

Article

Future Directions—Engaged Scholarship and the Climate Crisis

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Abstract: Climate change has the potential to disrupt ecosystem services and further exacerbate the effects of human activities on natural resources. This has significant implications for educational institutions and the populations they serve. As the current crop of landscape architecture students struggles to define its role within the climate crisis and its related social and political underpinnings, a core mission of colleges and universities moving forward should be to provide students with applied knowledge about how climate change affects the landscape. This goes beyond coursework in climate science or policy; for landscape architecture students to be leaders in the response to climate change, they need applied, practical skills. An ever-growing body of the literature focuses on landscape design strategies for climate change adaptation; however, few frameworks integrate these strategies with the hands-on experience students will need to face real-world challenges after graduation. Educational institutions have the potential to utilize their campuses as demonstration sites for applied ecosystem research programs and actively engage students with the design, implementation, politics, and ongoing stewardship of these landscapes. This paper uses a case study methodology to understand how experiential and public-engaged learning pedagogies contribute to student preparedness to address climate change. It examines three cases of engaged learning at the University of California, Davis campus and attributes their impact to intentional connections with research, to the delegation of responsibility; to the openness of spaces for experimentation, and to self-reflection that connects climate with everyday behavior. By promoting experiential learning programs that require students to actively use their heads and their hands to construct and sustainably manage their own campus landscapes, service-learning studios and internships can provide opportunities for students to address the real scenarios of climate crisis and resilience.

Keywords: experiential learning; climate change; engaged scholarship

1. Introduction

As a people and planet, we are facing improbably large problems: climate change, pandemics, social and economic inequality, and massive biodiversity loss. The scale and urgency of today's challenges differ from anything we have previously encountered in our existence as a species. Half of the world's wealth is now in the hands of only 1% of the people; the U.S. is both the richest and the most economically stratified nation. Simultaneously, plant and animal species are going extinct in record numbers, with two thirds of assessed plant species, a fifth of all mammals, and a third of amphibians currently threatened with extinction [1].

Climate change promises to dwarf all other issues. Climate scientists no longer have confidence that global temperatures by the end of the century can be limited to a 2 °C increase, as pledged under the 2015 Paris climate agreement. Instead, they project a more realistic rise of nearly five degrees or more by the end of this century [2]. In response to Arctic melting, the sea level is projected to rise

6–9 m, flooding nearly all of our coastal cities well before 2100, regardless of emission reductions [3]. Weather is becoming more extreme: heatwaves, hurricanes, and storm surges are not only more severe, but also more frequent. The oceans are already 30% more acidic than previously, threatening the world's largest ecosystem, while habitats across the globe are becoming less hospitable for wild animals and native plants [4].

Coupled with these environmental challenges is an equally significant list of concerns related to social and racial inequalities that disproportionately place the burden of these environmental challenges, such as impacts to public health, transportation, or access to emergency services, onto existing disadvantaged and marginalized communities [5–7]. To date, predominant strategies to address resilience to climate change rely on the application of innovative technology, engineered solutions, or policy-making, such as mitigating climate impacts through renewable energy investments, transportation planning, or emissions regulations. The broad-strokes of policy-making or adaptation planning often exclude some of the most vulnerable communities, including those of low socio-economic status, color, underrepresented minorities, and/or youth and the elderly, from discussions that address these challenges [8]. In this context, we need new strategies that engage these communities in “examining, problematizing, and designing alternatives to our current notions of climate crisis, vulnerability, and adaptability” [9].

Landscape architecture programs are well positioned to address issues of climate change through a socially or politically driven lens, specifically with studio classes focusing on community engagement and the process of building back after disasters [10]. They are similarly positioned to address climate change by leveraging ecological processes in cities through design courses on climate-appropriate plantings, urban sustainability, and green infrastructure [11]. Curricula weighted highly towards science and policy, however, do not respond sufficiently to the complex challenges of climate change [12]. Despite technological advances in green building and other architectural aspects of climate change adaptation, educators still struggle with preparing design students to effectively address the ecological challenges of a warming planet (Guzowski, 2010) [13]. True climate responsive design, which involves the integration of both quantitative scientific information and social factors into the creative design process, has been incorporated only superficially into the education of landscape architects [14]. A pedagogy of climate change resilience, therefore, requires an expansion of the current paradigm to include representatives of all disciplines and perspectives including social and ecological scientists, landscape architects, architects, engineers, planners, community residents, and students of all related disciplines [15]. This more comprehensive approach expands the scope of services by combining existing landscape architecture capabilities with emerging professional knowledge in urban ecological science, planning, and design [16]. To adequately address complex issues such as climate change, landscape architecture education must also satisfy conditions of engagement, knowledge, interaction, and communication [12].

