

Article

# Regional Collaboration for Sustainability via Place-Based Ecology Education: A Mixed-Methods Case Study of the Upper Valley Teaching Place Collaborative

Michael Duffin <sup>1,\*</sup> and Elizabeth E. Perry <sup>2</sup>

<sup>1</sup> PEER Associates, Richmond, VT 05477, USA

<sup>2</sup> Department of Parks, Recreation, and Tourism Management, Clemson University, Clemson, SC 29634, USA; eeperry@clemson.edu

\* Correspondence: michael@peerassociates.net

Received: 10 December 2018; Accepted: 28 December 2018; Published: 29 December 2018



**Abstract:** Place-based Ecology Education (PBEE) has emerged as a compelling approach to achieving the sustainability goals of Environmental Education (EE), including helping children understand, care about, and take action to protect the environment. Collaboration for teacher training can amplify and expand the reach and effectiveness of PBEE within a given geographic region. This case study of a collaborative of five PBEE professional development organizations provided a noteworthy example of collective evaluation. The primary data source was quantitative and qualitative analysis of 156 survey responses from K-12 classroom teachers, administered from 2016 to 2018 in the Upper Valley region of New Hampshire and Vermont. On average, teachers reported medium-sized (Cohen's *d* 0.4 to 0.6), statistically significant changes over the prior year for all six PBEE core practices measured. Teacher responses to open-ended survey items suggested that PBEE often involves coordination between and contribution from multiple players with different roles but similar goals. Cross tabulation with quantitative results suggested that collaboration within schools was a central factor associated with high levels of PBEE practice.

**Keywords:** collaboration; environmental education; place-based education; ecology education; mixed methods; evaluation; professional development; K-12 education; collective evaluation

## 1. Introduction

Over thirty years ago, the founding document establishing Environmental Education (EE) as a strategy for achieving sustainability at national and global levels called for EE to focus outward toward the community [1]. More recent international declarations [2] have both broadened and deepened the aims of sustainable development to include issues of poverty and empowerment, even as evidence of the undesirable consequences of anthropogenic climate change and exponentially increasing population and resource consumption continues to mount. Geography as a discipline is well suited as a conceptual framework for translating these broad goals into tangible educational action. Geo-literacy has been defined as “the ability to reason about Earth systems and interconnections to make far-reaching decisions” [3,4]. But what does that look like in practice?

Environmental educators have often used the geographic notion of “place” to examine food systems, forest resources, watersheds, and other local resources to make broader and more complex ecological phenomena more relevant and understandable [5]. Place-based Ecology Education (PBEE) integrates community connections and seeks to use local places to achieve the sustainability goals of EE and the educational goals of geo-literacy. PBEE has been defined as “... the process of using the

local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science, and other subjects across the curriculum" ([6], p. 7). Although the content of PBEE explorations is often not explicitly environmental sustainability or geography per se, PBEE does incorporate a developmental perspective [6]. The most developmentally appropriate (and thus most potent) scale of inquiry for school age children on a path toward environmental values and behaviors as adults is often the local community [7].

An emphasis on place and local contexts, however, is often unsupported by national standardized curricula [8,9]. To make a sustainable, rather than idiosyncratic, connection between schools and communities, collaborations are necessary [10]. PBEE researchers have posited that collaborations with experts and community resources outside of the school system are potentially one of the most important strategies for successful PBEE [9]. Although partnerships between schools and community organizations (and related student outcomes) have been examined in the literature, collaborations focused on teacher training have received less attention. Collaboration for teacher training is a particularly important issue for EE sustainability because shared resources and networks among educators can amplify and expand the reach of PBEE within a shared geography.

This case study of ways in which a regional PBEE collaborative for teacher training contributed to changes in teacher practice was an opportunity to investigate the rich intersection between the ideas of collaboration and community connections described in the literature.

### *1.1. The Case*

The Upper Valley Teaching Place Collaborative (UVTPC, or the Collaborative) is a group of five organizations providing PBEE professional development (PD) programs. They met from 2015–2018 to "increase the quality, capacity, coordination, collaboration, and accessibility of PBEE professional development offerings in the Upper Valley," (UVTPC, personal communication, 26 January 2016). The Upper Valley is a region consisting of 61 towns spanning part of the Connecticut River watershed in Vermont and New Hampshire, USA. The partner organizations are Shelburne Farms' Forest for Every Classroom (FFEC), Four Winds Upper Valley Linkages for Environmental Literacy (UVLEL), Vermont Institute of Natural Science—Center for Environmental Education (VINS), Vital Communities—Upper Valley Farm to School (UVFTS), and the Wellborn Institute (WI). The two main objectives of the Collaborative were to implement rigorous and replicable tracking of PBEE teacher practice in the region and to promote higher quality collaboration among the PD providers that make up the Collaborative. The organizations interacted routinely through in-person and remote meetings as well as through subgroup interactions on related projects, including a structured protocol (adapted from [11]) for documenting how participating in the Collaborative led to useful changes in practice for members.

From its inception, the UVTPC integrated program evaluation into their work. They hired professional evaluators to guide and execute a shared evaluation and research agenda, and to provide critical, supportive insight into the Collaborative's direction and operations. The Collaborative's commitment to evaluation was notable given that the EE community is still at the beginning stages of embracing evaluation into its culture as a capacity-building tool for reflection and growth [12].

