PROJECT REPORT

Cultivating Sustainability Praxis on a Campus Farm

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Abstract

This mixed methods study investigates student learning outcomes from undergraduate STEM and non-STEM courses, employing farm-situated place-based experiential learning (PBEL) modules at a private liberal arts university in the Midwest. Given that these courses occurred during both COVID-19 and U.S. police brutality protests, this study critically interrogates the influence of this "dual pandemic" on student meaning-making. The study examines how student scores on environmental science literacy, civic-mindedness, sense of place, and scientific reasoning measures changed throughout the PBEL courses. With the exception of scientific reasoning, change in each measure was statistically significant ($p<0.001$). A stepwise linear regression determined whether any measures predicted civic-mindedness. Environmental science literacy and university place attachment were found to be predictive of civic-mindedness. Focus group data revealed how PBEL modules affected student learning outcomes and how the dual pandemic affected student civic-mindedness and place attachment.

Introduction

This paper examines how a series of STEM and non-STEM courses incorporating Place-Based Experiential Learning (PBEL) on a private Midwestern university's campus farm impacted students' situated sustainability meaning-making (Sorge et al., 2022), place attachment (Williams & Vaske, 2003), civic-mindedness (Hess et al., 2021; Steinberg et al., 2011), environmental science literacy (Liang et al., 2018), and scientific reasoning (Drummond & Fischhoff, 2017). The courses in this research study were enhanced with PBEL by their instructors, who had participated in a Faculty and Staff Learning Community (FSLC) on PBEL and sustainable food systems (Angstmann et al., 2022).

PBEL is a promising pedagogical framework for articulating situated learning with a meaningful interdisciplinary location. Place-based and experiential learning are gaining popularity in the earth and environmental sciences (Semken et al., 2017), as well as in a wide range of other disciplines (Hamer, 2000), because PBEL can increase instructor and student enthusiasm and enjoyment (Dabbour, 1997; Lawson, 1995), enhance perceived value of the learning experience to students (Graeff, 1997), and positively impact student performance in content knowledge, course engagement, critical thinking skills, and civic-mindedness (Ernst & Monroe, 2004; Gruenewald, 2003a; Lieberman & Hoody, 1998; Sobel, 2004). PBEL also has the potential to provide students with a sense of agency through a "pedagogy of responsibility" (Martusewicz & Edmundson, 2014) that encourages them to construct rather than consume knowledge (Smith, 2002). Real-world experiences enable them to actively consider their civic role and its impact on broader society (McInerney et al., 2011; Smith & Sobel, 2014).

According to Donaldson, et al. (2020), place-based education (e.g., fieldwork research experiences), particularly when implemented through a situated learning theory lens (Lave & Wenger, 1991), can create experiences of legitimate peripheral participation for students within a community of practice situated in authentic disciplinary contexts. Experiences of legitimate peripheral participation provide opportunities for students to embody scientific practices, develop scientific identity, and interact within a community of practice as they develop along a novice to expert continuum (Donaldson et al., 2020). By engaging in the thought and practices of the earth and environmental sciences in legitimate but developmentally-appropriate ways and in a relevant local place, learners have opportunities to use their knowledge and skills and, in doing so, to create connections between the values and identities of learners, the relational situatedness of places, and the applicability of scientific concepts in establishing coherent systems understanding of the environmental problems and conflicts that vex society (Brown et al., 2020; Galt et al., 2012; Williamson et al., 2023).

While many benefits of PBEL have been reported, its successful implementation can be challenging, because it requires an intentional and explicit linkage of local place-based phenomena to global economic, social, and environmental problems (Furman & Gruenewald, 2004; Gruenewald, 2003b; Gruenewald & Smith, 2014; Nespor, 2008; Spring, 1998). Further, development and implementation of a PBEL curriculum is often disincentivized by a lack of training, extensive time commitments, and the need to connect and collaborate with meaningful community partners; moreover, most efforts to implement PBEL are spearheaded by individual instructors with little to no formal pedagogical training or institutional support. This results in a lack of programmatic consistency, common learning framework, and cohesive best practices, which limits research on the impact of PBEL on students to a single course rather than demonstrating its applicability to a wide range of disciplines.

By cultivating students' capacity to construct and expand their own critical awareness of the present ills born from unsustainable modes of thought and practice, educators help to prepare their students to act and intervene in ongoing environmental and sustainability crises (Kahn, 2010). To support this learning, educators must reflect critically on their educational thought and practice. Educators and the learning experiences they facilitate create important opportunities for students to construct sustainability and environmental science knowledge and skills and to cultivate their commitments to sustainable food systems and civic life within the local places they inhabit. By providing educators with space to collaborate in cross-disciplinary communities of practice, where discourse, discussion, and critical reflection on teaching and learning are used to improve teaching practice, FSLCs

can help educators expand their disciplinary perspectives, contextualize instruction within the institution and local and global communities, build confidence and knowledge to try new instructional approaches, and foster civic engagement and pride (Borrego & Henderson, 2014; Calkins & Light, 2008; Lynd-Balta et al., 2006; Schlager et al., 1998; Ward & Selvester, 2012).

This study is part of a three-year NSF Improving Undergraduate STEM Education project (Award #1915313) that aimed, using a PBEL approach, to integrate a campus farm across courses in nine different disciplines (both STEM and non-STEM departments) of a private, predominantly white, primarily undergraduate university in the midwestern United States. The PBEL FSLC was the primary engine of course transformation.

In the first year of the project (Fall 2019–Spring 2020), university faculty and staff participated in an FSLC beginning in Fall 2019 and ending in Spring 2020. Monthly meetings took place throughout the course of that year. The meetings started as in-person gatherings but were switched online during the spring due to the COVID-19 pandemic, which halted the university's in-person instruction. During the FSLC, participants explored their own scholarly identities (Price, 2018), interrogated their modes of inquiry, and were introduced to critical reflection (Ash & Clayton, 2009), as well as the PBEL approach. (For a complete view of the FSLC curriculum see Angstmann et al., 2022.) The FSLC was intentionally designed so that pre- and post-session work fostered an intentional, collaborative, and reflective meeting space that ultimately resulted in the development of a tangible portion of each faculty's farm-based PBEL course module.

