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ORIGINAL ARTICLE

Framing for resilience through social learning: impacts of environmental stewardship on youth in post-disturbance communities

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Abstract Civic ecology practices, such as community gardening and citizen-led urban reforestation and wetland restoration, provide opportunities for social learning. Because social learning is an important component of community resilience, we suggest that civic ecology practices can be a strategy for responding to and mitigating environmental disturbances in an era threatened by climate change. Despite the links between civic ecology, social learning and community resilience, empirical research that systematically considers these connections is limited. This study addresses this gap by introducing 'frames' as an approach to considering social learning outcomes and process. More specifically, we provide a model for investigating the role civic ecology education programs play in shaping youths' capacity to understand and respond to environmental disturbance. We used participant observation and cognitive mapping to assess social learning among three youth restoration programs working in the wake of Hurricane Sandy in New York, NY, and after the 2013 floods in Boulder, CO. In all three programs, youth demonstrated social learning and cognitive change by shifting their emphasis from the *impacts of disturbance* towards a *solutions-based* framing that focused on community, action, and mitigation. However, the depth of these changes was not uniform across all programs, suggesting that variations in program length, community context, social identity, and opportunities for self-defined action may shape overall impacts of programs and youth capacity for future action.

Keywords Civic ecology · Social learning · Framing · Community resilience · Environmental education

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Introduction

Sea level rise, increasing inundation and wildfire, and decreasing water availability all represent climate change-related threats to social–ecological systems (SES; Parry et al. Hanson 2007). Living through such events can be traumatic, leading to denial, a sense of powerlessness, and social divisiveness related to lack of collective understanding, hindering cooperation around recovery and mitigation efforts (Orom et al. 2012). Thriving in the wake of these disturbances depends in part on whether communities possess the structures and processes that enable people to live with, respond to, and learn from these events (Adger et al. 2005).

Civic ecology practices are local environmental stewardship actions taken to enhance green infrastructure, ecosystem services, and community well-being in urban and other human-dominated systems (Krasny and Tidball

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2012, 2015). Often civic ecology practices engage youth during summer or out-of-school time, and provide opportunities for more structured lessons as well as less structured social learning, which we refer to as civic ecology education (CEE; Tidball and Krasny 2010, 2011). Whereas a large body of research within the social–ecological resilience tradition examines social learning in the context of adaptive co-management (Gunderson 2001; Schusler et al. 2003; Berkes 2004; Gunderson et al. 2006; Berkes et al. 2007; Blackmore et al. 2007; Pahl-Wostl et al. 2007; Armitage et al. 2008; Pahl-Worstl et al. 2008; Plummer and FitzGibbon 2008; Marschke and Sinclair 2009), only a few papers consider social learning that occurs through participation in civic ecology practices (Lee and Krasny 2015; Krasny et al. 2009; Tidball and Krasny 2007). We address this gap by investigating the following questions: (1) to what degree do CEE programs exhibit process indicators of social learning, and (2) what types of cognitive shifts occur among participants in CEE programs? More broadly, we consider whether social learning within a CEE context might not only alter youths' understanding of disturbance events, but also improve their capacity to respond to future events by fostering social cohesion, open communication, and collaborative problem solving—in short, contribute to community resilience.

This study focused on youth in three CEE programs in CO and NY. The research sites were identified based upon the existence of a recent environmental disturbance and the presence of youth-based initiatives designed to respond to the disturbance events affecting their communities. Each youth group was involved in a 5–6 week summer restoration program in an area impacted by a significant flood (CO) or hurricane (NY). Cognitive mapping exercises, in-depth interviews, and participant observation were used to assess the social learning process, and the impacts of these processes on individual and group-level cognitive change regarding environmental disturbances.