Starting in the early 2000's, various UVTPC programs began receiving funding for both program implementation and program evaluation from the Wellborn Ecology Fund of the New Hampshire Charitable Foundation. Many other related organizations in the Upper Valley region have also received consistent and substantive financial support from the Wellborn Ecology Fund for sustainability related work. This includes the Place-based Education Evaluation Collaborative (PEEC), whose work from 2002 to 2010 laid much of the specific groundwork on which activities of the Collaborative were built. In sum, UVTPC's results occurred in a context of consistent support from a regional community foundation.

### 1.2. Research on Collaboration for PBEE

Research outside of formal education suggests that collaborations for community-focused EE are a powerful way for EE to reach its intended audience and promote its goal of educational transformation through collective involvement [13–16]. In a comprehensive review of the community-based EE peer-reviewed literature from 1994–2013, Aguilar [13] found the majority of the programs being studied were the product of some form of collaboration (e.g., NGO/grassroots, government agencies, university research). Collaboration helped the programs to maintain sustainability and reach their objectives. Similarly, Norlander and colleagues [7] found that successfully engaging interpretive staff in a collaboration among informal science education institutions required a trusting and diverse team, an iterative development process, and effective structures for sharing resources and ideas.

Small groups of programs pursuing EE have been successful when they viewed differences of approach as complementary and beneficial [17,18]. Gupta and colleagues [19] examined two types of collaborations in the USA for incorporating EE in K-12 education: between community groups and between established EE groups. Although both types of collaboration had differences in power balances and EE perspectives, the authors found that awareness among collaborators in both groups about these differences supported more integrated and sustainable group dynamics. Smith and colleagues [9] studied four Australian EE-related professional associations collaborating on sustainability education and teacher professional development. The groups identified ways in which their goals and terminology did and did not overlap. The researchers found that promoting shared goals was associated with more positive and sustainable group dynamics.

In evaluating the collaborative processes and outcomes of a group of four PBEE programs in New England, Powers [20] found that participants expected to learn from the other programs in the group and enrich their own program offerings through these interactions. For the classroom teachers served by these programs, six areas were consistently positively impacted: teachers' use of local resources and locations, interdisciplinary approaches, peer collaborations, leadership and growth, curriculum planning and delivery skills, and integration of service-learning.

The UVTPC case explored in this manuscript exemplified all of the collaboration dynamics described in these previous studies. Participants in the Collaborative worked very well together toward their shared sustainability goals. It was within this context that we investigated the PBEE practices of the classroom teachers served by the UVTPC.

### 1.3. Research on Collaborations for Teacher Professional Development (PD)

Teacher practice change is a logical precursor to changes in student learning [21]. Yet, outcomes research routinely focuses on student or participant assessments [12,13,22] more than on outcomes for the connecting agent, the teacher. Investigations of teacher training also routinely use factual knowledge (e.g., environmental literacy) as a measure of training effectiveness, rather than change in practice [13,23,24]. Examining how teachers are trained via pre-service schooling and through in-service PD is an important way to improve the field of PBEE [8,25,26].

Examples of how collaborations for teacher training have promoted teacher preparedness to deliver PBEE have been detailed in relatively few contexts in the literature. McKeown-Ice [25] and Powers [27] noted that training for EE tends to be partial or non-existent in many university-level preservice teacher training programs. The PBEE training they found tended to emphasize individual practice rather than engaging in a learning community [25] or to emphasize printed EE resources that focus on topical knowledge rather than knowledge networks [27]. Both authors highlight the potential role of professional organizations and community partners as a means to enhance teacher preparedness. Additionally, Smith [9] noted that teachers are often underprepared for how to seek out collaborations for PBEE with their colleagues and/or the community.

A few notable instances of PBEE teacher training in the research literature occurred in the southeastern USA and Australia. In Kentucky, an evaluation of a 6-day professional development program found post-training increases in: building teacher confidence for integrating EE across the

curriculum, engaging in collaboration with community members and fellow participants, incorporating reflective learning practices, incorporating experiential learning practices, linking classroom content to relevant current issues, and promoting citizenship education [26]. McNerney and colleagues [8] examined these types of collaborations in Australia. They found that a team approach to teacher training involving multiple courses and topics with university partners helped nurture a more inclusive understanding about local geographies and cultures, establish collaboration as a primary means of functioning for EE in the region, and instill reflective practices as teachers grew in their learning.

Because all member programs of the UVTPC are explicitly teacher professional development programs, examination of their case was well suited to contribute to the relatively few instances of related work in the empirical, peer-reviewed literature.

#### 1.4. Research Question

Given the current knowledge about collaborations for sustainability and PBEE, and, in particular, teacher training for PBEE, the broad research question guiding this case investigation was: In what ways did the UVTPC contribute to changes in PBEE teacher practice? To examine this overarching question, we present detail on three specific areas of inquiry:

- What trends characterized teacher changes in PBEE core practices?
- What helped and hindered teachers in making progress on PBEE core practices?
- How did practice changes and reported helps and hindrances vary by the amount of recent PD and current level of PBEE practice?

## 2. Methods

Data for this case study consisted of quantitative analysis of closed-ended survey items, and qualitative analysis of open-ended survey items and notes from meaning making conversations between program staff and evaluators, as described in detail below.

