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Adult Climate Change Education Advances Learning, Self-Efficacy, and Agency for Community-Scale Stewardship

Sarah-Mae Nelson [1,*], Greg Ira [1] and Adina M. Merenlender [2]

[1] UC California Naturalist Program, University of California Agriculture and Natural Resources Division, Davis, CA 95618, USA; gcira@ucanr.edu
[2] Environmental Science, Policy, and Management, University of California Berkeley, Berkeley, CA 94720, USA; adinam@berkeley.edu
* Correspondence: smanelson@ucanr.edu

Abstract: Education per se does not necessarily foster positive environmental behaviors; rather, a complex assemblage of influences including social integration, discovering shared values, strengthening environmental identity, self-efficacy, and agency is needed to foster environmental stewardship. We examine the participant outcomes from a new adult climate education and service course, which is delivered by local organizations. The UC Climate Stewards certification course includes relationship building, social-emotional learning, climate science, climate communication, monitoring resilience, and how to take community-scale action. Based on results from ~154 participants, we observed significant improvement in self-efficacy, with confidence to help protect communities increasing from $\bar{x}$ = 3.59 (3 is neutral) to $\bar{x}$ 4.32 (4 is agree) ($p < 0.00$). The importance of doing something or taking action about climate change appears to be a value that was strongly held prior to taking the course and aligns with motivations for becoming a certified Climate Steward; hence, it only slightly increased from ($\bar{x}$ = 4.25) to ($\bar{x}$ = 4.57) ($p < 0.00$). Climate Stewards' feeling of competency in talking about the subject increased (from $\bar{x}$ 3.05 before to $\bar{x}$ = 4.24 after, $p < 0.00$, N = 111). Finally, we examine the community-scale stewardship taken by the Climate Steward volunteers, from information provided through self-reporting, and explore additional approaches to researching pathways from education to agency.

Keywords: environmental agency; climate action; climate communication; social-emotional resilience

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1. Introduction

While global warming had been on the radar of scientists for over 100 years, it arguably rose to worldwide public attention in 1988, with James Hansen's testimony to the United States' Congress [1]. It was following this attention that various convenings were brought to bear on the topic, including the United Nations Framework Convention on Climate Change presented at the 1992 Rio Earth Summit. Understanding that no amount of governmental or institutional effort would succeed without the will of the people, Article 6 of the Framework [2] stipulated that education, training, and public awareness would be critical to both local and global efforts to mitigate and adapt to climate disruption. Unfortunately, the response was neither swift nor far-reaching, and the initial call to bolster climate education was taken up by only a small number of informal education organizations. It has only been in the last two years that a handful of national climate education plans have been written (e.g., Kenya, Italy, New Zealand) or, at least, initiated (e.g., Argentina, Mexico). It should, therefore, come as no surprise that most adults in the United States did not receive climate change education as part of their formal schooling.

Studies such as those detailed by Falk and Dierking [3] indicate that it may be possible to educate adults on climate change-related topics through contemporary informal education. These and other studies [4–6] show that a majority of adults in the United

States get their science information from free-choice, informal science education learning opportunities such as visiting institutions (e.g., national parks, museums, aquariums), reading topical books or web materials, or attending adult education courses (e.g., state master naturalist programs, continuing education classes, museum lecture series). Other recent research has shown that an adult's identity pertaining to the environment is not necessarily predicated on childhood experiences, but may develop at any time and is not dependent on a particular level of "environmental" activity [7]. There is also evidence that the more connected a person is to social networks focused on climate change, the more likely it is they will support actions necessary to mitigate and adapt to change [8,9]. People are motivated to take action when they feel like they can make a difference [10] and are more likely to participate in activities that the communities with which they identify with are engaged [11]. Related work has suggested that adults may make behavior choices based on the influence of their cultural group/identity [12]; as such, focusing education efforts on influencing community identity through the lens of social factors such as networks, norms, and capital may be a vector through which to promote taking climate action [7,13].

With a mission to increase community and ecosystem resilience, the UC Climate Stewards course was designed not only to increase climate literacy but also to increase social capital and community cohesion that would promote higher engagement in climate stewardship, particularly at the local level. It is well-documented that education per se does not necessarily foster positive environmental attitudes and behaviors; rather, pro-environmental behaviors result from a complex and non-linear assemblage of influences, including social integration, discovering shared values, strengthening environmental identity, self-efficacy, and agency [8,14–17]. In particular, previous research reveals that when climate knowledge leads to shared values, increased self-efficacy and agency, and the necessary skills to act, people show increased engagement in climate-friendly behaviors [18,19].

From a social-psychological perspective, climate change education should not focus solely on imparting scientific facts but rather be part of a socializing process addressing the needs of the whole person [20–22], attempting to impact the self-efficacy, identity, and value system of the learners. Motivation, shared values, self-efficacy, agency, and skills (such as how to communicate about climate change) are known to be important components when deciding to take action [23]. A key approach employed by educators across the environmental spectrum is to design courses, discussions, programs, and field experiences to move participants toward an identity, sense of agency, and skillset that will most likely result in or increase the desired behavior relevant to the issue at hand [24].

1.1. Advancing Climate Stewardship

Climate stewardship encompasses the wide variety of actions needed to stave off and adapt to fast moving climate change for the well-being of the entire community of life. It is a sense of responsibility that is part ethic and part behavior, addressing as well as recognizing the human-caused nature of climate degradation. The UC Climate Stewards initiative's theory of change focuses on enhancing people's motivation, confidence, and capacity to participate in community-scale climate stewardship to advance community and ecosystem resilience through relationship building, coursework, communication training, place-based climate experiences, and service-oriented actions. The focus is on helping Climate Stewards adopt approaches to resilience for their community instead of just individual behavior change; for example, by advancing community choice clean energy and reducing food waste while increasing food security. The initiative builds on the idea that complex social and environmental challenges require more than just collaboration, but also a centralized infrastructure, a shared agenda, a process for collaboration, and a mix of mutually reinforcing activities conducted by a diverse assemblage of partners in what is described as a collective impact network [25].