Today's landscape architecture students are neither immune nor ignorant to the challenges of climate change. As a population, they are engaged in climate action and eager to address the social, political, and environmental implications of a rapidly changing landscape. Collectively, they worry that the profession as a whole is not doing enough to propose equitable, sustainable, and, perhaps most importantly, actionable solutions. In a 2019 open letter on climate action addressed to the leadership of the American Society of Landscape Architects (ASLA, Washington, DC, USA), students voiced fears that while the “threat of climate change and the danger it inflicts are certainly invoked within the profession, we are concerned with how these words are acted upon” [17]. The letter, signed by more than 500 current landscape architecture students, culminated in a bold vision that asked ASLA to endorse and help define the Green New Deal, assert a commitment to serving the public realm, and advocate for climate science in curricula and licensure. Research shows that before students can act authentically on an issue like climate change, they must first feel a personal sense of investment in that issue [18]. Thus, collective actions such as this open letter can serve as powerful tools to engage students with climate change and nurture the belief that even small-scale actions can lead to empowerment and further action [19].

Education is one of the most effective ways to promote awareness and change on socio-environmental issues such as climate change [20]. However, psychological research confirms that the communication of scientific knowledge is not enough to stimulate behavior change or substantive action on the climate crisis [21]. Charged with encouraging, supporting, and furthering education in the field [22], instructors of landscape architecture and their affiliated institutions should directly address these student demands. In fact, we maintain that endorsing, asserting, and advocating for addressing the climate crisis is not enough. As landscape architecture students prepare for a rapidly changing future, a more comprehensive approach to climate adaptation is needed [16]. To create meaningful change within the profession and to empower the next generation of landscape architecture leaders, landscape architecture programs must act to support student needs for an education that promotes the transfer of theory into practice and vice versa [23].

University campuses represent an underutilized pedagogical opportunity for educators of landscape architecture. Comprising areas of urban density, pastoral lawns, and wild and open spaces, campus landscapes bridge the spectrum from rural to urban, formal to informal. As physical spaces where students and academics are encouraged to experiment and test new ideas, campus landscapes are inherently dynamic. Since campuses face many of the same problems as small cities (habitat degradation, food insecurity, watershed problems), they make excellent sites for field work and case studies, with research results that can ultimately be translated and scaled up to the public realm.

Although universities have made great strides in reducing their environmental footprints, campus sustainability programs tend to focus primarily on large-scale operational transformations (energy/water conservation, emissions reductions) or academic curriculum initiatives [24]. Though important, these initiatives fail to take advantage of the potential to systemically link academia (research and teaching) with on-going campus operations and facilities management [25]. Fully integrated sustainability research efforts are rare on university campuses, as linking institutional transformation with academic research and empirical monitoring requires a level of collaboration difficult to achieve across operational and academic units [26]. Moreover, opportunities to address both collective and individual behaviors around sustainability and other human-centered approaches are under-explored.

Internationally, the idea of college campuses combining research and operations to create living design laboratories for applied research and teaching is not new [27–29]. In the United States, land grant universities provide an ideal canvas to pilot the applied ecosystem research already happening on campuses [30,31]. Additionally, university campuses offer a unique setting to promote partnerships with other departments, both academic (landscape architecture, design, environmental science, public health, ecology) and operational (facilities, grounds maintenance, campus planning), as well as with external stakeholders (construction, architecture, and landscape architecture professionals with projects on campus) to “prove out the technical, economic and behavioral aspects of sustainability in the simpler institutional environment of a single campus” [29]. Living labs can thus provide the university with a holistic and iterative framework for the co-production of knowledge, while enhancing its contributions to climate change research [27].

Perhaps most importantly, the campus landscape offers students and educators opportunities for experiential learning and a canvas upon which to make climate change more visible to the surrounding community. This role of landscape as both experiential medium and visual message is often missing from consideration in strategies to engage communities with climate change [32]. By integrating a knowledge/information approach to climate change with ‘affective-experiential’ and ‘social-normative’ approaches [33], landscape architecture educators can both directly engage students with climate change and develop landscapes to positively influence community behavior. The local and physical aspects of a warming climate can be visually highlighted through these experiential landscapes and projects, making climate change more real and meaningful for people where they live.

1.1. Experiential Learning

Universities around the world have embraced pedagogies of experiential learning, as evidenced by a simple keyword search in the scholarly literature. The model has been adopted across educational disciplines, including health sciences, urban planning, management, engineering, information technology, geography and biology [34]. However, this shift has not been fully explored for campus landscapes. In fact, as we build out college campuses and cram them with technology hubs and state-of-the-art learning centers, we may be leaving less space available for active learning. Campus landscapes can be ideal experiential laboratories—well equipped but loosely programmed spaces that encourage interdisciplinary collaboration and allow students to propose projects, execute them, and learn from their successes and failures. These spaces allow students to collaborate with university design, planning, facilities, and groundskeeping staff and work through the inevitable layers of rules and regulations to provide a level of real-world problem solving that lectures and homework assignments cannot reflect.

Lessons gleaned from the field of education posit that learning is most effective when students are given opportunities to formulate ideas, test them through concrete experiences, and reflect on the outcomes. Psychologists David and Alice Kolb referred to this theory as experiential learning and defined it as “the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming the experience” [35]. Pedagogically, this translates into taking classroom principles and materials and enhancing them by providing students with opportunities to test them in action. Studies show that experiential learning in outdoor environments improves information recall and creative problem solving [36]. Experiential learning courses provide students with a deeper understanding of the issues through firsthand experience [37], give them a more personal and collaborative group learning experience [38], and foster the development of core competencies such as communication, self-motivation, presentation skills, and independent learning [39]. Other research indicates that adults are more likely to adopt new behaviors when they are learned in experiential settings that are meaningful to them [40]. Design educators can provide immersive student learning experiences through the creation of: 1. Applied opportunities to learn (and practice) leadership skills and organizing; 2. Outdoor laboratories to propose, test, and learn from new ideas and research; and 3. Multi-disciplinary spaces that encourage collaboration and diversity.