### 2.1. Groundhog Day Survey Instrument Development

At the beginning of the three-year engagement with the UVTPC, a central task was to build a tool to measure delivery and outcomes of PBEE across the five programs' collective professional development offerings. Staff from organizations in the Collaborative worked together with evaluators and the main funder to identify and refine six diagnostic features of PBEE, and labeled them the "PBEE core practices" (Table 1). They include using local areas, collaborating with the community, collaborating with fellow educators, adapting teaching style, adapting standardized curricula, and using locally relevant curricular content. These practices are consistent with the distinctive characteristics of place-based EE [28] and are articulated at a level of detail that is approachable for teachers from varied grades, schools, and pedagogical approaches. Essentially, this definitional work completed efforts begun by the Place-based Education Evaluation Collaborative (PEEC) [29] and reflected in published research by Powers [20,27].

The main content of the survey included a retrospective-pre structure asking teachers to self-report their level of practice "one year ago" and "now" on the six PBEE core practices (Table 1). Members of the Collaborative selected a five-point Stages of Change response scale for these items. The scale was adapted from research on behavior change in smoking cessation [30], with terminology further adapted for climate change studies [31]. The five Stages of Change are: (1) Disinterest—Not necessarily opposed to making this part of my teaching practice, but not intending to change soon; (2) Deliberation—Thinking about making this part of my teaching practice, perhaps unsure about costs versus benefits; (3) Designing—Actively preparing to make this part of my teaching practice soon, feeling fully convinced; (4) Doing—This is my regular teaching practice; and (5) Deepening—This has been my normal, automatic teaching practice for a long while, I'm seen as an enthusiastic "champion".

**Table 1.** Core Place-based Ecology Education practices reported for “One year ago” (Pre X) & “Now” (Post X) for the Upper Valley Teaching Place Collaborative, aggregated for 2016, 2017, and 2018.

Description <sup>1</sup>	Pre X	Post X	$\Delta X$	SD	Cohen's <i>d</i> Effect Size	$\Delta R^2$	df
<i>Average of six place-based ecology education core practices items</i>	3.2	3.7	+0.5 ***	0.9	+0.6	0.06 **	119
I regularly use the area immediately around the school and other community locations as places for learning	3.4	3.9	+0.5 ***	1.1	+0.5	0.02	119
I regularly collaborate with local organizations and community members for planning and teaching	3.2	3.6	+0.4 ***	1.1	+0.4	0.06 **	119
I regularly collaborate with fellow teachers to make our teaching more place-based	3.3	3.7	+0.4 ***	1.0	+0.4	0.06 **	119
I regularly adapt my day to day teaching choices, language, and cultural references to incorporate locally relevant content	3.2	3.6	+0.4 ***	1.0	+0.4	0.03	119
I regularly adapt standardized curriculum to make it more locally relevant	3.2	3.6	+0.4 ***	1.1	+0.4	0.04 *	119
I regularly use locally relevant content to anchor interdisciplinary curriculum units or overarching learning themes	3.1	3.6	+0.5 ***	1.1	+0.5	0.05 *	119

<sup>1</sup>  $n = 160$ , with participation within each of the five programs  $n = 22-45$  and  $X = 32$ . \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Other questions on the survey included open-ended items about helps and hindrances for PBEE implementation, and quantification of the amount of PBEE training received from various sources over the previous year. Additional program-specific items were included as well, but are beyond the scope of this case study of the UVTPC as a whole.

## 2.2. Groundhog Day Survey Administration

The survey population was defined as formal K-12 teachers who had been active in at least one UVTPC program in the past three years. From this population, evaluators created a sampling frame consisting of either a census of program participants for the smaller programs, or a random sample of 20–30% of program participants for larger programs, resulting in a range of 10–27 teachers per program.

In 2016, 2017, and 2018, on or around February 2nd (Groundhog Day in the USA), the survey was administered to teachers participating in UVTPC programs. This time of year was chosen because it coincided with a relatively flexible period in the school year rhythm. Also, there was an attempt to make an analogy with the promise of the pending season of spring and growth symbolized by Groundhog Day, as well as with the Audubon Christmas Bird Count, an annual data collection event that is both fun and useful. In December and January of each year, individual programs in the Collaborative sent notification of the survey directly to their own program populations within their routine communications (e.g., newsletters, workshops). The sampling frame was then contacted via email and invited to participate in the online survey. Non-respondents received up to five email invites and a phone call. The survey was open for six weeks and closed mid-March.

Over the three years, 156 teachers (of the 288 teachers invited) provided usable survey responses, yielding an overall effective response rate of 54%. This was below the target of 70% that evaluators had established as sufficient to confidently claim representativeness. Response rates for subsample strata by program ranged from 32–100%, with higher rates coming from subsamples that had more recently participated in an in-person PD event. Thus, the sample may be biased somewhat toward teachers who were more engaged in PBEE.

The survey tool itself underwent minor refinements from year to year. There were no substantial changes to the Collaborative, the five programs, or the respondent pool in the three years.

### 2.3. Member Checking

Another way the UVTPC embodied collaboration was in the process of holding meaning-making conversations between program staff and evaluators after preliminary data analysis but before final reporting. For each year's data set, this comprised at least one two-hour face to face discussion between evaluators and the Collaborative as a whole, plus two to four one-hour conference calls with various combinations of program staff and evaluators. The purpose was to integrate the external, data-driven perspective of evaluators with the rich understanding of people with day-to-day knowledge of a program's inner workings and nuance. This dialectical interactionist approach built trust and strengthened data interpretation through critical discourse.