Studies show that the public is experiencing depression and despair over climate change [26] with younger adults showing higher rates of climate anxiety [27]. These same and similar studies indicate that connecting with others on actions that transcend self is a

path to joy and hope. This and other emerging information on social-emotional resilience, climate change anxiety and grief, climate trauma, and social capital led to the decision to center UC Climate Stewards on concepts of community such as relationships, shared identity, and shared values [28]. Social-emotional resilience is the ability to endure turmoil and to anticipate, adapt, and flourish in the face of change [29,30]. These become easier when you know other people are having similar experiences and you have someone to talk to about your shared experiences (i.e., social-emotional support) [31]. Grief is a natural emotional response to the loss of cherished people, places, and ways of being. Anxiety is an anticipatory feeling of unease or worry related to uncertainty about an imminent event or outcome. Climate anxiety and grief can take many forms, from more manageable feelings of solastalgia (i.e., the feeling of homesickness while at home due to environmental damage or change) to the trauma of seeing a beloved family home lost to wildfire [20,32]. Understanding the expanding reality of climate trauma—Defined as a range of traumatic experiences related to climate including personal experiences (e.g., loss of a home to tornado), vicarious experiences (e.g., interacting with victims while volunteering with relief efforts), and community experiences (e.g., an entire town being lost to wildfire) [33,34]. Climate Stewards employs, as well as teaches, trauma-aware communication practices. Social capital, the goodwill available to individuals or groups that lies in the structure and content of social relations, is critical for collective action in community spaces [35,36].

This paper describes climate education theory that influenced the design of UC Climate Stewards and presents survey data from the first graduates measuring the change they reported experiencing around shared stewardship values, self-efficacy (i.e., belief they can make a difference), environmental agency (i.e., desire to do something), and communication skills. We also discuss the importance of the whole person, social-emotional learning, and trauma-aware practices, along with the components of the course most aligned with the results presented.

1.2. UC Climate Stewards: Bringing Theory into Practice

UC Climate Stewards employs a theory-driven approach to move beyond climate science and reach climate literacy as defined by the National Oceanic and Atmospheric Administration [37], which assumes a climate literate person not only understands the science behind climate change but can also communicate about it meaningfully, make informed decisions, and act accordingly. This definition of climate literacy is consistent with our definition of climate stewardship, as noted above—A responsibility to recognize and address climate degradation. Importantly, this definition of climate literacy includes an outcome of increased knowledge as well as using that knowledge to facilitate stewardship behaviors. Social science research shows that these types of outcomes do not automatically flow from increases in knowledge [38] and that providing information alone does not directly cause changes in behavior [39], even though people will often self-report that the information changed their behavior [40]. With an eye to holistic learning, we emphasize and incorporate self-reflection, social-emotional resilience, trauma-aware practices, interdisciplinary science, and communication science throughout the UC Climate Stewards curriculum. We also address some noted gaps in formal adult climate change education, including a place-based connection to nature and climate solutions as well as evidence-based training on how to successfully communicate about climate change [41].

The course is made up of six units and begins by focusing on relationships and community before delving into the concepts of social-emotional resilience and trauma-aware practices–two components of the curriculum that are mostly, if not entirely, unique to the UC Climate Stewards course. The curriculum then moves on to teach climate communication skills which both enables more and deeper conversations around the topic and gives the participants language to better understand the science aspects of climate disruption. Since climate science is complex, and there is the need to address global concepts as well as local impacts, the middle units use best practices of science communication, interdisciplinary science, and trauma-aware practices to explain global earth and climate

system concepts, then focus in on the local ecosystem and human system impacts. These units also have a particularly strong tie-in to the course textbook, *Climate Stewardship: Taking Collective Action to Protect California* [42], a collection of stories highlighting positive, active, and community-oriented solutions happening across California, with climate science relevant to California woven throughout. The final units seek to crystallize several concepts that are introduced in earlier units, including community-level, collective solutions; critical issues of justice, equity, diversity, and inclusion; vulnerability assessment; and meaningful public participation. The latter is implemented through participatory science activities that are used to leverage community connections and resources for contributions to research and community climate resilience.

Paralleling the units, all participants undertake a service-oriented capstone project, often with a local nonprofit, to initiate their climate stewardship activities while they are still actively engaging in the curriculum. Capstone projects are a form of service learning that helps both the learner and the community, a form of authentic assessment where participants can demonstrate their proficiency, a way to introduce participants to climate stewardship opportunities, and an entry point to future—And hopefully sustained—Volunteer service [43]. It has also been shown that immediate application of learning and acting on newly experienced expectations or values can lead to increases in sustained behavior over time. Participants conclude the course by presenting a summary of their capstone work to each other–sharing insights and experiences as well as lifting up each other's work.

1.3. Social-Emotional Resilience and Trauma-Aware Practice

Since climate stewardship work is grounded in the relationships and trust we foster with other community members (i.e., social capital), it involves significant social and emotional effort. It also requires finesse when approaching others about this emotionally challenging topic—especially if they or we have already been traumatized by climate disruption. No matter the situation or activity, humans cannot detach from any of the mental, physical, emotional, or spiritual aspects of ourselves. Indeed, taking in new information, entering new relationships and communities, developing new skills, and thinking outside our established patterns can be emotionally draining [44,45]. Given the scope and scale of climate-related education, communication, and action, providing a foundation for social-emotional resilience is critical to promoting pro-environmental behavior. What's more, Bec et al. [46] demonstrated the connection between social-emotional resilience and community resilience, revealing that community groups were more resilient when they were emotionally stable and had gained adaptive characteristics before an incident occurred.