1.2. Engaged Scholarship

Engaged scholarship was first promoted in the early 1980s by U.S. Commissioner of Education and Chancellor of the State University of New York (Albany, NY, USA) Ernest Boyer. With disinvestment, suburbanization, and de-industrialization on the rise in cities, and with poverty rates increasing across the country, Boyer supported campus-based community service efforts by students and faculty, famously stating “to give knowledge to students but also to channel knowledge to humane ends are our most compelling obligations as educators” [41]. Engaged scholarship takes the hands-on principles of experiential learning and extends them to include community engagement by *connecting the rich resources of the university to our most pressing social, civic and ethical problems and creating a climate in which academic and civic cultures communicate more continuously and creatively* [42].

Engaged scholarship can take many forms and includes collaborative relationships with local communities, as well as providing access to university resources, to intellectual pursuits and organized research that inform and shape public policies and debates, to scientific and technological innovations that improve people’s lives and the environments in which they inhabit. Collectively, these activities have impacts at different geographic scales, across sectors, and between disciplines that aim to improve the wellbeing of individuals, communities, and the planet. This reflects a shift away from using the terms “service” or “outreach” and instead an embrace of “engagement” to describe reciprocal and mutually beneficial relationships between faculty, students, and non-university groups. Equally important is a

conception of knowledge that has relevance beyond the academy, and is often produced with, not for, non-university groups, towards actionable outcomes [43].

These scholarly practices are familiar to our field with its focus on the design, planning, and management of land. Indeed, direct interaction with communities, who often serve as co-collaborators in our studios, facilitates the integration of public engagement into the classroom [44]. In fact, the Landscape Architecture Accreditation Board requires that accredited programs “establish an effective relationship with the larger institution, its alumni, practitioners, the local community, and the public at large” [45]. At universities across the U.S., programs typically facilitate interactions between students and non-university groups through studio projects, practicum courses, education abroad, and internships. They may organize these activities through community engaged centers or non-profit organizations. These centers are part of a larger ecosystem of publicly-facing and multi-disciplinary design organizations that, since 2000, have nearly tripled in North America from under 70 to over 200 [46].

1.3. Collaboration with Professionals

The landscape architecture profession demands the training of designers who have some experience with community development, citizen participation, applied ecological science, and conflict resolution. Collaboration with professionals who work in these fields exposes students to practical applications of classroom lessons and provides them with real-world opportunities to test theory in action across a wide spectrum of social-ecological systems. This approach capitalizes on the concept of a science of integration, which relies on team-based interdisciplinary research and partnerships with stakeholders, to co-produce knowledge for solving real-world problems [47]. A model of success is therefore one that integrates student learning with the day-to-day tasks and challenges of the professional realm. This process of working collaboratively with professionals across disciplines presents students a singularly unique environment independent of traditional learning styles, vital in preparing them for full time employment after graduation [48].

Traditionally, professional/student collaborations in landscape architecture have taken the form of either internships or studio projects, with professionals assuming an authoritative role. This study examines collaborations in which students and professionals work together on a more equal footing, to co-create local solutions to global problems within a framework of the campus landscape. This collaborative and horizontal approach is also supported by a renewed focus at institutions of higher learning on the acquisition of practical skills, graduate employability [49,50], and the co-creation of the student university experience [51]. Equity, interaction, and knowledge sharing serves as the foundation for a model of co-creation [52], providing students with an action-learning template to create responsible change at the local level and providing professional staff with a front-line student perspective on issues related to the campus. Other benefits to the co-creation model include increased perceptions of employability, enhanced self-efficacy, and increased student ownership and belongingness within the university community [53].

2. Materials and Methods

In this paper, we utilize qualitative issue-based case study methodologies [54–56] to evaluate the impacts of three examples of experiential learning on the UC Davis campus. Social scientist Robert Yin describes a case study as “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” [55]. Within the design fields, case studies are particularly useful, as Mark Francis has noted, to elevate noteworthy projects and as “a source of practical information on potential solutions to difficult problems” [54]. As detailed below, this case study is conducted using mixed methods including qualitative content analysis, direct observation, participant observation, interviews and surveys. Multiple cases are explored within a broader institutional case, in order to provide multiple perspectives and to reveal patterns as engaged pedagogies are practiced across the UC Davis campus.

The three cases in this paper include the UC Davis Arboretum and Public Garden's Learning by Leading program, the Sustainable Living and Learning Communities, and the first-year seminar "Communicating Climate Change in the Small." Each case was conceived separately and undertaken prior to this analysis; as such, specific methods used to evaluate each case, as well as primary researchers, differ. In each of the cases, the authors' extensive participation within the projects has provided the basis for substantive evaluation, as well as access to key informant interviews and documents.