By the end of the FSLC, participants were expected to have identified a course in which they could integrate the campus farm using the best practices of a PBEL approach. Farm-situated PBEL best practices (Angstmann et al., 2019) recommend

- providing a broad introduction to sustainable agriculture including sociopolitical and environmental aspects of agriculture and the role of a campus farm in the food system,
- defining an authentic, real-world problem or question for students to explore,
- facilitating attachment and meaning to place through a minimum of four hours of interaction with the campus farm space,
- using inquiry-based, place-situated, iterative experiential learning,
- utilizing reflective questioning to help students identify learnings and personal change.

A total of ten courses were enhanced to include PBEL activities on the campus farm. There were five STEM courses and five non-STEM courses. For the former, there were two introductory-level ecology courses and three upper-level courses across three disciplines: chemistry, biology, and pharmacy. For the latter, there was one introductory-level course in environmental studies and four upper-level courses across four disciplines: marketing, communications, education, and religious studies. Table 1 identifies the courses, which were first offered during the Fall 2020–Spring 2021 academic year, and offers a brief description of each.

In this study, we examine the extent to which, and how, student outcomes were affected by the incorporation of campus farm PBEL modules in the above courses. Our specific research questions are as follows:

> **RQ1**: How and, if so, to what extent does student civic-mindedness, situated sustainability meaning-making (SSMM), place attachment, environmental science literacy, and scientific reasoning increase due to participation in PBEL farm modules?
>
> **RQ2:** How and, if so, to what extent do any of the factors listed in RQ1 predict student civic-mindedness?
>
> **RQ3:** How, if at all, did the circumstances surrounding the COVID-19 pandemic, civil unrest, and protests against police brutality impact student outcomes?

Through these questions, we explore how PBEL on an urban campus farm (Angstmann et al., 2019) contributed to the development of student civic commitments, their environmental science literacy, their place attachment, and their ability to create place meanings within a sustainability framework. Specifically, we examine how PBEL learning that engages the three pillars and overlapping dimensions of sustainability (e.g., social impacts of environmental degradation) enabled new place meanings and connections.

TABLE 1. PBEL Farm Courses, Modules, Descriptions, and Students

Course	Module Title	Module Description	Students
Ecology	Soil Respiration, Biodiversity, and the Analysis of Variance	By combining biological concepts and socio-environmental impacts of local and global food systems with applied research, students explore 1) how sustainable urban farms contribute to a more balanced food system and 2) the importance of soil activity and biodiversity for food production through the experimental testing of hypotheses comparing soil respiration and arthropod diversity in a variety of macro- and micro-habitat types.	20/18
Environmental Studies	Exploring Urban Agriculture in Indianapolis	Students read, reflect, and discuss Michael Pollen's *The Omnivore's Dilemma* to become familiar with food system issues. They also examine the environmental impact of their food consumption via a carbon footprint exercise. Utilizing ethnographic methods at the campus farm and other local urban farms, students will localize readings and discussions to examine diverse urban farmer perspectives on food production and consumption. Qualitative data are interpreted using course concepts culminating in a paper/presentation.	18
Upper-Level Ecology	Bringing Microbes and Carbon Cycling Down to Earth	Students build upon what they learn in course lectures and from prior courses to design and conduct hypothesis-driven research at the campus farm and its adjacent prairie on soil carbon and controls of moisture and temperature. Students write a final report, present at the cross-disciplinary poster session, and contribute to a multiyear soil archive used in faculty research to quantify long-term soil ecosystem function in urban agriculture systems.	14
Chemistry	Urban Agriculture & Environmental Health: Characterizing Risks of Soil Contamination	Environmental health is discussed in the context of the types, prevalence, and levels of soil pollutants in an urban landscape, including urban sustainable agriculture in contrast to industrial farming. Students develop hypotheses for a suite of contaminants and design experiments requiring collection and analysis of soil and vegetation samples from the campus farm and other local urban farms. Students discuss challenges and solutions to urban contaminated soils, present at the cross-disciplinary poster session, share their data with farmers, and contribute to a long-term temporal dataset of urban contaminants.	13
Theology	Employing the "Loving Eye" in Nature Journals	Students learn about the complex ecological processes at play in an urban agriculture context, using ethnographic methods with the farm manager, interns, and patrons. These data are put in conversation with discourses in theology, particularly those that explore nature through two "eyes": the "arrogant" and the "loving" (McFague, 1997), via weekly journal prompts. The module provides a possible model for the ethical development of scientifically literate citizens capable of critically inquiring into ecological issues.	20
Education	Exploring Scientific & Historical Gardening Contributions with Young Learners	Pre-service education students, in collaboration with fourth graders at a public school and the campus farm, design and implement a curriculum guide that utilizes project-based inquiry and active experimentation based on learned content about scientists and their experimental contributions to botany and gardening. Pre-service students test lessons with fourth grade students at the campus farm and engage in reflective practice as they adapt their lessons. This project gives pre-service teachers a deep understanding of curricular design and pedagogical awareness, exposes young learners to environmental science concepts and botanical/agricultural history, and results in publicly available lessons for grades 3-5.	29