Research has shown that social-emotional resilience and hope [20,47], along with social-emotional support from a peer-group or community of practice, are needed for environmental educators to be able to effectively communicate about distressing environmental issues such as climate change [21,48]. Establishing relationships early allows the participants to begin to see each other as sharing beliefs, values, and norms which helps create a sense of shared identity [13]. Anecdotal evidence from climate communication, education, and interpretation training from the National Network for Ocean and Climate Change Interpretation (NNOCCI), among many others, shows that individuals need this support as they learn the heavy news of climate science as well as the impacts and implications of climate disruption [44]. Other work by Ojala [20] indicates that in order to achieve desired transformative participant experiences, social-emotional aspects must be included in climate education.

The trauma-aware component of the course is based on trauma-informed practice better known from public health [49] and public school settings [50]. We employ the phrase trauma-aware because we are raising awareness of the issue with our participants, rather than training them to execute trauma-informed behaviors (S. Moser, personal communication, 13 March 2020). While the potency of trauma-aware and trauma-informed practices is still an emerging topic in relation to climate education and communication, the

scholarship is well-established in the related fields of public health and public education. Given the prevalence, magnitude, and range of trauma associated with various aspects of climate work and the increasing number of people personally and directly exposed to the impacts of climate change [51], we chose to incorporate the use of and education about trauma-aware practices in the UC Climate Stewards course. Moreover, knowing that trauma-aware practices influence people's ability to learn and act (based on scholarship linked to trauma-informed work in public schools) [50,52], we anticipated a trauma-aware lens would: (1) be less likely to trigger a memory that might cause them unnecessary pain; (2) be less likely to overwhelm participants causing them to deny the state of affairs and/or isolate themselves from all thoughts of climate disruption, its impacts, and, most significantly, its solutions; and (3) mitigate communication concerns related to crisis-laden language that can make situations seem hopeless and cause "normal" people to shut down and dissociate themselves from the distressing issue [10,13].

1.4. Climate Change Communication

Studies have shown 66% of people in the United States are interested in climate change and 71% say it is important to them personally, yet 61% of people rarely or never talk about climate change with friends and family [53]. This self-silencing is due largely to the incorrect assumption that others do not share the desire to talk about climate [54]. Since we tend to act on topics of mutual care and concern, simply communicating about climate change is a critical form of action. However, it requires that people feel comfortable communicating with friends, family, colleagues, and community members in new and potentially unfamiliar ways [19]. Evidence also indicates that when people have the language to adequately understand and describe phenomena, they are more likely to understand and internalize it [55]. The discomfort often associated with unfamiliar experiences further reflects the need to support the whole person during the learning process–social, emotional, and spiritual as well as intellectual needs [30,44].

To increase a sense of comfort in the participants' ability to talk about climate change, best practices of climate communication, education, and interpretation are the focus of the second unit. Drawing attention to the science of communication, knowledge of respective audience characteristics, evidence-based communication techniques, and national opinion data, this unit addresses one of the biggest issues for climate action–breaking the spiral of silence around climate change [54,56,57]. The communication techniques taught in the course are centered around the evidence-based strategic framing for climate change communication from the National Network for Ocean and Climate Change Interpretation (NNOCCI). Not only are these techniques grounded in research [58–61], studies of trained communicators have shown that climate-based dialogues increased because of increases in the practitioners' feelings of self-efficacy, that is, being capable of discussing climate change once they received communication tools that increased their confidence in their ability to do so [19]. What's more, studies of these communicators indicated that increased conversations lead to increased pro-environmental behavior, and, therefore, offer an important part of and path to climate stewardship [62].

2. Materials and Methods

2.1. Course Design

The UC Climate Stewards course of the University of California, Division of Agriculture and Natural Resources, is an adult education and service initiative designed and coordinated by the UC California Naturalist Program. The course prepares participants to effectively engage in a wide range of community-level climate stewardship activities across six categories of service—education/interpretation, conservation/restoration, participatory science, community resilience and adaptation, environmental and climate justice, and program support—with the goal to advance community and ecosystem resilience (i.e., the ability of a system or community to survive disruption and to anticipate, adapt, and flourish in the face of change). During the course, participants are introduced to local

groups working on climate action and provided with a list of possible service opportunities with which to engage. Courses are delivered in specific locations by community-based organizations with expertise in informal science education that enter into a formal partnership agreement with the UC California Naturalist Program, which serves as the backbone organization of this statewide collective impact network.

The program trains qualified instructors to deliver the ~40-hour UC Climate Stewards course curriculum including asynchronous, in-person, online, and field components. After certification, UC Climate Stewards are encouraged to continue volunteer service in the categories described above. Prior to launching the UC Climate Stewards course, a call was put out to existing UC California Naturalist Program partner organizations seeking volunteers who would be willing to pilot the new course. Eleven organizations stepped forward and instructors from these organizations were trained in July 2020. Of these trained organizations, the first UC Climate Stewards courses were offered in 2020 and 2021 at seven locations in the state (see Table 1, Figure S1: Partner Organization Map).

Table 1. This table shows information for each partner organization in this study that offered the course, including the number of certified participants, number of returned surveys, location from north to south (city, county, and region in California), and the number of courses offered.

Partner Organization	Number of Certified Participants	Number of Returned Surveys	Location of Organization	Number of Courses Offered
Pepperwood	33	31	Santa Rosa, Sonoma County, Northern Inland	2
Point Reyes National Seashore Association	13	12	Point Reyes Station, Marin County, Northern Coast	1
Columbia College	8	6	Sonora, Kings County, Central Sierra	1
Community Environmental Council	24	22	Santa Barbara, Santa Barbara County, Southern Coast	2
Pasadena City College	60	43	Pasadena, Los Angeles County, Southern Inland	2
Riverside-Corona RCD	12	12	Riverside, Riverside County, Southern Inland	1
UC Riverside Palm Desert Center	47	37	Palm Desert, Riverside County, Southern Inland	2

After executing the partnership agreement and completing the UC Climate Stewards Instructor Training Workshop, local partner organizations are largely responsible for all aspects of course delivery from scheduling to registration and pricing. Partners determine the course frequency, dates, class schedule, class size (typically between 10 to 25 participants), and location. Participants register for a course directly with the partner organization, most often through the organization's website or chosen online registration platform. Partner organizations market their courses to their community, both locally and further afield, at a minimum through the partner organization's and the UC California Naturalist Program's website and social media. Some partner organizations engage in additional marketing efforts such as fliers, local media, and informational meetings. Partner organizations set their own course fees based on their cost recovery needs and remit a portion of the fee to the UC California Naturalist Program for curriculum maintenance, course evaluation, access to the volunteer management system, and aggregating and communicating about

the network's collective impact. Scholarships are available to offset course fees for full time students or when financial need is present.