2.1. *Learning by Leading*

Comprising eleven student internship teams, the Learning by Leading internship program focuses on an array of environmental issues including water conservation, food security, environmental education, and habitat restoration. For this case study, qualitative methods were used to evaluate its impactfulness to the undergraduate students involved in the leadership-based internship program over a two-year time period from 2017 to 2019. As a program manager, one of this paper's authors directly participated in the program; observations were compiled from notes and reflections following the direct involvement. Additionally, five informal interviews were conducted by the author with program staff and volunteers. Student input was collected through formal internship evaluations and video-recorded post-graduation reflections. The above data was manually coded into meaningful keywords and grouped into relevant themes. Evidence of physical impacts of the project was compiled from a survey of program-related websites and documents, as well as from direct site analysis. No identifiable information from participants and informants has been included.

2.2. *The Sustainable Living and Learning Communities (SLLC)*

The SLLC consists of numerous student-driven on-campus sustainability initiatives; as an umbrella organization it has been actively meeting and advocating for its members and causes since 2014. The data for this paper derives primarily from participant observation and community-engaged design and planning, which was initiated in 2015 under the coordination of one of the paper authors and involved over 100 individuals. Documentation of this process was recorded in fieldnotes, meeting minutes, sketches, and site analysis drawings. Additional qualitative data was collected during a 2018 SLLC visioning process by student participants through workshops, focus groups, and semi-structured interviews, as well as through post-project student reflections compiled by the author. Identifiable information from participants has not been included in this study. Evidence of project impacts derives from a publicly-available vision document, direct site analysis, SLLC archives and the U.C. Davis library collections, which were collected by students and the author.

2.3. *First Year Seminar*

Communicating Climate Change in the Small is an experiential seminar for first-year UC Davis students that has been offered biannually since Fall 2015. As one of this paper's authors is the instructor of the course, primary data for the case study includes participant observation, anonymous student course evaluations, and an analysis of content provided by student assignments. To ensure student privacy, identifiable information from reflections and student work are not included in this study. Impacts of student work are documented through informal interviews with campus administrators and through publicly available documents.

3. Results

3.1. *Case Studies: University of California, Davis*

The University of California, Davis was initially launched as the "University Farm" for the University of California, Berkeley with multiple disciplines collaboratively organized around a big problem—the production of food for a growing world and the scaling up of efficient science-based agriculture nationally. With 5300-acres, the campus provides what could today be called a "maker space,"

providing UC Davis students room to pilot and experiment with practical place-based projects. As a land grant university, UC Davis, like its land-based counterparts throughout the U.S., is well suited as an experiential learning campus, with majors that include agriculture, plant sciences, and landscape architecture and courses that train students to drive tractors, butcher animals, and construct landscapes. One campus unit that helps to provide a framework and structured approach to experiential learning across the university is the UC Davis Office of Public Scholarship and Engagement. Established in 2018 to expand the public visibility and impact of engaged scholarship work being done on campus, Public Scholarship and Engagement focuses on finding connections between scholars, researchers, and educators that focus on public issues both on and off campus. Major goals of the office include rewarding public scholarship, supporting spaces that foster collaboration, integrating engaged scholarship into the university's administration (governance, budgeting), enhancing community-based learning experiences, and increasing community engagement and impact [57].

Three case studies illustrate the current shift towards integrating engaged scholarship and active learning into the creation of climate resilient landscapes: 1. The UC Davis Arboretum and Public Garden has eschewed a traditional model of educational plant displays and tied aspects of design, installation, and maintenance to student-led internships that focus on climate change, biodiversity, and environmental stewardship; 2. The Sustainable Living and Learning Communities occupies 40-acres of the core campus, and has been managed by students since the 1960s as a learning laboratory for sustainability. It includes a student farm, a self-built housing cooperative, and other organizations focused on experiential learning, community cooperation, and agriculture; and 3. The First Year Seminar course, *Communicating Climate Change in the Small*, asks students to design campus interventions to encourage the types of individualized behavior change necessary to combat climate change. All three models of engagement (internship, community-based learning, and first-year seminar) are included in Kuh's "High-Impact Educational Practices", and represent active learning practices that have been shown to increase rates of retention, persistence, and engagement in college students from many backgrounds [58–60]. Collectively, these three case studies encourage environmental awareness and collective stewardship through active engagement with the campus landscape.

3.1.1. Learning by Leading

The UC Davis Arboretum was founded in 1936 to "support teaching and research at the University of California." Initially comprising approximately 100 acres along the southern edge of campus, its boundaries expanded to 5300 acres in 2011 with a merger between the Arboretum, the Grounds and Landscape Services Unit, and the campus' riparian reserve. The Arboretum and Public Garden (APG, Davis, CA, USA), as it is now officially called, includes all campus landscapes, and has a mission to demonstrate through teaching landscapes, displays, and gardens some of the issues being tackled by researchers and academics on campus [61].

A core component of this mission is the assertion that students learn best when leading others, exemplified through a student internship program known as Learning by Leading. Each year, APG staff and campus faculty members work with more than 100 undergraduate and graduate student interns in all areas of public garden and campus operations. Intern teams collaborate with campus planners, grounds staff, faculty, botanical garden staff, professional landscape architects, and community volunteers to create new public places and sustainable, climate resilient landscapes. Additionally, they produce free public programs that focus on university research for local families and the wider community. Students use knowledge gained from traditional lectures and labs and directly apply it, using the campus as a training ground, to tackle authentic, real-world projects.