TABLE 1 CONTINUED. PBEL Farm Courses, Modules, Descriptions, and Students

Business/Management	Food as Space, Place, and Identity	Using industry and issues analyses combined with 1) visits to the campus farm, a local orchard, and an urban food production facility, 2) case studies of Gerber in Poland, Amazon, Whole Foods, and Second Helpings Food Rescue, and 3) a joint class with nutrition students from the Pharmacy program, students analyze the effects of globalization, sustainability, emerging technologies, politics, and ethics on consumer, investor, and citizen choices related to food. Students also use strategic and ecosystem thinking to better understand the shifting landscape of the food industry.	119
Communications	Using Digital Media To Empower Marginalized Populations	This inquiry-based, service-learning module centers upon a communication challenge presented by a farm organization to their assigned student group consultant. Students, with their urban farm, create a model of the farm-defined communication problem, conduct formal interviews to learn about how the community is impacted by the farm, and devise strategies to solve the communication challenge; these strategies may include developing media content to advertise a specific event, developing a campaign strategy or website, or live Tweeting a silent auction.	20
Pharmacy	Sustainable Healthy Nutrition	Students are led through an inquiry-based investigation into the nutritional and environmental characteristics of a local, seasonal diet and learn how those characteristics contribute to human and environmental health. Students journal experiences gathered through course readings and discussions, farm tours, cooking demonstrations, and personal reflections to create a knowledge base of diet, lifestyle, and nutrition and their relationship to disease.	37

With the third question, we examine how the "dual pandemic" of COVID-19 and the ongoing experience of systemic racism (Jones, 2021; Newman et al., 2023), especially as embodied in the highly visible social movements opposing systemic racism (e.g., Black Lives Matter), affected the aforementioned student learning outcomes in this farm-based PBEL context and brought out students' altruistic ideals and motivations. For this latter point, we are primarily interested in exploring whether "dual pandemic" events contributed to a greater awareness among students regarding environmental, social, and food-related issues and solutions. To be clear, by talking about a "dual pandemic," we are not arguing that systemic racism was some new "pandemic"; rather, the term is meant to refer to the notion that as the U.S. began sheltering in place, concerned about the uncertainty of what might lie ahead, we were also bombarded with images of racialized suffering "in a manner that was impossible to unsee or to look away" (Jones, 2021, p. 427). The horror before us was not just a virus; the horror was also comprised of the most despicable facets of our society, which could no longer be willfully ignored as we fretted in solitude over the future.

Methods

We used a mixed methods intervention research design (Creswell & Creswell, 2017) to answer our research questions. With this research design, quantitative and qualitative data were collected during the semesters in which the PBEL interventions were implemented. We analyzed both types of data for points of convergence and used the qualitative findings to interpret quantitative patterns. While our quantitative measures never aimed to examine how students were affected by COVID-19, protests, and civil unrest, our qualitative data helped to dissect how these significant events were impacting students during the 2020–2021 academic year and were, in turn, influencing how and why we saw statistically significant change across our quantitative measures.

Students were recruited from the 10 PBEL courses during their first course meeting. During the Fall 2020 semester, all recruitment took place online, while in the Spring 2021 semester it was conducted in person. A member of the research team visited each class, either via recorded video, Zoom, or in person, and spoke with students about the research project and provided study information sheets and consent forms. Students were then emailed an individual link via Qualtrics to a pre-survey.

Three additional reminder emails were sent to students who had not completed the survey over the next 10 days. Members of the research team then visited each course two weeks before the end of the semester to remind students about the study, recruit them to focus groups, and tell them to expect an email with a link to a post-survey. As with the pre-survey, emails were sent via Qualtrics to students over a two-week period with periodic reminders about the post-survey. Institutional Review Board approval was obtained at the institution where the research was conducted.

Quantitative Methods

Participants

One hundred and sixty-six students (43% of potential population) completed both the pre- and post-survey during the 2020–2021 academic year. The university's Office of Institutional Research and Assessment provided student demographic data, such as year in school, gender, race/ethnicity (white/non-white), major, and GPA. Demographic data by course and combined for the 166 students are provided in Table 2. One student was enrolled in two participating courses; that student's data were counted in each course but only once in the combined analysis.

Instruments

The pre-/post-Qualtrics surveys were composed of five different surveys. The Environmental Literacy Survey (Liang et al., 2018) was a national survey developed in Taiwan with a specific focus on environmental literacy in undergraduate students. Our version of this scale was composed of 42 questions with no sub-constructs. Altering the survey presented in Liang et al. (2018) was

TABLE 2. Student Demographic Data by Course and Overall.

	Bio	Pharm	Chem	Ed	Env St	Mgmt	Eco1	Eco2	Comm	RL	Total
GENDER											
Female	7	20	6	18	9	17	9	3	5	12	106
Male	3	10	1	0	4	21	4	10	1	5	59
Unidentified	0	2	0	0	0	0	0	0	0	0	2
RACE/ETHNICITY											
White	7	28	6	17	13	33	11	10	6	15	146
Non-White	3	4	1	1	0	5	1	3	0	2	20
Unidentified	0	0	0	0	0	0	1	0	0	0	1
LEVEL											
First-Year	0	0	0	0	5	0	5	8	0	1	19
Second-Year	0	1	0	1	5	0	2	4	0	2	15
Third-Year	3	7	3	12	1	0	4	1	2	1	34
Fourth-Year	7	20	4	5	2	38	2	0	4	13	95
Professional	0	4	0	0	0	0	0	0	0	0	4
TOTAL	**10**	**32**	**7**	**18**	**13**	**38**	**13**	**13**	**6**	**17**	**167**

necessary to make it fit our context. The Scientific Reasoning Scale (Drummond & Fischhoff, 2017) is a series of yes/no questions focused on an individual's scientific reasoning skills. Scores are represented as a percentage correct. The place attachment survey (Williams & Vaske, 2003) contains two sub-constructs: place identity and place dependence. It examines students' attachment towards the place they call home, their university, and the campus farm (or other urban farm in some classes). The Situated Sustainability Meaning-Making (SSMM) survey was created during the project's pilot to understand students' perceptions of a local farm (Sorge et al., 2022; Williamson et al., 2023). The survey was informed by conceptual and theoretical literature (Kudryavtsev et al., 2012; Stedman, 2002; Young, 1999), because there was no previous survey instrument for this purpose. The SSMM survey was designed with sub-constructs for sustainability's main themes: environmental, social, and economic. The Civic-Minded Graduate (CMG) survey (Steinberg et al., 2011) was used in this research in its unidimensional format. The survey has focus area constructs on students' knowledge, skills, disposition, and behavioral intentions towards civic participation.