The course requires a minimum of 43 hours of contact time. Each partner organization chooses how to achieve this requirement through their course schedule. The asynchronous portion of the course, involving review of required materials (i.e., readings, videos, slide decks, graphics, assignments, discussions, unit reviews), takes between 21 to 25 hours. Synchronous portions of the course involve, at least, another 22 hours of contact time and include class meetings and field trips. Across the seven organizations, class meetings accommodated the COVID-19 pandemic, primarily through virtual class sessions ranging from two to four hours long over a span of 9 to 10 weeks. In addition, partner organizations conducted field trips ranging from five, two-hour, virtual field trips (i.e., recorded or live video broadcast) to three, two-hour, in-person field trips.

All participants undertake a service-oriented capstone project, often with a local nonprofit, to initiate their climate stewardship activities. Capstone projects are independent service learning applications of the knowledge and skills acquired during the course. They can be done individually or as a small group and require a minimum of eight hours of volunteer service time outside of the required contact hours. Participants choose their own capstone projects, with partner organization often suggesting topics and ideas around which to center the project. These suggestions may include specific organizations for the participant to work with, specific work that the partner organization needs support for, ideas based on a service category (e.g., community resilience and adaptation), or prior capstone projects that could be further developed or implemented.

2.2. Survey Design, Collection, and Analysis

We surveyed the Climate Stewards participants at the end of their course using a retrospective pre-post design. Participants received an anonymous link to an online questionnaire containing the survey instrument built and facilitated through Qualtrics. All surveys were completed online. Question topics included impressions of the overall quality of the course, demographic information, and various possible motivations for participating in the course. The survey also included the DEVISE (Developing, Validating, and Implementing Situated Evaluation Instruments) scales described below. The complete survey can be seen in the Supplemental Materials, End-of-Course Survey Questions.

We compared scores from the participants' perceptions before the course (measured retrospectively) and after the course for all statements within the four DEVISE scales and mean averages across all statements. Significant differences based on paired *t*-tests are presented along with means and standard error bars. It is possible for $\pm$ 1 SE error bars to overlap and still have a significant pairwise *t*-test result because the test is for within subjects data and the error bars are calculated on the between subjects data. All participant data collection complied with U.S. federal regulations and policies for the protection of human subjects (U.C. Davis IRB 1797893-1).

DEVISE Scales

We adapted survey protocols developed by the DEVISE project. These protocols were initially developed to evaluate the influence of participation in citizen science on an individual's motivations, self-efficacy, agency, and acquired skills [63,64]. Due to their demonstrated consistency and effectiveness, these survey protocols are increasingly used for science education evaluation [65,66]. These pre-tested survey instruments [63,64] include scales to examine Self-efficacy for Environmental Action (SEEA), Motivation for Doing and Learning Science (MDLS), Motivation for Environmental Action (MEA), and Skills of Science Inquiry (SSI). The series of questions for each scale measure individual participant responses using a 5-point Likert scale with 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. Most of the scales include one negatively phrased question, which is reversed prior to quantitative analysis. An example of negative phrasing is "It's hard for me to imagine myself helping to protect the planet". The SEEA

scale was used verbatim from the DEVISE scale protocol. The MEA, MDLS, and SSI scales were customized for climate stewardship topics using the customized survey protocol recommendation in the DEVISE scale's user guide [64]. We added the customized SSI Scale for communications skills after the first two courses were completed, hence, the sample size for these questions is smaller (N = 111) than for the other survey questions. Cronbach's alpha is reported as a consistency reliability coefficient for the data we collected across statements within the same scale and how relevant all the statements are to the composite score (alpha result of >0.7 is commonly used as a threshold to indicate that the items or statements used are inter-related and test the same concept) [67].

2.3. Volunteer Actions

We also analyzed provisional data (i.e., less than a full year post-course) on the self-reported volunteer activities of the Climate Stewards following the training courses, collected through an online volunteer management system (VMS). Data included the number of hours of service contributed by category of service (Table 2). These data include information about the required minimum of eight hours of volunteer service for each participant (i.e., the capstone service-learning component). We were only able to access and analyze 13 months of provisional data, since volunteers continuously add hours to the VMS throughout each service year until the end of the reporting period (i.e., 31 January of the following year). Moreover, since courses occur at different times during the calendar year, participants who completed their course early in the year had more time to record volunteer service than those who completed their course later in the year. All of the data reported in the VMS are contributed by individual volunteers who record their volunteer hours in one of six categories of service. The hours reported by the volunteers are accepted without further verification due to time and personnel constraints.

Table 2. This table shows the number of hours served and the percent of the total hours served by category of service (numbers include volunteer hours for both capstone projects and post-course volunteer service). During the survey period, 1581 total volunteer hours were recorded by 149 certified Climate Stewards.

Category of Service	Hours Served	Percent of Total
Conservation/Restoration	108.5	6.9%
Education/Interpretation	625	39.5%
Participatory Science	225.5	14.3%
Program Support	76.75	6.1%
Community Resilience and Adaptation	374.5	23.7%
Environmental and Climate Justice	96.75	4.7%
Not Specified	76.75	4.9%

3. Results

3.1. Participants and Motivations

The program certified 197 course participants with 163 submitting end-of-course survey responses (83% response rate). Some respondents did not fully complete the survey. Survey responses came from participants in 11 courses across seven partner organizations spread across the state (Table 1, Figure S1: Partner Organization Map). Out of 162 survey responses to the question "Overall, how satisfied were you with the course you attended?," 93% selected very satisfied (5) or somewhat satisfied (4), with an average score of 4.57 (S.D. = 0.91) on a scale of 1–5 (very satisfied).