The Learning by Leading internship program differs from other university programs in a number of ways. Each internship is closely aligned with a department or academic major, so students not only gain hands-on experience working on actual projects and problems within the campus, they also receive relevant instruction on the specific topics they study in class, allowing students to test innovative solutions and directly apply new technologies and knowledge in the physical realm.

The internships focus on team-based, experiential leadership lessons and provide students with practical 21st century skills, such as visioning, strategic planning, decision-making, fundraising, communication, and professionalism, all within the context of environmental and sustainable garden-based projects. Analysis of the internships reveals two key elements crucial to their success: 1. The use of student-led teams to deliver “real results in the real world,” and, 2. The manual demonstration of practical skills applicable to future careers.

The Arboretum and Public Garden has been working with climate scientists on and off campus to more fully understand the projections for climate change in California’s Central Valley. In response to predicted temperature rises, the APG is focusing on a series of applied strategies and targets to prepare, manage, and transition its landscapes and plant collections, with an ultimate objective of transforming campus into a living laboratory that can be used by faculty and students for scientific research and as a demonstration project for local communities. Primary to this is a commitment to include student leadership training into each phase of the process.

Using applied research co-produced by UC Davis professors, cooperative extension specialists, research scientists, and student interns, and working closely with the campus planning leadership, the APG has developed a 75-year plan to transition the landscapes of UC Davis to a climate-ready campus. The goal of the Living Landscape Adaptation Plan (LLAP), as it is known, is to prepare and adapt the campus landscape to the likely impacts of climate change, including reduced water supplies, unsuitable plant populations, and potential health and disease threats. A key component of this plan is the integration of students into its implementation. Learning by Leading teams play a significant role in identifying and effecting changes to the campus landscape, as well as in engaging the public on climate change adaptation planning. In conjunction with the landscape crews responsible for the maintenance of campus gardens, and drawing upon the UC Davis faculty expertise and scholarship, these interns have been modeling data and designing, constructing and maintaining climate-resilient landscapes across campus.

The *Climate Assessment Learning by Leading Team* incorporates student learning with long-range campus planning by linking faculty scholarship in climate modeling, plant science, water, and soil systems to actionable projects within the local landscape. In collaboration with research faculty in the UC Davis Information Center for the Environment, interns are developing campus-specific projections of future climate conditions from two global climate models and two emission scenarios. The data is being used to strategically determine which campus landscapes appear to be most vulnerable to climate change and which may be more resilient.

Utilizing the *Climate Assessment Team’s* data models, the *Tree Team* is focused on replacing highly vulnerable species in the campus’ tree canopy with ones better adapted to the changing climate. Incorporating research and methods gleaned from a recent climate adaptation workshop put on by the USDA Forest Service, interns are working with faculty and Campus Planning to ensure a climate-ready campus tree canopy. Over the next year, interns will work with horticulturists and faculty to propagate, plant, and monitor oak acorns collected previously in Texas. These oaks will be tested for their suitability to the higher Central Valley temperatures predicted with climate change.

Learning by Leading interns on the *Sustainable Horticulture Team* analyze data on landscape types, uses, visibility, activity level, and maintenance workload, to determine which landscapes on campus are underutilized. These spaces, typically narrow areas of turf between building and road edges, are then converted into low maintenance, drought tolerant gardens. Students replace outdated irrigation systems with efficient drip tubing and then plant the area with a mixture of plants identified by interns on the Learning by Leading *Plant Propagation Team* for their low maintenance, low-water needs. Hands-on training with campus groundskeepers includes irrigation design and installation, planting design, plant selection and installation, as well as long-term maintenance.

Student reflections provide insights into the value of the program. For many, the internship experience provided them with a more realistic view of the work required in future careers. For others, the experience enhanced their desire to pursue professional opportunities in related fields. In post-graduation testimonials

and interviews, Learning by Leading students appreciated the hands-on nature of the internships. They wrote of being given the opportunity “to apply the design skills I’ve gained into real-world projects (identified here by the initials HK)” and “to work with and learn about plants and trees outside of the classroom (LH).” In addition, students remarked on the practical and professional climate adaptation skills they acquired from working directly on the campus landscape. As one student on the *Plant Propagation Team* wrote, “I think it was valuable because we don’t get to apply learned concepts outside of classes enough (VM).” Others commented on the value of learning practical skills within a setting that “sparks curiosity (RG)” and provides an “escape from my major curriculums (NJ).” They extolled the experiential learning model, stating “the hands-on casual learning nature makes the internship more fun (EG),” and that they “learned by making mistakes and struggling – this gave me the chance to think critically and become adaptable to changes (VS).” Not all students thrived in this type of environment, however. A small portion of participants desired a more structured internship experience. This group of students advocated a hybridized model of experiential learning and traditional curriculum, believing that such an approach would provide “more structure (KH).” They found some of the tasks they performed repetitive and would have preferred a model that allowed them to “diversify what we learn (LM).”