Qualitative Methods

Near the end of the Spring 2021 semester, the first and third author, both experienced qualitative researchers, conducted three focus groups and one interview of 60–90 minutes each. The interview was conducted with one male student from the Spring ecology course (Eco2). One focus group was comprised of all 20 students in the Theology course (RL). The other two focus groups were comprised of two and three students, respectively. These focus groups included students from every course except the chemistry (Chem), environmental studies (Env St), and pharmacy (Pharm) courses. Specifically, one of these focus groups included a female student from the education course (Ed) and a female student from the communications course (Comm); the other focus group included a male student from the business capstone course (Mgmt), another female student from the education course, and a female student from both the education and ecology courses (Eco2). While we attempted to recruit students to focus groups at the end of the Fall 2020 semester, we were unsuccessful. We attribute our recruitment struggles during that semester to the stresses and disruptions caused to the lives of students, researchers, and instructors by the COVID-19 pandemic.

The focus group/interview protocol (see Appendix 1 for the full protocol) was designed to collect data that could help to explain the quantitative findings, particularly those related to civic-mindedness, sense of place, and environmental science literacy. To give one example, we asked students the following question: "Since beginning course work on the campus farm, have you experienced feelings of greater attachment to it—or feelings of greater attachment to the environment, more generally?" Given that the data collection occurred during the height of the "dual pandemic," our focus group/interview protocols also included questions about COVID-19, as well as questions about civil unrest and national protests against police brutality. To give an example of this line of questioning, we asked: (1) "Has your perspective on civic engagement changed in any way since the COVID pandemic? If so, how? (2) Has your perspective on civic engagement changed in any way since the recent national protests and civil unrest? If so, how?" Qualitative data were thematically analyzed to deepen our interpretations of the quantitative results.

Each of the Spring 2021 focus groups and the interview were recorded. The audio was later transcribed for analysis. During the focus groups/interview, the first and third author took notes, which helped to identify follow up questions, to document student responses that were surprising, and to support our subsequent thematic analysis. To begin the thematic analysis (Braun & Clarke, 2006; Creswell & Creswell, 2017; Guest et al., 2011), the first and third authors inductively developed themes by first reflecting on the focus groups/interview and then reviewing the written notes taken by both authors. These themes focused on growth in civic-mindedness and environmentalist attitudes, attachment to university and campus farm, environmental science literacy, and the impact of COVID-19, civil unrest, and national protests on their attachments and civic interests. The first author then reviewed the transcripts and began to organize and categorize the data into specific codes and descriptions. The third author provided a critical review of the first author's thematic coding structure and reported full agreement with the results of the analysis.

Results

Quantitative Findings

We do not report results for each individual course in this paper, as we are here concerned with the overall effects of our PBEL approach measured by the instruments. Additionally, sub-constructs for the survey instruments are not included in this study. Dummy questions were inserted into the online survey and students who answered them incorrectly had their data removed from the analysis. Independent sample t-tests of survey responses were run for all remaining students for each instrument using SPSS v27. Additionally, Cohen's d was calculated for each t-test (see Table 4) to determine effect size. No outliers were found in the data used in the analysis, and differences between the pre- and post-surveys were normally distributed. Assumptions for a paired-sample t-test were met by these data.

Finally, a stepwise regression model was run using student demographic information and other survey results to predict student post-civic-mindedness. The assumptions of a linear regression were met, such as the absence of multicollinearity and autocorrelation. The response rate was 62.8%.

Cronbach's alpha was quantified for each of the pre- and post-constructs to determine internal consistency. All constructs, except for Scientific Reasoning, had an $\alpha > .900$ on both the pre- and post-assessments. While the alpha for the pre-Scientific Reasoning was within an acceptable range, the post-assessment was not (Table 3).

TABLE 3. Cronbach's Alpha for Pre- and Post-Assessments

Assessment	Pre	Post
CMG	.904	.937
Environmental Scientific Literacy	.954	.971
Home Place Attachment	.909	.909
Butler Place Attachment	.932	.930
Farm Place Attachment	.973	.950
Scientific Reasoning	.881	.518
SSMM	.962	.974

TABLE 4. Pre- and Post-Assessment Means for All Courses Combined

	Mean	N	Std. Deviation	Std. Error Mean
CMG PRE	112.75	166	13.50	1.05
CMG Post	120.60	166	14.21	1.10
Env. Sci. Literacy Pre	168.26	166	20.64	1.60
Env. Sci. Literacy Post	173.55	166	23.83	1.85
Home Place Attachment Pre	41.83	166	9.10	0.71
Home Place Attachment	45.30	166	8.58	0.67
Butler Place Attachment Pre	41.11	166	9.85	0.76
Butler Place Attachment	44.41	166	9.53	0.74
Farm Place Attachment Pre	29.31	166	10.10	0.78
Farm Place Attachment Post	32.81	166	8.97	0.70
Scientific Reasoning Pre	.6703	166	.227	.018
Scientific Reasoning Post	.6616	166	.225	.018
SSMM Pre	81.59	166	11.55	0.90
SSMM Post	87.57	166	11.35	0.88

Paired-sample t-tests were run on pre- and post-survey constructs to determine change over the course of the semester. Table 4 provides the pre- and post-assessment means for Civic-Mindedness, Environmental Scientific Literacy, Place Attachment for Home, University, and the Farm, Scientific Reasoning, and Farm Place Meaning. For all instruments, except Scientific Reasoning, the mean increased from pre- to post-assessment.