Out of 159 participant responses, 31% were young adults ($\leq$24 years old) with the remainder being 24% 25–40, 9% 41–50, 16% 50–60, and 20% over 60. When asked about ethnicity, 31% of 163 participants self reported as Hispanic or Latino. When asked about racial identity, out of 150 who responded to the question, 63% selected White (not of Hispanic

origin), 4% selected Black or African American (not of Hispanic origin), 13% selected Asian, 9% selected American Indian or Alaska Native, and 11% selected race not listed (for more detail on these categories see Supplemental Materials, End-of-Course Survey Questions). These frequencies are significantly different than the frequencies reported in the 2019 US Census for California $\chi^2 = 34.466$, df = 4, $p < 0.01$. The proportions among our survey participants showing White, Black, and Asian participants underrepresented compared to the state averages, 72%, 7%, and 16%, respectively, and American Indian participants over-represented compared to the state average of 2%. The number of participants identifying as ethnically Hispanic or Latino was slightly lower than the state average of 39%.

When asked to identify characteristics that described their work status, 33% selected employed full-time; 28% employed part-time; 9% currently not employed; 9% full-time student; 20% retired, some volunteering; and 2% selected full time at home partner/spouse/caregiver. The large majority of 162 respondents have attended some college with 30% holding a bachelor's degree, 34% a graduate degree, 19% with some college or technical or associates degree, 15% with a high school diploma, and 1% without a diploma. Household income levels spanned 10–18% across most classes, with 22% below $24,999/year (Figure 1).

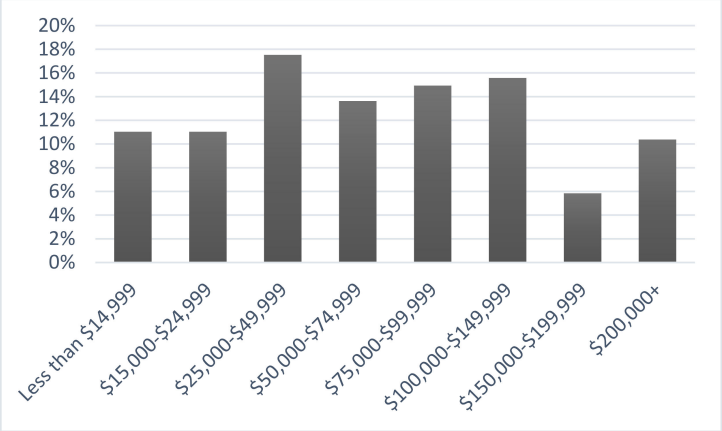

Figure 1. This figure illustrates self-reported income levels, N = 154.

In terms of motivation for taking the UC Climate Stewards course, the four most commonly selected reasons (out of 15 options) were to: Learn how to communicate about climate change; Learn more about solutions to climate change; Learn more about climate science; and Learn about community resilience. See response rates for all motivation options in Figure 2.

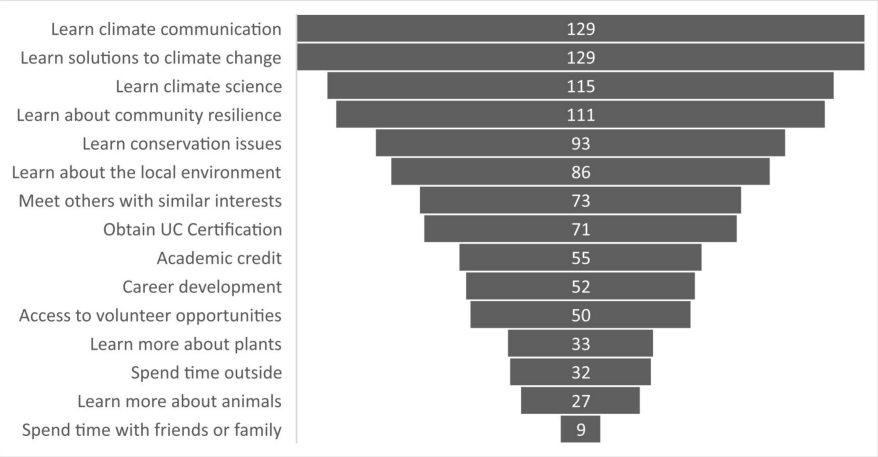

Figure 2. This figure illustrates the number of responses received for each motivation option listed (multiple selections allowed), N = 154.

3.2. Learning Climate Stewardship

The value placed on learning stewardship was covered in the Motivation for Doing and Learning Science scale that included six statements, and the value of Cronbach's alpha was 0.78 for our sample. Significant improvement was observed for all items and averaging across all five revealed a mean of 3.59 for before responses and 4.14 for after the course ($p < 0.00$) (Figure 3).

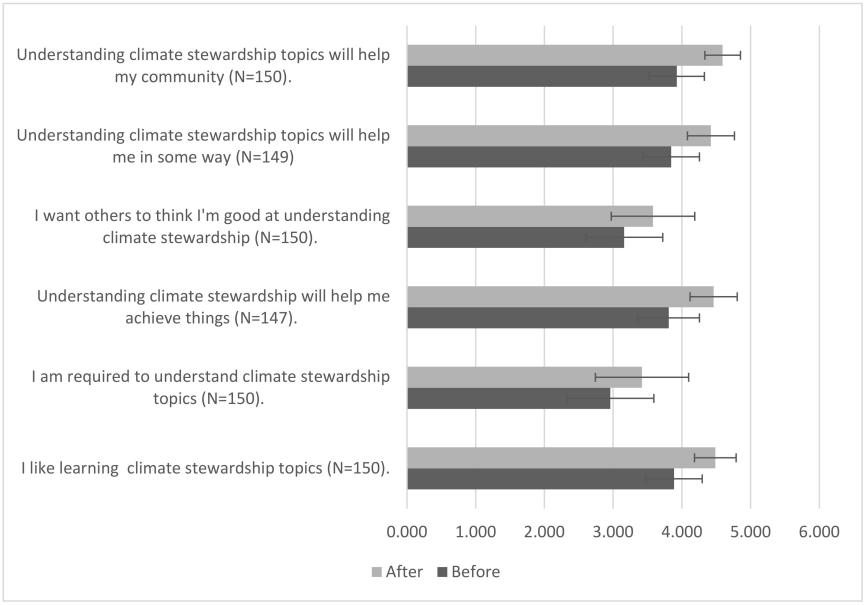

Figure 3. This figure illustrates the mean observed differences (+/−1 std error) reported for before and after the course regarding learning about climate stewardship with N = number of respondents and all are significant ($p < 0.01$).

