and theoretical underpinnings, so collaboration could be feasible.

8. Open your labs to the community

The SEED center recommends using a campus living laboratory as a model for the community through utilizing tours and field trips, signage, web presence, and workshops (Cohen and Lovell 2013).

(Score 2: Some work in this area) The Sustainability Office routinely offers sustainability tours of campus, and sustainability staff routinely give off-campus presentations. The Sustainability Office also works closely with the Upper Midwest Association for Campus Sustainability, the regional campus sustainability organization. The Sustainability Office also developed a printed sustainability campus tour map and a self-guided tour for the LEED platinum building on campus. The campus prairie and wind turbine have educational signs, but most of the other sustainability projects on campus do not have signage. Also, the sustainability office has limited web information on the office website about the living laboratory program.

Figure 1 shows a spider diagram of Macalester College's scores from the SEED Center eight elements for campus living laboratory programs. The elements are listed around the diagram. Scores close to the middle are weak areas for the living laboratory program. Scores on the outside are strong areas for the living laboratory program.

The Macalester College Living Laboratory program scored highly with a "3" in the areas of "ID key collegiate programs" and "Build partnerships with industry." All of the key collegiate programs identified by the SEED Center that Macalester College offers have been involved in the living laboratory program. The Sustainability Office also has one solid partnership with an industry partner, and the college has engaged three industrial partners for projects.

The college scored a "2" in the areas of "Integrate into curriculum" and "Open your labs to the community." While instructors using a living laboratory approach often include material about the projects in their syllabi, they do not necessarily provide links to the larger sustainability goals of the college. The Sustainability Office has done a good job of educating the local community about the sustainability projects on campus by hosting tours and developing educational material,

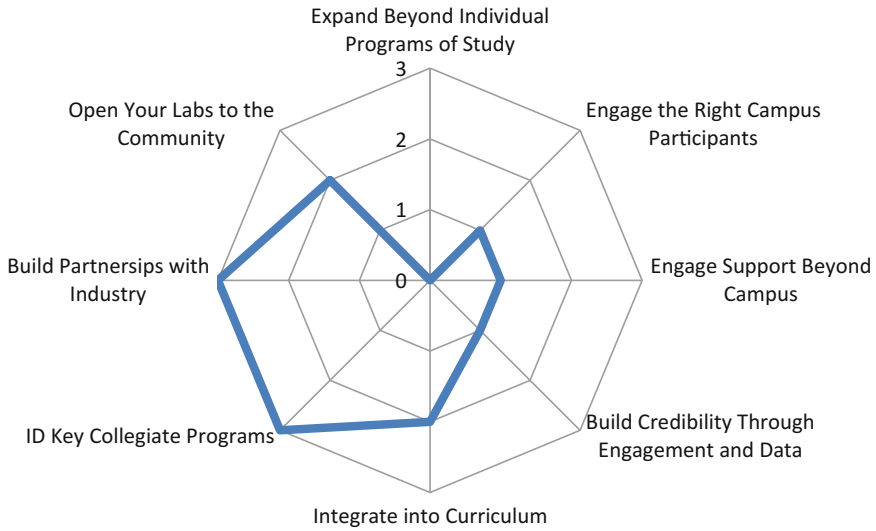


Fig. 1 Macalester College scores in the eight living laboratory elements

but many of the projects on campus have no signage. Information about campus sustainability is on the website, but the website is lacking specific living laboratory information.

The college scored a “1” in the areas of “Engage the right campus participants,” “Build credibility through engagement and data,” and “Engage support beyond campus.” The Sustainability Office has engaged some, but not all, of the key personnel needed for a living laboratory to be successful. Macalester College has a supportive facilities and sustainability staff actively working on making the campus a living laboratory. However, gaining the attention of high-level academic administrators would be needed to move beyond the individual course approach.

Data has been used to change the campus, and individual classes have had impact, but the college’s living laboratory program has not yet engaged beyond individual instructors and personal connections of the Sustainability Manager. The college has yet to fully institutionalize the program by engaging with senior personnel on the academic side of the institution. In addition, the living laboratory program does not connect well with the already existing IGC and Serie Center.

The college scored a “0” in “Expand beyond the individual programs of study.” All of the living laboratory projects have been in individual classes, and most of the classes are environmental studies classes. Although the environmental studies courses use an interdisciplinary approach, there is an opportunity to engage disciplines in larger interdisciplinary projects.

7 Lessons Learned

Based on the analysis of Macalester College's living laboratory program through the eight criteria set forth by the SEED Center, the following recommendations are given to improve the program:

- Macalester College should continue to seek out industry and grant support for the living laboratory program.
- The Sustainability Office should make sure that individual course instructors have suggested language about how the project fits with the larger sustainability goals.
- The college should also focus on improving campus sustainability signage and bolster the living laboratory website.
- The Sustainability Office should look for ways to engage with other departments that currently work with faculty, such as the Serie Center and the IGC.
- The Sustainability Office should actively engage upper administration to highlight the results of the living laboratory projects.
- The Sustainability Office and the Civic Engagement Center should look for ways to link the campus living laboratory with the work already underway in the community.
- The Sustainability Office should expand on the current interdisciplinary projects in environmental studies to incorporate other disciplines not currently working with the living laboratory program.

8 Conclusion

Macalester College Sustainability Office has built a living laboratory program through teaching classes, working with environmental studies faculty, and assisting faculty in incorporating projects into existing classes. This paper analyzed Macalester College's program by using the "Eight Elements to Living Lab Programs" identified by the SEED Center (Cohen and Lovell 2013). Macalester College's program does a good job of partnering with key participants and with industry. The school could improve by making sure that faculty include the links to wider sustainability efforts in course syllabi, as well as improve signage and web presence. The school could further improve by moving beyond the individual class paradigm. The college should develop ways to engage the upper administration with the results of the projects already underway and move to partner more closely with departments that have a congruent mission, such as the Institute for Global Citizenship and Serie Center.

Higher education institutions have an opportunity to improve sustainability education through using a living laboratory approach. Tools and resources are currently available, such as the SEED Center guidebooks used in this analysis, so educational institutions can build on experiences at other locations. This paper shows how one higher education institution used existing resources to improve the Sustainability Office's approach to using campus buildings and grounds as a living laboratory for sustainability education. By using the buildings, grounds and local community as living laboratory sites, higher education can both educate students and offer solutions for the challenges of sustainable development.

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