Table 5 provides the results of the paired sample t-tests. All constructs showed statistically significant increases ($p < .001$) except for Scientific Reasoning. Additionally, the Cohen's d scores reveal that, of those constructs that had statistically significant increases, three had medium effect sizes (CMG overall, Home Attachment, and SSMM), while the rest were nestled between the small to medium effect size range (Lakens, 2013).

Stepwise Linear Regression: Predicting Civic-Mindedness Scores

This research also examined the factors that impact/predict an individual's civic-mindedness as measured

TABLE 5. Paired Sample t-Test Results for All Courses Combined.

				95% Confidence Interval Difference					
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig (2-tailed)	Cohen's d
CMG Pre-Post	7.85	11.87	14.21	9.70	6.03	-8.516	165	0.000	.661
Env. Sci. Literacy Pre-Post	5.29	16.06	1.25	7.75	2.83	-4.242	165	0.000	. 329
Home Attachment Pre-Post	3.46	16.06	23.83	4.96	1.96	-4.562	165	0.000	.654
Univ. Attachment Pre-Post	3.30	8.25	0.64	4.56	2.03	-5.143	165	0.000	.3999
Farm Attachment Pre-Post	3.51	9.49	0.74	4.96	2.05	-4.760	165	0.000	.369
Sci. Reasoning Pre-Post	0.01	0.23	0.02	-0.02	0.04	0.555	165	0.580	.043
SSMM Pre-Post	5.87	10.80	0.84	0.63	4.32	-7.123	165	0.000	.553

by the CMG survey. A stepwise linear regression was performed using SPSS v27 with post-CMG score as the dependent variable, all other post-assessment scores were used as potential independent variables as well as the student's race/ethnicity, level, sex/gender, course, and post-course GPA.

With these data, a student's Environmental Science Literacy score and their post-Attachment score to the university were the only statistically significant predictors of their Civic-Mindedness as represented by their CMG score (see Table 6). This regression model has a $R2=.620$, $F(2,163)=133.252$, $p<.001$ and a regression equation of: CMG=31.786 + (.429) (Post-Env Scientific Literacy Score) + (.325) (Post-University Place Attachment)

TABLE 6. Final Model Linear Regression Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Constant	31.786	5.555		5.722	.000
Env. Sci. Lit.	.429	.029	.719	14.658	.000
Univ. Attach.	.325	.073	.218	4.446	.000

Qualitative Insights: Explaining Statistical Change

Using focus group/interview data, we now focus on explaining how and why we see statistically significant changes in student Civic-Mindedness, Environmental Science Literacy, and Sense of Place and also explain why Environmental Science Literacy scores and University Place Attachment were predictive of student Civic-Mindedness scores. We also examine the effect that the COVID-19 pandemic and national protests against police brutality had on students as they engaged in PBEL courses. All student names given below are pseudonyms.

Civic-Mindedness and Environmental Science Literacy

When students spoke about civic engagement during the focus groups, it was often discussed relative to two different codes: 1) care for the environment (i.e., environmentalism) and 2) U.S. civil unrest and national protests against police brutality. For the first code, students often expressed concerns around anthropogenic climate change and unsustainable food systems and were interested in personally

addressing their own role in those problems. Several students attributed these concerns and interests to their PBEL courses and spoke about how, in these courses, they constructed a deeper understanding of the environmental and ecological sciences. For example, Johanna, a theology student, reported that having a scientific understanding of "the ecological system ... and how humans fit in" can be the foundation for "a new perspective" for how to "interact with the environment ... and care for it." Other students also articulated how the knowledge constructed in their PBEL courses created a desire to interact carefully with the environment. For example, Mary, a student from the communications course, stated, "I've just seen from this course ... how important the environment is, how important it is to protect it, and [the importance of understanding] different environmental injustices." Similarly, Sally, a student from the education course, added that her experiences on the campus farm helped develop her environmental consciousness: "[the farm] just reminds me that, like, I need to be very conscious of the impact that I'm making on the environment."

Students also identified several specific ways to protect or provide care for the environment. Generally, several students across the qualitative data set reported that they could provide such care by recycling, by volunteering on the campus farm, by purchasing locally and sustainably grown produce, and by voting for politicians who will support sustainability efforts. Students' intentions to care for the environment, however, were also often attached directly to their programs of study. For example, Sally discussed how she could introduce sustainability, sustainable food systems, and the idea that "you can actually make a difference based off of your actions" in her future elementary school classroom. She explained that she wanted to help her future students understand that they "have an impact on the environment" and that—echoing her course's carbon footprint activity—they need to strive to "leave as little of a footprint" as possible, to "take the time to really appreciate everything the environment has to offer," to take "note of how quickly it's starting to deteriorate," and to ensure that her young students can identify ways that they "can have a positive impact on the environment."

The students in the Theology course also brought up a deeper problematization when they discussed the relationship between worldviews (e.g., subject-object vs subject-subject; arrogant eye vs loving eye, see McFague, 1997) and human interaction with the environment. Johanna described how she likes to frequent a state park that is close to her home. She explained that when she does so, she likes to take a trash bag with her to pick up garbage carelessly discarded along the trails. She reported that this practice stems from her belief that the park should "be respected and, like, should be celebrated." She elaborated by articulating that she has a "mutual respect" for the environment: "I'm looking at, like, a place like a subject and not like an object." Morgan added that through her experience in the theology course and its PBEL farm module, she has "changed." She reported that in the past, she saw plants "more as objects than I ever did as like their own beings," and that in shifting this worldview she had become "more acutely aware that my surroundings are alive." Finally, to build upon this a little further, Miranda stated: "the perspective that we use, and the way that we view things determines ... how we act and what we think; what we prioritize and act upon." Here, we find students acknowledging the important role dominant mental models, such as subject-object worldviews, play in how humans go about addressing sustainability and how different modes of thought, such as subject-subject worldviews, might affect human interaction with the environment.