3.3. Self-Efficacy and the Belief One Can Help

The Self-efficacy for Environmental Action scale included eight questions with significant improvement observed for all statements (Figure 4), and the value of Cronbach's alpha was 0.87. Averaging across all eight revealed a mean of 3.59 for before responses and 4.32 for after the course ($p < 0.00$).

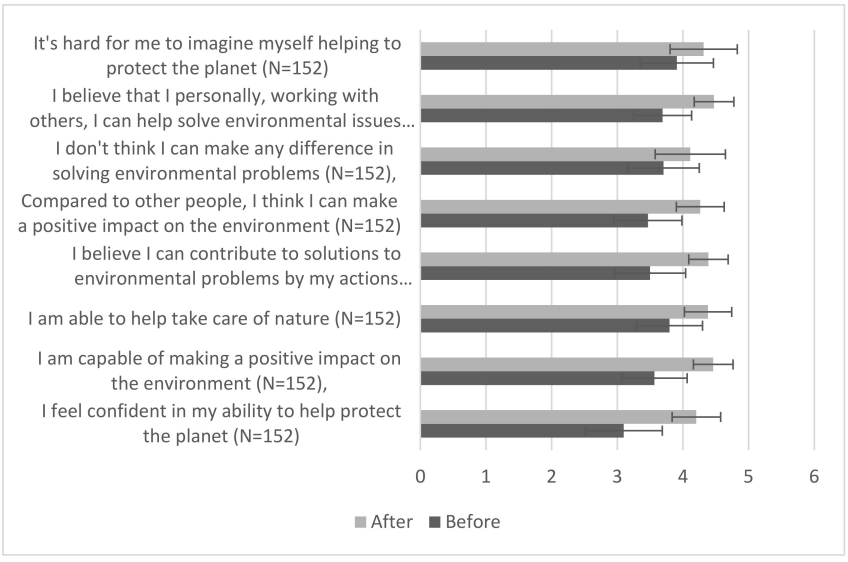

Figure 4. This figure illustrates the mean observed differences (+/−1 std error) reported for before and after the course on the self-efficacy scale or items about the participant's confidence that they can do something about climate change, with N = number of respondents and all are significant ($p < 0.01$).

3.4. Agency and the Interest to do Something about Climate Change

The Motivation for Environmental Action scale included four statements with significant improvement observed for all, and the value for Cronbach's alpha was 0.82. Averaging across all revealed a mean of 4.25 for before responses and 4.57 for after the course ($p <$ 0.00) (see Figure 5).

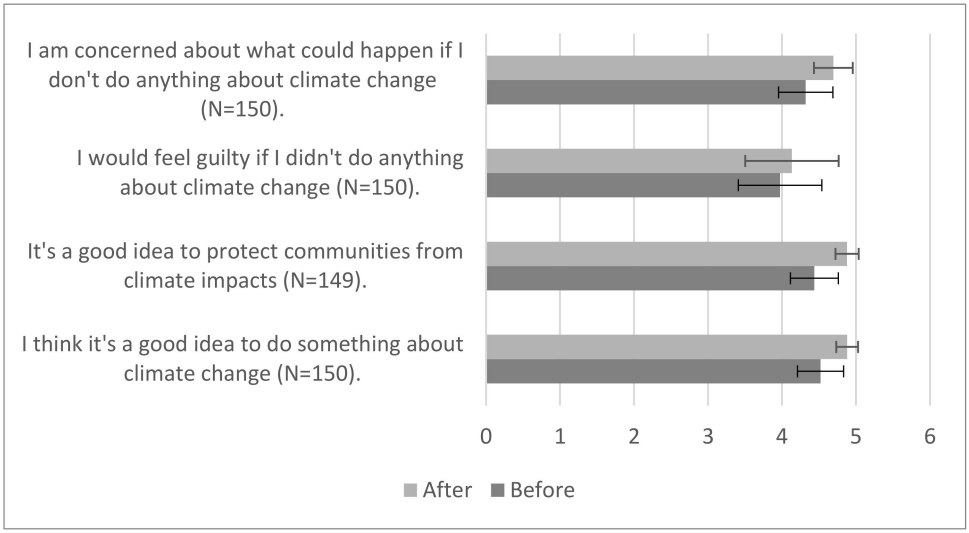

Figure 5. This figure illustrates the mean observed differences (+/−1 std error) reported for before and after the course on the environmental agency scale or statements about the importance of doing something about climate change, with N = number of respondents and all are significant ($p < 0.01$).

3.5. Climate Communication Skills

The customized Skills of Science Inquiry scale for climate change communication included eight questions with significant improvement observed for all questions (see Figure 6), and the value of Cronbach's alpha was 0.77. Averaging across all questions revealed a mean of 3.05 for before responses and 4.24 for after the course (N = 111, $p < 0.00$).