### 2.4. Analysis

Multiple sources of quantitative and qualitative data were interpreted to generate overall conclusions for this case study. Survey data were aggregated over the three years of administration. Changes over time of within group means from pre- to post- for PBEE practices (individually and as an aggregate index) were tested for statistical significance with *t*-tests. Regression analyses were used to test if the dose of PBEE PD (i.e., the weighted sum of all reported training over the prior year, ranging from 0–325 h [0–8 weeks] equivalents) significantly predicted changes in PBEE practices. Open-ended survey responses about PBEE implementation were analyzed for themes using a constant comparative qualitative data analysis process, grouping for main themes. Cross tabulations of dosage clusters and Stage of Change response categories with themes from the open-ended survey items provided a finer-grained look into the question of what factors were associated with the highest levels of PBEE teacher practice change. Quantitative analyses were conducted using SPSS v24. Qualitative analyses were conducted with Google Sheets and HyperResearch v4.

## 3. Results

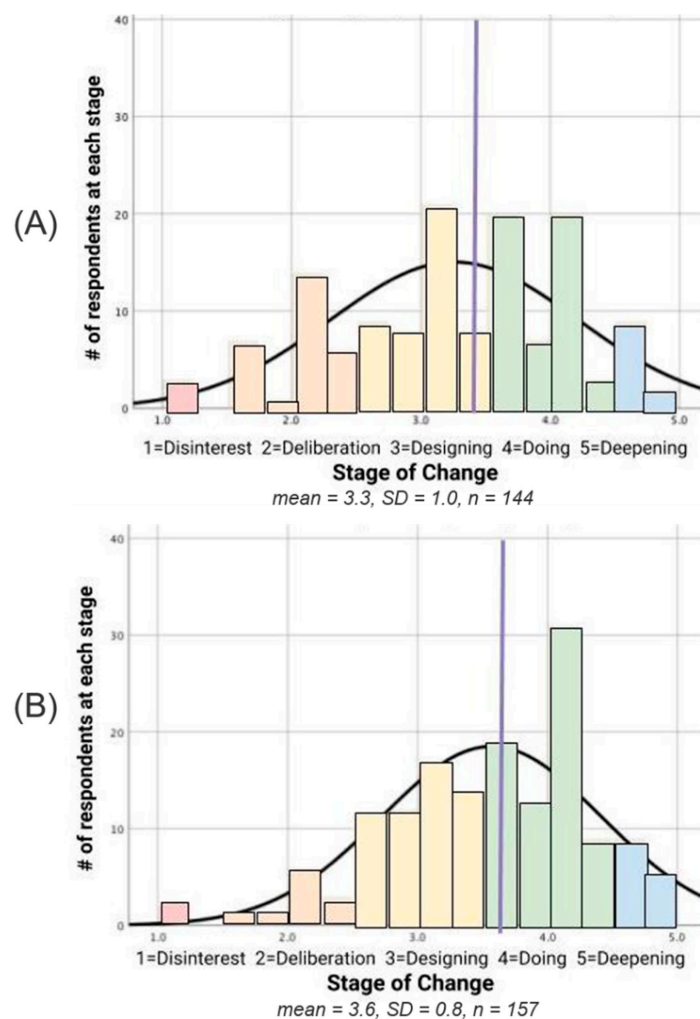
### 3.1. Teacher Practice Change

The main finding relevant to our research question was that teachers reported strong, medium-sized, statistically significant changes over the prior year for all PBEE core practices. The magnitude of change pre- to post- was approximately a half a standard deviation (see Cohen's *d* in Table 1). On average, this represented a move from a little above "Designing" to a little below "Doing" on the Stages of Change scale (Figure 1).

The relationship between dose of PD over the prior year and PBEE core practices ( $\Delta R^2$  in Table 1) was statistically significant ( $p < 0.05$ ) for some PBEE core practices. However, inconsistent patterns at the finer-grained level of individual programs led us to conclude that this analysis did not yet warrant confident interpretation. We suspect that there was noise in the mechanics of the way the PD dose variable is measured, and that other factors that contribute to practice change (e.g., cultural norms within schools) were not captured by this instrument.

### 3.2. Qualitative Descriptions of PBEE Implementation

Teacher responses to open-ended survey items suggested that PBEE often involves coordination between and contribution from multiple players with different roles but similar goals. In that way, PBEE is like a team sport. Respondents expressed appreciation for collaboration with teacher colleagues as well as for the ongoing, personalized coaching and support they received from PD providers. Teachers reported wanting hands-on support for themselves to overcome logistical and time challenges in implementing PBEE, often characterized as competing school priorities. An example that captured this dominant theme is the teacher who wrote that the most helpful support factors were "my colleagues and outside resources".



**Figure 1.** Distribution of place-based ecology education core practice index for aggregate 2016, 2017, and 2018 samples **(A)** One year ago and **(B)** Now.

Teachers also reported that PBEE was engaging and hands-on for their students. A quote that exemplified this theme was: “PBEE has absolutely made learning more relevant for my students, particularly with the local connections we have made”.

When asked which topics they would like support on as they relate to PBEE, the seven most common selections from the list of options were, in descending order of frequency: addressing state or national standards (e.g., Next Generation Science Standards, Common Core), student-driven learning, nature play, differentiated instruction/personalized learning, engineering and design, service-learning, and integrating technology into outdoor learning.

### 3.3. Factors Associated with Higher Levels of PBEE Implementation

To discover insights into best practices for PBEE professional development, themes from some open-ended survey items were cross tabulated with the level of PD dose and with reported Stage of Change of PBEE practice (Tables 2–6). The open-ended items asked what helped or hindered teachers in making progress on any of the PBEE core practices. The driving idea was to look for clues about how to move teachers from “Doing” to “Deepening” in their PBEE practice. A cluster analysis of 105 eligible cases yielded three groups of PD dosage from the prior year: Low ( $n = 36$ ,  $X = 37$  h); Medium ( $n = 59$ ,  $X = 142$  h); and High ( $n = 10$ ,  $X = 246$  h).