Given the timing of the focus groups/interview during the height of the COVID-19 pandemic, civil unrest, and widespread protests in the U.S., we decided to explore how, in the context of this PBEL farm modules project, environmental concerns might intersect with sociopolitical concerns around current events. This is represented by the second code introduced in the beginning of this section. In our data set, students articulated connections between sustainability concerns, current social justice issues, and their own thoughts on, and intended actions within, civil society during discussions on civic-mindedness. For theology students, subject-subject worldviews again came into perspective; for example, Sarah stated: "Every human, like, deserves to be valued as a subject. ... I think we've struggled to do that, like, just in basic human rights ... water, food, and shelter and then race and then ... sexuality. ... We objectify a lot of things for a lot of reasons that aren't, you know, necessarily correct." Here, we witness a student acknowledging

an entanglement between objectification, sustainable and just food systems, and systemic racism. Johanna elaborated that the pandemic and civil unrest have "made it easier to, like, recognize these problems" and that civil unrest has brought people together as "collaborators" working to address "social justice issues" and "environmental issues," which, according to her, were all "tied up together." A desire and passion to address social and environmental issues throughout one's career was articulated by multiple other students across the focus groups.

Sense of Place

During focus groups, discussions around sense of place—place attachment, place dependence, and place meaning (i.e., Situated Sustainability Meaning-Making)—introduced new articulations of place attachment and what contributes to the constitution of that attachment. These discussions provided greater insight into why we saw statistically significant increases in place attachment scores relative to home, university, and campus farm (see Table 5). To explain these changes that occurred throughout PBEL experiences during the "dual pandemic," we identified four key codes: 1) attachment to home through sheltering in place or absence/longing, 2) attachment to university through meaningful social relationships, 3) attachment to campus farm and the natural world through alleviation of isolation, and 4) attachment to farm and university through feelings of reciprocity.

First, we identified that student home attachment was most often attributed to students who had to isolate in their homes with family members or, when home could not be accessed due to COVID-19 precautions, who had a longing for their home and family. For the former, Steve, a theology student, reported that he and his two older brothers sheltered in place at their parents' home for several months during the pandemic and completed their respective schoolwork online. He reported that this arrangement was "a blessing in disguise," because it provided him the opportunity "to reconnect with them." As a result, the COVID-19 pandemic increased his attachment to home. The latter group included multiple students who lamented that they were unable to go home because of the need to protect family members, mainly grandparents, who were at high risk for COVID-19 complications. While attachment to home may have increased for a variety of reasons, many students also reported the desire to get out of their homes during the pandemic.

Second, Spring 2021 students elaborated extensively on the important role social relations play in the formation of our place attachments. This was most evident when students discussed their university attachment, which was most often articulated as being developed through their social relationships with peers during COVID-19. John, a student from one of the ecology courses, portrayed place as the physical environment in which relationships are nurtured and values shared. Attachment to the university, for him, then flowed from these relationships, which he needed to rely on more during the "dual pandemic." He stated, "it's not necessarily the buildings, the things that I'm involved with, the classes I've taken. It's the fact that I've met people here that I would not have met anywhere else. So, I think that definitely contributes to maybe not the physical place, but the fact that without that, without this physical place ... I would never have been with some of the people that I care about most." As he explored place attachment and social relationships further, he described going to local protests with his fraternity brothers. He stated that "it has made me more attached to the friends and the people that I've gone with to these protests, because I know that these people ... are of similar values, of similar thought to me. And, I guess I value them more knowing that they would be willing to go to things like that with me." Sally also acknowledged that at the university, she could be around people who share similar viewpoints, concerns, and values. This attached her more to the university and her peers than to home, because her hometown, she reported, was "very white and very conservative."

Third, many students, including over half the theology students, reported that their attachment to the farm, and the environment more broadly, was influenced by the opportunity such places offered for them to safely escape from COVID isolation. Johanna reported that it was "so nice" to be able to take walks in parks on her own or with friends and feel safe from the risks of COVID. Such walks provided her with opportunities to "reflect" on "everything that was happening." When visiting the farm during her PBEL course, she reported that "the farm did that for me, as well." Morgan agreed with Johanna and added, "As for like the farm and everything, it kind of almost feels like a little escape, because it's like I can be out in nature and be

like enjoying this [farm] that's on campus." For Johanna and Morgan, as well as other PBEL students, the farm and the broader environment provided a safe reprieve from the stress of COVID isolation.

Interestingly, several students seemingly saw the benefits offered by such places almost as gifts, which created a sense of responsibility to give in return. For the final code, students articulated the role of reciprocity in their formation of place attachment. This means that students were grappling with complex ideas around their responsibilities and their indebtedness to what they receive from the places with which they interact. PBEL students described how the campus farm, the broader environment, the university, and even the surrounding city have given them so much and that they must reciprocate. Here, we see the ways that reciprocal relationships can knit one to specific places. Sally, the education student mentioned above, stated: "if [the campus farm was] looking for help, I feel like I would feel comfortable signing up to do whatever it is. Even though I may not have all the knowledge, I feel like I could give back because they welcomed me in and taught me a little bit about the farm and how it works." Similarly, John described his feelings about the farm in this way: "The farm produces food that's healthy, that goes to our table, that the friends that I have in the fraternity, and the people—my brother's coming to Butler—the food that he will eat here, is maybe produced by the campus farm. So, I guess it gives me an investment [in the farm] knowing that it has given something back." In other words, some students expressed that they wanted to "give back" to places that have impacted their lives and that their attachment to such places, like the campus farm, inspired them to provide the same care that was provided to them in that place.