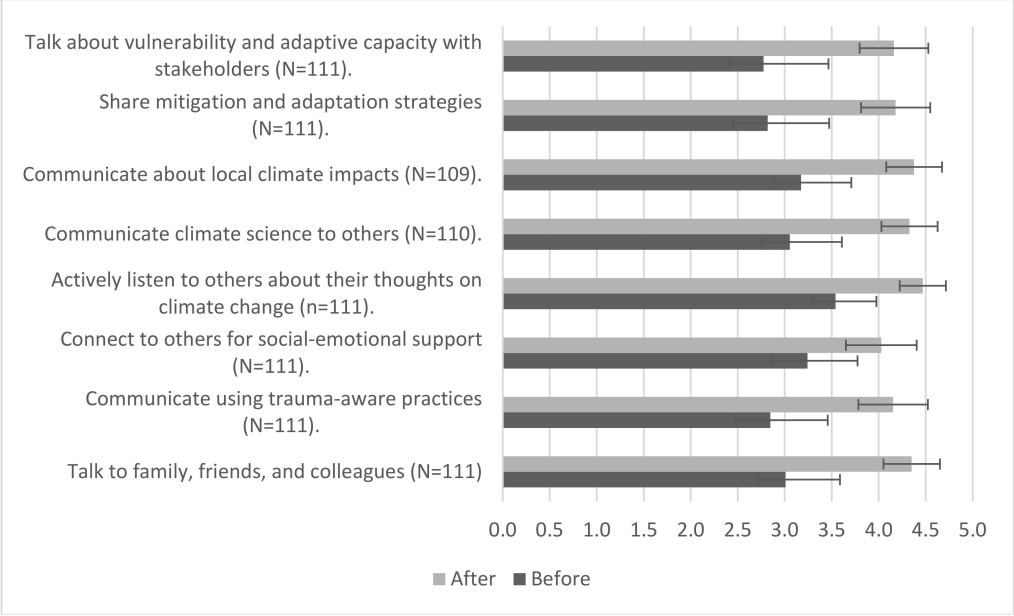

Figure 6. This figure illustrates the mean observed differences (+/−1 std error) reported for before and after the course for the communications skills scale (N=111 for all questions) with N = number of respondents and all are significant ($p < 0.01$).

3.6. Volunteer Actions

Volunteer hours by the Climate Stewards are recorded in six categories of service using a volunteer management system. "Education/Interpretation" was the most commonly reported type of service, followed by "Community Resilience and Adaptation," and then "Citizen Science" (referred to elsewhere as participatory science). A smaller number of hours were devoted to "Conservation/Restoration," "Environmental and Climate Justice," and Program Support", to add capacity to local community organizations often delivering the UC Climate Stewards course (Table 2).

Participation in service starts during the course with a capstone project that, when possible, provides a benefit to a local community organization or will guide future community-scale actions for the certified Climate Steward to continue to contribute to after graduating. Since capstone projects may be done individually or in small groups, the total number of capstone projects is slightly smaller than the total number of participants. During the survey period, there were 122 capstone projects across all course participants, including those who did not respond to the survey. These efforts include helping youth learn about climate change and resilience strategies such as exploring landscape connectivity. There were also a number of garden projects including community-scale composting, permaculture, and planting native plants. Some projects promoted sustainable solutions such as sharing electric car options through social media, reducing broad-scale waste at retirement communities, and reducing food waste. Wildfire preparedness and addressing post-fire conditions were also popular actions. One can see the characteristics of the capstone service projects done by certified Climate Stewards as a word cloud (Figure 7).

Figure 7. This figure is a word cloud formed from the titles of the UC Climate Stewards capstone projects to illustrate the themes they are addressing.

4. Discussion

Our results indicate that after completing the UC Climate Stewards course, participants report increased conviction about the importance of climate stewardship, increased confidence in their ability to address climate change, and increased ability to communicate about climate change as well as to apply the knowledge, skills, and attitudes gained in the course in support of community-oriented service. The data provided here reflect changes in the participants who experienced a wide variety of approaches to environmental education; however, they do not allow us to specify which interventions contributed most to the outcomes (self-efficacy, agency, and community-scale climate actions, in particular).

The diversity in age, ethnicity/race, household income, and work status of participants is greater than previously observed in statewide extension public education and service programs which are predominantly comprised of older, white, retired, female participants [68]. While the racial and ethnic diversity of the course participants does not yet mirror the same percentages in the state's 2019 US Census Data, they represent significant

improvements in several areas. Specifically, the percentage of ethnically Hispanic or Latino participants was close to the state average, American Indian participation exceeded the state average, and Asian participation was only a few percentage points below the state average. We attribute this to specific efforts by the program to build relationships with workforce development programs, community colleges, and community-based organizations that have an environmental justice focus. In addition, the program continues to increase the local relevance of course content through its co-design process and remove barriers to participation including online delivery and providing partial scholarships. Exploring the moderating influences of demographics such as age across and within participant responses would require more data within demographic groups and a longer time horizon to record post-course volunteer service.

Information on participant motivations has proven to be useful to understanding why participants are engaged, how they might be recruited, and the types of volunteer service that might help retain participants [69,70]. Motivations for participating in master naturalist programs, specifically, have also been studied. For example, in Minnesota, participants were motivated to learn about, benefit from, and teach others about nature and expected personal benefits such as stress reduction, relaxation, and opportunities for exercise while participating in volunteer activities [71]. Our data reveal similar inclinations with the widespread motivations focused on learning about climate science, stewardship, and communication. Since the motivation question in our survey allowed participants to select multiple, unranked responses, we cannot draw clear conclusions about which motivations connect to various other aspects of their course perceptions, including their level of satisfaction.

Some of the largest improvements from pre- to post-course, as measured by our survey, were in the area of self-efficacy (i.e., general belief and confidence that one can make a difference). These findings are similar to what we observed with UC California Naturalists, whose feelings of self-efficacy regarding environmental stewardship improved after taking that course [68]. This aligns with the findings from Geiger and Swim [54] that perceived self-efficacy for discussing climate change can indicate the benefits of knowledge-based interventions designed to increase discussions of climate change. Participants' perceived self-efficacy also correlates well with pro-environmental attitudes, but less is known about the relationship of these attitudes to behavioral change related to environmental stewardship [72]. Given that learning about solutions to climate change is one of the top motivations selected for taking the course, it is not surprising that participants had a strong belief that they themselves should do something about climate change. The fact that they want to do something is revealed in their high scores for agency observed prior to the course (Figure 5).