The highest levels of PBEE practice were reported by teachers who had the highest dosage of PD (Table 2). This group also found the connections to a learning community and local resources to be the

most valuable for improving their PBEE practice (Table 3). On the other hand, many teachers in the lowest PD dosage group also reported relatively high levels of PBEE practice (Table 2). These teachers reported feeling most supported by the curriculum content and the expertise of PD providers (Table 3). This contrast suggests that the role PD plays in supporting high levels of PBEE implementation was not the same for everyone. This is consistent with the Concerns Based Adoption Model, which describes ways in which different teachers need different levels and types of PD [32]. It is also consistent with the idea that PBEE, by definition, adapts and responds to variety in local conditions.

**Table 2.** Percentage of responses by professional development dosage cluster for composite index of mean response to six Place-based Ecology Education core practices.

Stage of Change <sup>1</sup>	Low PD Dosage	Medium PD Dosage	High PD Dosage
N/A or Unsure	6	5	0
Disinterest (1.0–1.9)	6	5	0
Deliberating (2.0–2.9)	14	24	0
Designing (3.0–3.9)	36	42	40
Doing (4.0–4.9)	36	17	50
Deepening (5)	2	7	10

<sup>1</sup> Composite is the mean of a respondent’s answers to the six place-based ecology education measures (Table 1). All respondents answered at least three of the six measures, and most answered all six.

**Table 3.** Percentage of responses by professional development (PD) dosage cluster for main theme of response to “What helped you make progress on any of the practices?”

Theme <sup>1</sup>	Low PD Dosage	Medium PD Dosage	High PD Dosage
Community and mentoring connections/support from program	13	13	38
Knowledge of and connection to local resources	10	16	38
PD—specific programs or generally	23	19	12
Curriculum (specific and cross-discipline) support from program	20	19	0
Team mentality and support in-school	20	17	12
Program staff support (communications, personal connections, and in-person assistance)	10	7	0
Teacher reassignment	0	9	0
Seeing results	4	0	0

<sup>1</sup> No response and responses of “nothing” were excluded from the depiction of results and percentages. These exclusions totaled  $n = 6$  for Low PD Dosage,  $n = 15$  for Medium PD Dosage, and  $n = 2$  for High PD Dosage.

**Table 4.** Percentage of responses by professional development (PD) dosage cluster for main theme of response to “What hindered your progress on any of the practices?”

Theme <sup>1</sup>	Low PD Dosage	Medium PD Dosage	High PD Dosage
Logistics (funding, location, personal issues, weather, etc.)	19	10	0
Lack of team mentality, time with colleagues/professional community	15	10	43
Time (generally or in/with the class)	20	33	1
Competing school priorities	15	6	29
Teacher reassignment	11	17	14
Curriculum challenges	8	10	0
Lack of administrative support	8	10	0
Class composition	4	4	0

<sup>1</sup> No response and responses of “nothing” were excluded from the depiction of results and percentages. These exclusions totaled  $n = 10$  for Low PD Dosage,  $n = 10$  for Medium PD Dosage, and  $n = 3$  for High PD Dosage.



**Table 5.** Percentage of responses by stage of change for main theme of response to “What helped you make progress on any of the practices?” by Place-based Ecology Education composite index and with progressively darker shading for higher percentages of response.

Theme <sup>1</sup>	NA or Unsure (0)	Disinterest (1.0–1.9)	Deliberating (2.0–2.9)	Designing (3.0–3.9)	Doing (4.0–4.9)	Deepening (5)
Team mentality, support in-school	0	0	4	7	4	4
PD—specific programs or generally	0	0	4	7	6	2
Community, mentoring/support connections	0	0	2	6	7	0
Knowledge of, connection to local resources	0	0	0	11	5	0
Curriculum (specific and cross-discipline) support from program	0	1	4	9	4	0
Program staff support (personal communications, in-person help)	0	0	2	1	4	0
Seeing results	0	0	0	0	1	0
Teacher reassignment	1	2	1	0	0	0

<sup>1</sup> No response and responses of “nothing” were excluded from the depiction of results and percentages. Percentages based on *n* = 82.

**Table 6.** Percentage of responses by stage of change for main theme of response to “What hindered your progress on any of the practices?” by Place-based Ecology Education composite index and with progressively darker shading for higher percentages of response.

Theme <sup>1</sup>	NA or Unsure (0)	Disinterest (1.0–1.9)	Deliberating (2.0–2.9)	Designing (3.0–3.9)	Doing (4.0–4.9)	Deepening (5)
Lack of team mentality, time with colleagues, and/or professional community	0	0	4	2	6	2
Competing school priorities	0	0	0	7	2	1
Time (generally or in/with the class)	0	1	6	12	7	0
Logistics (funding, location, personal issues, weather, etc.)	1	0	2	5	4	0
Lack of administrative support	1	0	2	1	2	1
Curriculum challenges	0	1	1	5	1	0
Teacher reassignment	2	2	4	6	0	0
Class composition	0	1	1	1	0	0

<sup>1</sup> No response and responses of “nothing” were excluded from the depiction of results and percentages. Percentages based on *n* = 82.