The Learning by Leading internship program offers students an opportunity to construct climate-appropriate landscapes, as well as to share and develop ideas to ameliorate and adapt to climate change. When students help build a place, they become invested in it and continue to engage with that space, even after graduation. As evidenced by student testimonials and interviews, this experience of working with faculty, staff, and the community to co-create public spaces can be transformative.

3.1.2. The Sustainable Living and Learning Communities

Occupying close to 40 acres of the core campus of UC Davis, the Sustainable Living and Learning Communities has been a haven for student-driven experiential learning since the early 1970s. At the time, students seeking space to conduct experimental research, to grow food, and to live sustainably, started a community garden in 1970, a student farm in 1972, and a cooperative of self-built homes known as the Domes in 1977. Today, the site is characterized by a less orderly aesthetic compared to the rest of campus. At the Ecological Garden, student volunteers shepherd busloads of school children through rows of native flowers and edible plants, past remnants of a walnut grove that is close to a century old. In addition to the walnuts, students tend to rows of fresh compost and dump food scraps from the dining commons that will ultimately make their way back into the soil of the Student Farm. Beyond the farm, past the chicken coop and the bee sanctuary, dishes dry on an outdoor rack next to the yurt of the Domes cooperative. Inside, a small group is meeting to discuss equity and consensus processes.

The emergent student projects described above were not immediately recognized by the university for having measurable pedagogical value; on the contrary, students found themselves facing eviction rather than receiving accolades. In 1989, in an effort to fend off a proposed stadium project, students declared the site the “Sustainable Research Area,” asserting its value through a provocative position paper. “Besides being home to a diverse wildlife community which includes a Burrowing Owl Preserve,” they wrote, “the SRA also contains a remarkable variety of outdoor environmental education opportunities which are student inspired, maintained and directed” [62]. More recently, additional initiatives have taken root in this less formalized space, including Project Compost in 1999 and the engineering D-Lab in 2009. Since 2013, the communities have undertaken ambitious vision planning in order to preserve and enhance the experiential programs and the informal nature of the space; the current SLLC name derived from these efforts.

The SLLC outlines its core values around intentional action within three areas: food and land; community; and experiential learning. Experiential learning encompasses both formal, curricular aspects of the SLLC as well as informal and extracurricular activities. Formally, coursework within the SLLC is primarily anchored by the student farm, which engages hundreds of students annually

in classes, internships, and volunteer opportunities. In these formal courses, learning objectives are clearly aligned with experiential learning activities. Roughly 20 classes are connected to the farm's market garden and ecological garden, which produce vegetables and flowers for community-supported agriculture (CSA) subscriptions, on-campus dining commons, and donations to alleviate food insecurity. With staff support, the market garden is officially managed by students, who gain invaluable experience by selecting what, when and how to grow produce. Other formal coursework at the SLLC occurs within the D-Lab, which is run with students in the college of engineering to undertake service projects internationally using appropriate technology.

Less formally, students and community members converge on five fertile acres at the Experimental Community Garden, which is known for its plant diversity and its rural, unkempt appearance. Here, long-time gardeners may happen to be pomology professors or bee researchers or international students planting hard-to-find varieties of produce. The exchange of knowledge happens through chance encounters and through lived experiences. Just to the north of the garden, the Domes housing cooperative continues to support the creation and management of intentional living communities. Currently run by a nonprofit, Solar Community Housing Association, the Domes, also known as Baggins End, provides affordable housing to 26 students in 14 self-built fiberglass domes. Here, applying knowledge from a broad array of disciplines is an ongoing and everyday activity manifested in communal meals, cleanups, and consensus-based self-governance.

The physical environment needed to support these experiential learning activities is one that is unique within most university campuses. Generally speaking, UC Davis maintains a highly manicured landscape, which, while attractive, was never envisioned as spaces for students to initiate projects of their own creation. Examples in the previous case study aside, one interviewee commented, "sometimes it's really nice to not be at the Arboretum for your nature, you know what I mean, everything's so planned" [63]. In contrast, the SLLC provides what Karen Franck and Quentin Stevens might call "loose space," which they have described as a sense of indeterminacy and free access that allows for improvisation [64]. The ambiguous and informal nature of the SLLC landscape creates opportunities not available elsewhere—spaces that accommodate and even encourage appropriation, manipulation, and experimentation. These characteristics are vital to experiential learning about landscapes, and therefore SLLC members have prioritized the retention of informality, even as they ask campus planners for additional resources and infrastructure.

Beyond the physical informality of the SLLC, the intentionality that is demanded by a self-managed landscape creates many opportunities for student leadership, especially around issues of sustainability, climate change, resiliency and equity. Within the Student Farm, for example, a student-led call for food equity led to an ambitious initiative called *The Community Table Project*, which increased food production and teamed with the student pantry to better understand the connections between food, culture, and hunger. At another SLLC site, students, staff, and faculty pondered the long-term management plan for a one-acre wooded area that is home to raptors, native oaks, and an occasional coyote. Their efforts were recently acknowledged with a USD 19,000 award from the 2020 The Green Initiative Fund, which are now being used for tree care and further vision planning. These examples are among many others that emerged in the past five years, but beyond these, students and alumni report that their experiences at the SLLC prepared them for careers as leaders in sustainable agriculture, community development, journalism, and a number of other fields. That many alumni attribute their success to their formative years in the SLLC communities is evidenced by a successful giving campaign that launched the Green Fellowship in 2019, which now operates as a UC Davis prestigious fellowship to support two students conducting projects related to the SLLC mission.