Learning how to communicate about climate change was also a primary motivation for becoming a Climate Steward, and communication skills were greatly improved according to their responses to the skills scale (Figure 6). Perceptions of these skills before the course averaged less than 3 to over 4 for after the training. This is likely, in large part, due to the hands-on communication training provided using the evidence-based strategic framing techniques from the National Network for Ocean and Climate Change Interpretation (NNOCCI). The greatest gains within the scale were for the questions about their ability to communicate using trauma-aware practices and share mitigation and adaptation strategies. This likely reflects how new the use of trauma-aware practices is and the focused training we provide on this. Moreover, the public receives very little information on solutions and strategies to advance climate mitigation and adaptation locally. It should be no surprise to see gains related to mitigation and adaptation strategies given the course's emphasis on civic engagement through individual capstone projects, a class participatory science project, a local community resilience assessment, and post-course volunteer service.

Although we did not intentionally collect data about self-silencing attitudes (i.e., rarely or never talking about climate change because one assumes that others do not share the desire to talk about climate change), assignments during the course documented self-silencing behaviors among participants before the course. Knowing self-silencing exists

in the community at-large, this behavior was intentionally addressed during the course through the application of communication skills (i.e., knowledge-based interventions) required to complete course assignments and continued use of these skills was encouraged after the specific assignments were completed (i.e., use of acquired communication skills in end-of-course capstone presentations). Additionally, during course debriefs, several instructors shared similar anecdotes from participants that prior to the course they rarely, if ever, spoke about climate change with anyone and, with the knowledge and skills they had acquired during the course, they now felt comfortable enough to engage in climate conversations with friends, family, and colleagues.

Monitoring volunteer hours and the various categories these contributions fall into is valuable information for understanding sustained climate stewardship. This type of data on actual stewardship behaviors following an environmental education program goes beyond most studies of education programs that generally limit their data collection to participants' intentions to act. With only provisional volunteer service data (i.e., less than a full year post-course), it is too early to draw any conclusions regarding the extent to which increased self-efficacy, understanding of climate stewardship, and ability to communicate about the subject results in long-term stewardship behaviors. However, continued tracking of self-reported volunteer service and subsequent social learning as part of a UC Climate Stewards community of practice will provide a better picture of the role the course plays in increasing and sustaining public engagement. The use of self-reported volunteer service data provides both benefits and challenges. The primary benefit is the collection of data through little or no effort by the program. The challenges include the burden on the individual to record volunteer service hours consistently and reliably in the volunteer management system. In addition, the volunteer hours reported to the UC California Naturalist Program only capture the service hours associated with the certifying partner organization and do not necessarily capture all of the volunteer service in which a participant may be engaged. While categorization and brief descriptions of volunteer service provide some insight to what is done, they do not typically include measures of impact. More data would be required to measure the extent to which these climate stewardship service actions result in measurable improvements in community and ecosystem resilience. This question is of particular relevance given that local partners typically offer the Climate Stewards course annually to a new cohort of participants whose cumulative impact in the community would likely increase over time.

We lack information on participants' levels of volunteer service prior to the program. Further research on volunteer service should include assessment prior to participation to gather data on what participants were involved in related to climate action prior to taking the course. There are also multiplicative effects of the work Climate Stewards do in education and interpretation that may impact their secondary contacts and potentially amplify or extend their stewardship, justice, and research activities in the community at large. Moreover, additional research into how engaged a comparative group of residents not exposed to the UC Climate Stewards course are in climate stewardship would allow for a deeper understanding of how increases in self-efficacy and environmental agency demonstrated through our participant survey data relate to actions taken by UC Climate Stewards alumni. However, collecting information from a large enough control group would be difficult. Similarly, collecting information on what barriers may exist to participation from the public would be useful to improve equitable access to the program.

The observed shifts in learning, self-efficacy, and agency for community-scale stewardship add to the body of literature studying these educational outcomes employing similar survey instruments [65,66,68,73]. Another recent study has also shown the connection between climate change education and reduced individual carbon emissions, signaling how increased agency connects to pro-environmental behavior [74]. As previously stated, it is unclear which of the interventions implemented through the Climate Stewards course have the greatest impact on these outcomes. In addition, to better understand the long-term impact of the course on sustained climate stewardship (in the form of public volunteer

service), we need to know more about how the course changes participants' behaviors, including attempts to mitigate and adapt to climate change, that may not be captured by the volunteer reporting system. To date, we have not devised a way of measuring the extent to which the participants have truly developed a sense of shared identity as "Climate Stewards" nor the extent to which they will engage in a community of practice to continue as alumni.

In reflection, the participants are gaining exposure to what social-emotional resilience and trauma-aware practices are as well as important climate change communication skills, from Unit 1 and Unit 2, respectively. However, we know little about the extent to which they understand climate science and its local impacts covered in Units 3 and 4, or what they gained from evaluating their own community resilience (Unit 5). We need to develop better instruments to understand the strengths and weaknesses of our approach to sharing this information and the knowledge and insights gained.

While the UC Climate Stewards course is specifically designed to address the needs of the whole person, we do not know how comfortable participants felt in the course with others, and whether they perceive the instructor as a trusted source. Moreover, the Climate Stewards we surveyed clearly share values around the importance of climate stewardship (Figure 3), which bodes well for conducting pro-environmental behaviors [23], but knowing what other values they share after the course as compared to before could be helpful to understand the drivers of pro-environmental-action outcomes or the lack thereof.

In sum, while additional research is needed to understand the UC Climate Stewards experience, the participant surveys reveal improvements in their understanding of what to do and their confidence in making a difference, as well as a strong interest and some evidence of participating in community-scale climate stewardship.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su14031804/s1. Figure S1: Sustainability Article Partners Map.

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