The highest levels of PBEE practice were also reported by teachers who were helped by a team mentality in their school or hindered by the lack of it (Tables 4–6). These teachers more strongly embraced connections with community members and mentors. This suggests that although PD may be an important activity, the highest levels of PBEE practice also require a supportive culture, network, and context of collaboration within the school and community.

## 4. Discussion

The overall goal of this case study was to explore ways in which the UVTPC contributed to changes in teacher practice around sustainability or geo-literacy more broadly, and PBEE more specifically. A holistic synthesis of multiple types and sources of data revealed that collaboration was a theme that unifies at least three scales of phenomena in this case: the teacher, the school, and the region.

### 4.1. Collaboration for Teachers

Perhaps the clearest, most straight forward finding of this study was that teachers consistently reported strong, medium-sized, statistically significant changes over the prior year for all PBEE core practices. The data suggest that the professional development provided by UVTPC programs was at least one contributing factor to that teacher practice change. A closer examination of the content of those PBEE core practices reveals something of a tautology between PBEE and collaboration. PBEE is inherently about collaboration. Collaboration is explicit in several of the core practices and implicit in the others. For instance, the practices described as adapting teaching styles, themes, and curricula could also be seen as a kind of collaboration in that there is a dialectical interaction between the teacher and the content of what they teach. PBEE is about working with fellow teachers, community members, and elements of the local natural and built environment to make learning real and meaningful for students. This focus on collaboration among a variety of communities echoes the original intent of EE 40 years ago [1], as well as recent research on the power of collective efficacy [33] of teams of teachers in schools [34].

### 4.2. Collaboration for Schools

The finer-grained analysis of factors associated with the highest levels of PBEE practice in this study pointed to the importance of collaboration at the school level. Although professional development for PBEE may be an important hook for many individual teachers, our data suggest that teacher teams and school leadership and culture may be the powerful levers for allowing PBEE to flourish and be sustainable. This intermediate scale of school community (i.e., bigger than the classroom but smaller than a school district or supervisory union) should frame further investigation of the cultures and networks that grease the wheels of change for PBEE and sustainability.

### 4.3. Collaboration in the Region

The collaborative nature of the UVTPC itself was evident in several ways. The ability to create a tool to measure PBEE teacher practice change was predicated on the Collaborative working well together. None of the participating organizations had the resources or ability to design and administer such a measure on their own, but collectively they could. The regular meetings of participants in the Collaborative also served as a kind of professional development and support for the PD providers themselves. In the words of one participant: "The UVTPC is building the possibility of creating true collaboration such that anyone in the region can engage in 'seamless entry' into PBEE, no matter who they talk to first...AND continue to learn from each other". The fact that each of the five programs in the Collaborative offers PD that reflects common tenets of PBEE via pedagogically and geographically variable programs means that teachers in the Upper Valley region have a richer array of options for customizing their PBEE learning. This is consistent with research from Boyer and Roth [35], who contend that EE collaborations aid in accessibility as participants have options for enrollment in a program that suits their particular needs. This balance between collaborative and individual program identity was found to be an important aspect for program sustainability in other contexts as well (e.g., [10,14]).

#### 4.4. Limitations and Future Research

Two limitations warrant explicit mention. First, with an overall effective response of 54%, non-response bias was a factor to the extent that there were any systematic (though unknowable) characteristics of the slightly less than half of teachers in the sampling frame who did not provide usable survey responses. Second, effect sizes (Cohen's  $d$  in Table 1) were probably slightly exaggerated due to social desirability bias. We suspect this even though the reliability of the retrospective-pre design was tested each year by analyzing the responses of teachers who filled out the survey two years in a row ( $n = 22$  in 2017,  $n = 24$  in 2018). In both years, reported practices for "now" from the prior year were consistently higher than reported levels for "one year ago" in the current year, though  $t$ -tests and interaction effects typically revealed a lack of statistical significance. To increase the effective response rate, future administrations of this survey in the Upper Valley region could employ more rigorous messaging campaigns prior to administration, and/or could adjust the timing to align more tightly with the timing of in person trainings. Response rates could likely also be increased by shifting the sampling frame from individual teachers participating in PD programs to all teachers in a target school (e.g., by administering the survey at all staff meetings). Such reframing of the sampling could also extend the analysis by including teachers who had not participated in PBEE professional development.

### 5. Conclusions

How might the lessons from this case study of regional collaboration for sustainability via Place-based Ecology Education be usefully transferred to other contexts?

First, articulation and operationalization of PBEE into six core practices could be adopted by the field of PBEE more broadly as one response to the historical challenge of differentiating PBEE from other related and overlapping progressive educational pedagogies [16]. We encourage adapting and testing these measures of six practices in different contexts to elicit further reflections on the utility and generalizability of this six-item battery.

Second, UVTPC's main measurement instrument, affectionately referred to as the "Groundhog Day Survey" tool, could be easily replicated and adapted to other PBEE research and evaluation contexts. This would address a challenge noted in the literature that evaluations are often inconsistent across cases [12,13]. Sharing measurement tools like this across PBEE programs is one way to support current momentum for collective evaluation and building the field of EE promoted by groups such as the Pisces Foundation, Blue Sky Funders Forum, Children and Nature Network, and the North American Association of Environmental Education. One feature of the Groundhog Day Survey tool that was only cursorily detailed in this manuscript, but that would likely be essential to replication efforts, is that the survey also included program-specific items. This allowed individual programs in the Collaborative to replace prior evaluation instruments with a modified version that served multiple evaluation needs, as opposed to adding another instrument to the existing battery. This type of structuring for core principles while leaving room for program-specific inquiries is consistent with the "enabling sustainable actions" component of Monroe and colleagues' [5] framework for EE strategies. The Groundhog Day Survey tool is downloadable from the website of the evaluators who worked with the Collaborative (see [www.PEERassociates.net](http://www.PEERassociates.net)).