Stepwise Linear Regression and Qualitative Support of Findings

With the COVID-19 pandemic beginning in the first year of this project, the student body was affected by significant disruptions to their overall educational experiences, including not only how they engaged with the university community and their courses but also how they interacted with the campus farm in the PBEL modules. As reported above, for Fall 2020–Spring 2021 students, we found that both Environmental Science Literacy scores and post-University Attachment scores were strongly predictive of CMG scores. In other words, the higher PBEL students scored on environmental science literacy and university attachment measures, the more likely they were to have high civic-mindedness scores. In this section, we aim to examine the intersection of these three concepts in the qualitative data.

The codes presented in the first two subsections of the qualitative results section illustrated the complex ways in which PBEL students developed university attachment, civic-mindedness, and environmental science literacy. The data reported above point to the ways that PBEL students, during the "dual pandemic," began to experience entanglements between their attachment to the university, their attachment to the campus farm, their social relationships, and their desire to make a difference in the areas of environmental and social justice. Many students characterized the importance of their university peers—and, for education students, the importance of their professors—in how attached they were to a particular place. Oftentimes, these relationships were nurtured outdoors in natural spaces (e.g., parks, the campus farm) that were relatively safe from COVID infection. At other times, these social relationships led them to places on and off campus where they discussed/expressed their feelings, worries, or concerns. Melissa, a student from the university's education program, was especially vocal in describing how some education professors were willing to spend a lot of time supporting their students. For example, Melissa stated that her professors were very accommodating and that she could talk to them if she was "having a bad day" and even "get a cup of coffee" with them if she had concerns about an assignment. This reportedly helped instill in her "the sense that I am almost at home." John reported joining his university peers in an off-campus protest against police brutality. The university provided a place where students could connect with others and the natural world during a time of great uncertainty and upheaval.

In sum, our focus group data revealed the increased importance of the university, its students, and its undergraduate programs, particularly in the context of the "dual pandemic." The university was often named as one of the only consistent means of both environmental (e.g., the campus farm) and social (e.g., peer relationships) connectedness for students throughout the COVID-19 pandemic. The solitary experience of pandemic life was partially mitigated

by student relationships with their peers, opportunities for outdoor excursions, and also relationships within their departmental programs—the education program was a standout in this regard. It was also in the context of these social relationships that students processed the societal concerns and stressors (e.g., civil unrest) that were ubiquitous throughout the "dual pandemic." So, if students were attaching to the university via the social and environmental relationships that university life had made possible, and if within these relationships there were opportunities for discussion and, at times, action in response to environmental and social injustice, then it is evident that there is clearly some connection between university place attachment scores, environmental science literacy, and CMG scores.

Discussion and Conclusion

The purpose of this study was to examine the outcomes of implementing sustainability-themed PBEL on a campus farm. We found quantitative and qualitative evidence that PBEL farm modules, specifically when situated in relation to the complexities of the COVID-19 pandemic, civil unrest, and protests against police brutality, produced a learning environment that was particularly effective at increasing pro-environmental and civic thought and action, as well as student willingness to engage in social justice issues, such as food (in)security and how it is asymmetrically experienced by systemically oppressed communities. These findings build upon existing literature that demonstrates that embedding social and ecological issues into disciplinary learning experiences enables students to expand their views of their identities, agency, and roles in contributing to change (Garibay, 2015; McGee & Bentley, 2017; Williamson et al., 2023).

Our findings point to the power that generation-defining events can play on how people perceive their relationships to places, as well as how and what they learn through their place-based interactions or lack thereof. Our PBEL approach corresponds well with the literature that testifies to the value of place-based education, as well as the argument put forth by Carter et al. (2021) that students are drawn to the earth and environmental sciences—particularly topics related to environmental, ecological, or sustainability concerns—out of a sense of altruism. Student participants in this study, both STEM and non-STEM majors, increased their civic-mindedness, their place attachments, their sustainability meaning-making, and their environmental science literacy by engaging in PBEL modules. In doing so, they also encountered experiences that engaged their altruistic values and fostered their development of pro-environmental thought and action toward social and environmental justice. Altruistic outcomes were further evident in how students described the reciprocal obligations they have to the places that socially and emotionally nurture them.

The "dual pandemic"—and the multitude of crises arising from or revealed in its wake—appeared to create an educational milieu in which place attachment, civic responsibility, and knowledge of the environment could be cultivated and enhanced using PBEL farm modules. Students, like all of us, were isolated and experiencing a great deal of stress and uncertainty during the Fall 2020 and Spring 2021 semesters. Engaging on their campus, in their programs, with their peers, and on the campus farm in their courses seemed to at least partially, although perhaps only briefly, mitigate the loneliness and fear associated with life under COVID-19 and the societal injustices and repressive and ideological violence that it laid bare.

That said, there are limitations to this study. This study was conducted at a private, predominantly white university during the global COVID-19 pandemic, and our findings reflect that context. Future studies examining the impact of PBEL in urban and campus-situated agricultural contexts could expand upon our findings here by analyzing a more diverse sample of students and universities collected in a post-COVID environment. Our findings speak to a very complex moment, and we acknowledge that our specific results were shaped by many powerful, generation-defining forces that restricted access to particular places. The timeframe for our data collection could also be characterized as a time of great civil unrest, considering the social protests against police brutality, which affected students in a variety of complex ways and influenced how they made meaning of course materials. The COVID-19 pandemic also limited opportunities for classroom observations and discussions and affected whether students self-selected to participate in focus groups/interviews.

With the COVID-19 pandemic subsiding and with the issues igniting civil unrest and protest receding from mainstream visibility, a future study may find different

results. In fact, in this study, we found substantially different results than our previous studies on PBEL farm modules (Sorge et al., 2022; Williamson et al., 2023). In what remains of this paper, we will first discuss how this study compares to our previous studies. We will then close by considering future directions for research that explores in greater detail how a mixture of PBEL and course content that challenges student mental models might impact sustainability thought and praxis.