3.1.3. First Year Seminar: Communicating Climate Change in the Small

Generously funded by the University of California's Climate Action Champion Award, the First Year Seminar, entitled *Communicating Climate Change in the Small*, has been offered biannually since Fall 2015. Taught by faculty in the Landscape Architecture and Environmental Design program,

the ten-week course meets two hours weekly and has a limited enrollment of 19 students to encourage student-led discussion and interaction, with priority given to first year students (incoming freshmen or transfer students). As such, the course also serves as a curriculum-based orientation to the campus; or as noted on the University's website: *First-Year Seminars are an exciting program of small, innovative classes that reflect the instructor's intellectual interests. Limited to 19 students each, these once-in-a-lifetime courses promote intellectual exchange, critical thinking, and community* [65].

The course explores opportunities for addressing the climate crisis within the context of the UC Davis campus, and introduces literature-based methods for achieving successful youth climate engagement, including: 1. Framing messages as a "contemporary concern requiring immediate response"; 2. Identifying climate action as necessary to protect "the things they love"; 3. Focusing on "'social' as well as 'scientific' consensus"; 4. Employing "trusted messengers," such as peer-to-peer communications; and most importantly 5. Utilizing localized, solutions-based approaches with positive messaging. [66–70] Students lead weekly discussions that integrate climate issues to race, gender, social equity, public health, social media and technology, and the humanities. Final assessment of student learning in this course is achieved through a student-defined project that expresses their own personal relationship to course content and, most importantly, communicates this experience to others. Pedagogical goals of the final project include: 1. Synthesize the concepts related to climate change, as presented throughout the course; 2. Share student experiences and understandings of climate change; 3. Integrate student knowledge of climate change with their own passions and interests; 4. Propose solutions and/or actions in response to climate change; 5. Encourage further dialogue regarding climate change within their community and networks; and 6. Explore alternative tools for communicating ideas and information related to climate change (social media, digital narratives, humanities, and/or environmental design).

The course integrates students with staff from UC Davis' Office of Sustainability to address what has been identified as the last (and largest) hurdle to achieving campus carbon neutrality goals for 2050: behavior change. While the university's investment in renewables, energy efficiency, and transit infrastructure have yielded substantial reductions in emissions, the Office of Sustainability has noted that individual habits and decisions (such as selecting transportation alternatives, wearing weather-appropriate clothing, or reducing meat consumption) are a more difficult and necessary aspect of climate adaptation to address, and an approach underutilized by current campus efforts.

In response, the course reframes the current climate crisis as a more nuanced socio-ecological problem that requires more than climate scientists and politicians to address. Using environmental design theory and practices, students design interventions within their campus context to encourage the individualized behavior change necessary to combat climate change. By considering the hyper-locality of their surrounding contexts (dormitories, cafeterias, classrooms, daily commutes, peers, etc.) students are able to visualize more immediate impacts and challenges related to the climate crisis and often (and more importantly), witness immediate changes as a result of their design proposals.

Past projects have included a student-launched sustainability cookbook and YouTube cooking channel to encourage food waste reduction, a campus stickering campaign that labeled climate-unfriendly products on campus as such, wayfinding and environmental graphics that detailed solid waste management throughout the campus, and social media campaigns that utilized peer challenges to commit to climate-friendly practices. While the success of any individual project on climate mitigation is difficult to assess, the adoption of several student project ideas by the Office of Sustainability demonstrates the impact of the course on campus climate neutrality efforts. Moreover, many student projects have been actualized with funding support from various university sources, and four students from this course have been recognized as Climate Neutrality Fellows by the Office of Sustainability. These recognitions speak to the significance of experiential learning courses to meaningfully address climate change within the campus context, and the urgent need to continue to support and encourage such learning opportunities within the Landscape Architecture and Environmental Design curriculum.

The following anonymous comments were collected in Winter Quarter 2020 (the most recent offering of the course) in response to the course evaluation question, *What key ideas did you take away from this seminar?:*

I realized that I can actually make a difference to our changing climate. This is truly a job for everyone. I also learned that climate change really can connect to everything.

Climate change affects each and everyone of us. It has a more direct impact to our lives than most people care to acknowledge. I also learned that climate change affects different groups and communities differently.

I have learned to be a climate activist.

There was a lot I learned in this class that I didn't really think about or know before. I learned how art and humanities affect climate change, and the topics were very conversational and engaging.

These comments reflect the significant ways in which the approach of the seminar broadened and diversified student knowledge of climate change and empowered students to be involved in solutions.

4. Conclusions

4.1. Recommendations

Based on the case studies at the University of California, Davis, the following strategies are suggested for other landscape architecture educational institutions interested in taking a similar approach to campus-based engaged scholarship in response to the current climate crisis.