Third, findings from this case study provide guidance to other PBEE professional development providers. According to requests and reports from UVTPC teachers, optimal PD for PBEE is ongoing, personalized, and collaborative. To overcome the challenges of limited time and constrained curriculum requirements, teachers want hands-on, ongoing mentoring that includes tangible examples from coaches and colleagues, especially with respect to connecting PBEE to Next Generation Science Standards and other curricular frameworks. Providing time for planning is critical. Although broadly consistent with literature on best practices for PD in general [36,37], UVTPC findings tended to place greater emphasis on collaboration.

Finally, incorporating collaborations in PBEE (both within a school and between a school and community resources) highlights the central role that relationship-building has in supporting an

engaged community of EE practitioners and community members working toward sustainability and geo-literacy goals [1,38]. Indeed, research on collaborations in other environmental contexts suggests that this idea of cross-scale interactions that harmonize local context with overall goals can contribute toward sustainability and relevance in a powerful way [10]. The motivation and urgency to achieve national and global sustainability must fundamentally come from a growing societal recognition of the ecological and social stakes involved in our rapidly changing modern world. But it may be that collaboration at every scale becomes a necessary, if not sufficient, feature of education for sustainability.

**Author Contributions:** M.D. conceptualized the framework for this evaluation; led the data collection, analysis, and synthesis; and contributed to and edited this manuscript. E.E.P. prepared and edited this manuscript and co-led the data collection, analysis, and synthesis. Because PEER Associates operates in a highly integrated and inclusive way, several other staff at PEER provided meaningful contributions to the project design and implementation, as well as editorial review of this manuscript.

**Funding:** This manuscript was developed as part of a program evaluation contract between the Upper Valley Teaching Place Collaborative (UVTPC) and PEER Associates, Inc., funded by the New Hampshire Charitable Foundation's Wellborn Ecology Fund.

**Acknowledgments:** The results reported here would not have been possible without generous gifts of time and insights from the staff at UVTPC organizations, as well as from the teachers who participate in their programs.

**Conflicts of Interest:** The authors declare no conflict of interest. The funding sponsors were involved in the design of this evaluation and are supportive of sharing a narrative from the evaluation (i.e., this manuscript) with a wider audience, which includes the dissemination of results.

## References

1. UNESCO. *The Tbilisi Declaration. Final Report from the Intergovernmental Panel on Environmental Education* 14–26; USSR: Tbilisi, Georgia, 1977.
2. UN. Resolution Adopted by the General Assembly on 25 September 2015. Available online: <http://undocs.org/en/A/RES/70/1> (accessed on 22 December 2018).
3. National Geographic Society. What Is Geo-Literacy? 2018. Available online: <https://www.nationalgeographic.org/media/what-is-geo-literacy/> (accessed on 22 December 2018).
4. Nolan, R. Geo-Literacy: How Well Adults Understand the World in Which They Live. *Adult Basic Educ.* **2002**, *12*, 134–144.
5. Monroe, M.C.; Andrews, E.; Biedenweg, K.A. Framework for Environmental Education Strategies. *Appl. Environ. Educ. Commun.* **2008**, *6*, 205–216. [CrossRef]
6. Sobel, D. *Place-Based Education: Connecting Classrooms & Communities*; Orion Society: Great Barrington, MA, USA, 2004.
7. Dueck, C.; Rodenburg, J. Pathway to Stewardship and Kinship: Raising Healthy Children for a Healthy Planet. 2017. Available online: [pathwayproject.ca](http://pathwayproject.ca) (accessed on 22 December 2018).
8. McNerney, P.; Smyth, J.; Down, B. 'Coming to a Place near You?' The Politics and Possibilities of a Critical Pedagogy of Place-Based Education. *Asia-Pac. J. Teach. Educ.* **2011**, *39*, 3–16. [CrossRef]
9. Smith, G.A. Place-Based Education: Breaking through the Constraining Regularities of Public School. *Environ. Educ. Res.* **2007**, *13*, 189–207. [CrossRef]
10. Perry, E.E.; Kiewra, L.A.; Brooks, M.E.; Xiao, X.; Manning, R.E. "Parknerships" for Sustainable Relevance: Perspectives from the San Francisco Bay Area. *Sustainability* **2018**, *10*, 1577. [CrossRef]
11. Wenger-Trayner, B. Strategic Evaluation of Network Activities. 2014. Available online: <http://wenger-trayner.com/resources/publications/strategic-evaluation-of-network-activities/> (accessed on 17 October 2016).
12. Keene, M.; Blumstein, D.T. Environmental Education: A Time of Change, a Time for Change. *Eval. Program Plan.* **2010**, *33*, 201–204. [CrossRef]
13. Aguilar, O.M. Examining the Literature to Reveal the Nature of Community EE/ESD Programs and Research. *Environ. Educ. Res.* **2018**, *24*, 26–49. [CrossRef]
14. Monroe, M.C.; Ballard, H.L.; Oxarart, A.; Sturtevant, V.E.; Jakes, P.J.; Evans, E.R. Agencies, Educators, Communities and Wildfire: Partnerships to Enhance Environmental Education for Youth. *Environ. Educ. Res.* **2016**, *22*, 1098–1114. [CrossRef]