Comparison to Past Findings

The results of the current study were much different from one of our earlier studies (Sorge, et al., 2022), which surveyed students participating in PBEL activities on the same campus farm in Fall 2017 and Fall 2018. According to Sorge, et al. (2022), 2017–2018 student CMG scores were predicted by post-place attachment to the campus farm scores, the course in which the students had had the PBEL experience, and student SSMM scores. Notably, between the present study and the Sorge et al. (2022) study, civic-mindedness remained a scale upon which students reported increased development; however, what predicted these CMG scores was different between 2017–2018 and the 2020–2021 academic year, when CMG scores were predicted by university attachment and environmental science literacy scores.

We postulate that this shift is due to some extent to student experiences of life during the "dual pandemic." For example, given that students were attaching to the university campus due in part to the opportunities it provided for social relationships—which were, as a consequence of the "dual pandemic," often experienced outdoors in natural environments and, at times, in contexts (e.g., the university) where important values were shared and discussed (e.g., protests, conversations)—it is unsurprising that, with this current study, student civic-mindedness is connected with environmental science literacy and university attachment.

Additionally, in another one of our studies with PBEL students from the 2017–2018 and 2018–2019 academic years (Williamson et al., 2023), the development of farm place attachment was influenced by students' academic/career goal interests, as well as their background. According to Williamson et al. (2023), the campus farm provided students with opportunities to gain insight and hands-on experiences influenced by their recent and distant experiences. This was especially true for one student's recent academic experiences, which had contributed to increased anxiety and stress. The farm-based PBEL experience provided opportunities for that student to reportedly feel greater control over their life. Time on the farm, then, was capable of providing "emotional relief" (Williamson et al., 2023, p. 11). This is interesting because, in this current study, instead of the campus farm being the primary place where students might find alleviation of anxiety and stress from their university programs, students found such alleviation within the broader university, which contains the campus farm, because it provided an escape from the solitude and anxiety of the "dual pandemic." During the 2020–2021 academic year, the source of the anxieties and stress students faced was different. This does not necessarily mean that students were not concerned about their assignments and grades during this time; rather, perhaps it was simply that the stress and fear associated with the "dual pandemic" were much stronger.

Future Directions: Mental Models and Systems Thinking

Some of our qualitative data from the theology focus group suggests that by coupling critical frameworks (i.e., subject-subject worldviews, "the loving eye") with PBEL experiences on the campus farm, students began to develop alternative mental models and worldviews. These mental models articulated novel forms of relational subjecthood that refused simplistic human/non-human distinctions, as well as the modes of valuation that so often accompany the ideological systems that express a hierarchy of being, with humanity at the apex and all other entities, living or otherwise, beneath (see Blaser, 2010; Escobar, 2018; Fore, 2022; Latour, 2012).

When considered within a "systems thinking" framework (Kim, 1999; Meadows, 2008) mental models play a fundamental role in the realities we have constructed and uncritically reproduce. Mental models are the source of systemic structures from which repeated events or patterns occur, yet they are often hidden from decision makers, limiting the ability to create sustainable and effective change to wicked problems (Monat & Gannon, 2015). By understanding the often subconscious mental models that shape their worldviews, students can begin to intentionally interrogate and reshape their perspectives to foster

a paradigm shift in how nature and humans are valued and perceived. Future work in PBEL education and research should examine how students' PBEL experiences can help them to develop critical reflective frameworks and construct knowledge of novel modes of sustainability thought and praxis.

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APPENDIX:

NSF IUSE PBEL Farm Focus Group Protocols

Modified for COVID, National Protests, and Civil Unrest, October 2020

Student Focus Group
Hello, my name is _____.
This focus group will be recorded and then transcribed. The transcription will not include any personal information, so as to keep your personal information confidential. If anyone does not wish to be recorded, we will reschedule a time to get your input without the use of a recorder. Is everyone fine with being recorded today?

I am part of a research team from the _____. The objective of this focus group is to understand your experiences engaging with the campus farm in your courses. Your participation in this focus group is completely voluntary, and if you wish to decline responding to any question you may do so. You may leave this focus group at any time.

1. What aspects of the curriculum have you enjoyed the most? Least?
2. What are your academic and career goals?
   a. What specifically do you think draws you to this trajectory?
   b. Have these changed in any way since you engaged with the campus farm? If so, how?
   c. Have these changed in any way since the COVID pandemic? If so, how?
   d. Have your goals changed since the recent national protests and civil unrest? If so, how?
3. How has your feeling toward your academic career goals changed over time?
   a. What aspects of the curriculum have influenced these changes? How?
4. Since beginning course work on the campus farm, have you experienced feelings of greater attachment to it—or feelings of greater attachment to the environment, more generally?
5. In your experience, do you interact with a place differently when you feel some sort of attachment to that place?
6. How, if at all, has the COVID pandemic influenced or impacted your feelings of attachment to home?
   a. The university?
   b. The campus farm?
7. How, if at all, have the recent national protests and civil unrest influenced or impacted your feelings of attachment to home?
   a. The university?
   b. The campus farm?
8. What does civic engagement mean to you?
   a. How has civic engagement been portrayed in your courses?
   b. [If applicable] How has civic engagement been portrayed in your experiences with the campus farm?
   c. Has your perspective on civic engagement changed in any way since the COVID pandemic? If so, how?
   d. Has your perspective on civic engagement changed in any way since the recent national protests and civil unrest? If so, how?
9. In your experience, how does civic engagement occur or what does it look like?
   a. Where do you think these views come from?
10. In what ways do you think civic engagement is important to your own work?
    a. Do you have any examples of being civically engaged, in general?
    b. Do you have any examples of being civically engaged during your courses?
    c. Do you have any examples of being civically engaged during your work experiences?
11. What does it take to be a civic-minded professional?
    a. Do you have any examples?
12. Has your interaction with the campus farm affected the ways in which you want to interact with the community in the future (either personally or professionally)?