- a. Ground learning in a sense of place through the investigation of surrounding natural and human communities. Experiential learning is about going out into the field, researching the local context of a project, and proposing solutions that emerge from the particular attributes of the place. Utilizing campus as an experiential living lab harnesses the unique power of place to energize students to research and adopt applied climate change solutions for the spaces with which they are most intimate—where they live, work, study, and recreate.
- b. Explore strategies to promote collaboration between students and campus staff across a wide spectrum of professions. Not only should landscape architecture students have the opportunity to collaborate with and learn from members of the faculty in different departments and colleges within the university, but they should also be encouraged to work with professionals engaged with the physical development of the campus landscape, including the campus landscape architect and campus planner, professional consultants hired by the university for new building projects, such as architects, landscape architects, and real estate development firms, as well as with the professional service staff on campus. Climate change projects can thus be co-produced through consultation between non-academic and academic stakeholders within the clearly bound institutional and geographical context of the university. By working directly with Grounds/Landscape Services and Facilities to physically design, construct, and maintain the projects, for example, UC Davis learning by leading students gained hands-on experience using local landscape solutions to address climate change through the incorporation of smart irrigation techniques, turf conversions to drought-tolerant plantings, and stormwater management improvements.
- c. Develop networks between design programs and campus partners, especially through research projects. The Learning by Leading, Sustainable Living and Learning Communities, and First Year Seminar case studies were only accomplished through established campus connections. The University Arboretum and Public Gardens, Campus Planning, and Office of Sustainability represent just a few of the campus partners who collaborated on each of these projects, and these networks need to be cultivated and maintained.

- d. Reach out to the broader community beyond the campus and provide opportunities for students through co-production efforts with municipalities and other experts, including natural and social scientists, city planners, professional landscape architects. The vast urban and societal pressures we are collectively facing in the fight against climate change demand concerted collaborative efforts across sectors and between disciplines in and outside of the university. In one recent example, the Sustainable Horticulture Learning by Leading team partnered with local groups including the City of Davis, Davis Joint Unified School District, Tree Davis, and the Sacramento Tree Foundation to solicit donations and incorporate best practices into the design and construction of a garden for a local elementary school. The interns converted a patch of lawn into a flowering garden that provided habitat and food for pollinators, reduced water usage, energy consumption and maintenance requirements, and replaced water-loving plants with native and climate-adapted species. As part of their outreach effort, the interns created a series of community planting sessions and public workshops designed to engage the local Davis community in building a healthy urban ecosystem, connect them to their landscapes, and educate them on the benefits provided by low water, habitat gardens.
- e. Establish funding and support entities for experiential-learning and engaged scholarship. To support these collaborations, long-term resources and investment are needed. Internal grant funding such as The Green Initiative Fund, which both Learning by Leading and the SLLC have taken advantage of for specific projects, can provide an initial boost to a proposed collaboration, but stable funding mechanisms are key. Alumni donors and charitable foundations have financially supported both the SLLC and Learning by Leading efforts. They have been especially receptive to the concept of funding student leadership programs.
- f. Formally acknowledge engaged scholarship as a significant contribution to landscape architecture research. At UC Davis, the Office of Public Scholarship and Engagement provides support for faculty through training and funding opportunities, such as the Public Impact Research Initiative (PIRI). The University has also become the new institutional home for Imagining America, a consortium of scholars dedicated to engaged scholarship. This has catalyzed further initiatives for on- and off-campus collaborations for public interest, such as the Placemaking Grant for service-learning studios. These entities have also supported the final, and likely most difficult hurdle to the case studies described, acknowledgement of engaged scholarship in formal merit and promotion criteria. Collaborations with community and campus partners come with great time commitments that are not always recognized as contributions to the commitments to research; they are often relegated to merely a service contribution. Establishing formal recognition of engaged scholarship as a significant contribution to academic research within the discipline of landscape architecture would further support the efforts detailed in this paper. More importantly, this formal recognition would have a meaningful impact on building future climate resilience by training our next generation of landscape architecture professionals.

4.2. Conclusions

The aforementioned campus-based projects demonstrate four key characteristics that have been identified as successful approaches for meaningful climate engagement: 1. Build student capacity by connecting them with experiential, solutions-based research; 2. Provide opportunities for students to assume responsibility and co-create solutions in areas aligned with their existing interests; 3. Focus on localized issues and local spaces that are open for experimentation; and 4. Expand definitions of climate crises to include social and personal impacts, not merely physical ones [71,72]. As demonstrated by the student letter directed to the ASLA in 2019, tackling climate change is already a top personal and professional concern of students, and utilizing climate-related design scenarios begins to address this interest. It also allows students to take a solutions-based approach by conceptualizing speculative futures for a given site, building a sense of self-efficacy within students, as well as important skills for climate adaptation and resilience-building. In utilizing the university campus as the site for

experiential learning, students engage with hyper localized issues, allowing them to reframe what is typically portrayed as large-scale, global, and often overwhelming. Finally, the case studies outlined above exposed students to more localized climate impacts at each of the sites investigated—expanding the conversation from global impacts such as polar ice cap melts and/or global temperature increase, to include debates about drought, wildfires, impacts on public health, and social inequity. In this way, the climate crisis can be reframed from the common conceptualization of an environmental science or policy issue into a more immediate and complex socio-ecological challenge that requires not only design for adaptive ecologies, but also the capacity to propose and implement culturally-relevant responses.

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