15. Norlander, R.J.; Anderson, J.C.; Fraser, J.; Flinner, K. Collaborative tool and training design for social action. *Mus. Soc. Issues* **2018**, *13*, 24–40. [[CrossRef](#)]
16. North American Association for Environmental Education (NAAEE). Addressing Issues, Policies, Practices, and Research that Matter. *Int. J. Early Child. Environ. Educ.* **2014**, *2*, 184–186.
17. Sauve, L. Currents in Environmental Education: Mapping a Complex and Evolving Pedagogical Field. *Can. J. Environ. Educ.* **2005**, *10*, 11–37.
18. Disinger, J.F. Environmental Education's Definitional Problem. In *Essential Readings in Environmental Education*; Hungerford, H., Bluhm, W., Volk, T., Ramsey, J., Eds.; Stipes: Champaign, IL, USA, 2007; pp. 17–32.
19. Gupta, R.; Ardalan, N.; Fraser, J. The Intergroup Context of Environmental Education and Approaches to Facilitate Collaboration. *Small Group Res.* **2017**, *48*, 420–454. [[CrossRef](#)]
20. Powers, A.L. Teacher Preparation for Environmental Education: Faculty Perspectives on the Infusion of Environmental Education into Preservice Methods Courses. *J. Environ. Educ.* **2004**, *35*, 3–13.
21. Liebermann, J.; Hoody, L. *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning*; State Education and Environment Roundtable: San Diego, CA, USA, 1998.
22. Leeming, F.C.; Dwyer, W.O.; Porter, B.E.; Cobern, M.K. Outcome Research in Environmental Education: A Critical Review. *J. Environ. Educ.* **1993**, *24*, 8–21. [[CrossRef](#)]
23. Moseley, C.; Reinke, K.; Bookout, V. The Effect of Teaching Outdoor Environmental Education on Preservice Teachers' Attitudes Toward Self-Efficacy and Outcome Expectancy. *J. Environ. Educ.* **2002**, *34*, 9–15. [[CrossRef](#)]
24. Pe'er, S.; Goldman, D.; Yavetz, B. Environmental Literacy in Teacher Training: Attitudes, Knowledge, and Environmental Behavior of Beginning Students. *J. Environ. Educ.* **2007**, *39*, 45–59. [[CrossRef](#)]
25. McKeown-Ice, R. Environmental Education in the United States: A Survey of Preservice Teacher Education Programs. *J. Environ. Educ.* **2000**, *32*, 4–11. [[CrossRef](#)]
26. Meichtry, Y.; Smith, J. The Impact of a Place-Based Professional Development Program on Teachers' Confidence, Attitudes, and Classroom Practices. *J. Environ. Educ.* **2007**, *38*, 15–32. [[CrossRef](#)]
27. Power, A.L. An evaluation of four place-based education programs. *J. Environ. Educ.* **2004**, *35*, 17–32. [[CrossRef](#)]
28. Woodhouse, J.; Knapp, C. *Place-Based Curriculum and Instruction*; ERIC Document Reproduction Service No. EDO-RC-00-6; ERIC/CRESS: Charleston, WV, USA, 2007.
29. Place-Based Education Evaluation Collaborative. The Benefits of Place-Based Education: A Report from the Place-Based Education Evaluation Collaborative (Second Edition). 2010. Available online: [PEERassociates.net](http://PEERassociates.net) (accessed on 20 November 2018).
30. Prochaska, J.; DiClemente, C.; Norcross, J. In Search of How People Change: Applications to Addictive Behaviors. *Am. Psychol.* **1992**, *47*, 1102–1114. [[CrossRef](#)]
31. Doppelt, B. *The Power of Sustainable Thinking: How to Create a Positive Future for the Climate, the Planet, Your Organization and Your Life*; Earthscan Publishing: London, UK, 2009.
32. Anderson, S.E. Understanding Teacher Change: Revisiting the Concerns Based Adoption Model. *Curric. Inq.* **1997**, *27*, 331–367. [[CrossRef](#)]
33. Bandura, A. Self-efficacy: Toward a Unifying Theory of Behavioral Change. *Psychol. Rev.* **1977**, *84*, 191–215. [[CrossRef](#)] [[PubMed](#)]
34. Donohoo, J.; Hattie, J.; Eells, R. The Power of Collective Efficacy. *Educ. Leadersh.* **2018**, *75*, 40–44.
35. Boyer, L.; Roth, W.M. Individual and Collective Dialectic of Free-choice Learning in a Community-based Mapping Project. *Environ. Educ. Res.* **2005**, *11*, 335–351. [[CrossRef](#)]
36. Gulamhussein, A. *Effective Professional Development in an Era of High Stakes Accountability*; National School Boards Association: Alexandria, VA, USA, 2013; Available online: [centerforpubliceducation.org/](http://centerforpubliceducation.org/) (accessed on 18 November 2018).
37. Hardee, C.; Duffin, M.; PEER Associates. *Five (+) Guiding Principles for Professional Development: Summary Report, Professional Development Literature Review*; Project Learning Tree: Washington, DC, USA, 2013. Available online: [www.PEERassociates.net](http://www.PEERassociates.net) (accessed on 30 November 2018).
38. Cole, A.G. Expanding the Field: Revisiting Environmental Education Principles through Multidisciplinary Frameworks. *J. Environ. Educ.* **2007**, *38*, 35–45. [[CrossRef](#)]