Community resilience through learning and action

Community resilience is defined as the ability of a community to withstand and recover from external shocks, such as a social or environmental disturbance (Adger et al. 2005). Studies into community resilience and disaster resistance generally focus on the character of governance structures, physical infrastructure, and access to financial capital (e.g., Cutter et al. 2008; Mileti 1999; Geis 2000). However, social–ecological systems and other scholars increasingly recognize that community resilience depends on additional attributes including adaptive relationships between people and ecological systems that encourage learning through agency (Berkes and Ross 2013; Walker and Salt 2012). Norris et al. (2008) emphasize four primary sets of adaptive capacities—economic development, social capital, information and communication, and community competence. They argue that building resilient communities requires minimizing resource inequities, active engagement by local people in mitigation efforts, creation and maintenance of organizational linkages, and strengthening social supports that facilitate learning and information sharing.

Cultivating these capacities requires not only political and economic solutions, but learning opportunities that encourage knowledge building and information transfer, and strengthen the ability of diverse people to work together to adapt to and mitigate the threat of future events. In particular, recent scholarship has conceptualized social learning as important for building community capacity to creatively respond to current and future shocks (Krasny et al. 2010). Social learning in this context occurs through self-defined collaborative action, deliberation, and problem solving (Schusler et al. 2003; Wals et al. 2008). This leads to an environment where participants are both learner and teacher, creating a space where shared action and more equitable power relations can strengthen social ties, cultivate trust, and support the basis for present and future action (Schusler et al. 2003).

A conceptual model of social learning

Although scholarship on social learning abounds, the concept remains contested and often lacks an operational definition (Reed et al. 2010). One area that causes confusion is the difference between social learning theory (Bandura 1977, 1986) and the more normative concept of social learning that has emerged within adaptive co-management practices (Keen et al. 2005; Blackmore 2007; Pahl-Wostl et al. 2007). Moreover, lack of clarity between social learning as a process and as an outcome makes it difficult to identify and measure (Reed et al. 2010; Lee and Krasny 2015).

To address this problem, we adopt a conceptualization of social learning that draws upon both Bandura's theory (1977) and natural resource management. We define social learning as a process of *individual and collective frame alignment situated in communicative action*. We suggest that learning can, and does occur through observation and interaction with others as Bandura argues. We also embrace the normative perspective that defines social learning as shifts in thinking that occur through collaborative action focused on resolving a common social–ecological problem (Schusler et al. 2003). Moreover, responding to the critiques of Reed et al. (2010), this approach allows for a distinction between the learning process and learning outcomes that can be examined over time.

We use a model depicting learning as a continual cycle of feedback where cognitive frames structure and direct action, while action also shapes the formation of new cognitive frames (Fig. 1). This perspective suggests social learning occurs as a co-evolving relationship between frames and collaborative action that support collective capacities for resilience. Frames are mental models—cognitive shortcuts people use to help make sense of complex information (Fiske and Taylor 1991; Johnson-Laird 1983). These shortcuts often form the basis for directing and informing action, but they also represent the outcome of action and reflection. We use frames and the idea of frame alignment from social mobilization theory (Snow and Benford 1988) to emphasize this ongoing construction of meaning (learning outcomes) that can take place among individuals and groups, within situated communicative action (process). Frames are continually shaped by social, cultural, and linguistic factors, as well as our specific set of life experiences (Collins and Gentner 1987; Cranton 2002; Eckert and Bell 2005, 2006; Goffman 1974). They help us interpret the world around us and communicate that world to others (Lakoff 2009).

Humans have the capacity to alter their frames (e.g., about climate change or disturbance). Altering frames represents a shift in the construction of meaning and interpretation about the world. This includes the integration of new concepts, as well as the abandonment of old concepts that do not fit the modified interpretive scheme. Frames can also be "elevated" indicating that underlying mental models remain intact, but become more developed, or complex through new information. This process of elevation can also lead to a new prioritization of concepts that produces a reordering of existing interpretative schema. Finally, frames can be aligned (linked) with other frames by an individual, as well as with the larger group, to create "resonance" that can motivate collective action (Snow and Benford 1988). This often occurs through a range of communicative acts in open discourse, print and digital media, as well as forms of human learning, including social learning.

Processes of *alteration*, *elevation* and *alignment* are situated within specific activities over time (Greeno 1989). Cranton (2002) used the term "activating event" to refer to an event that "exposes a discrepancy between what a person has always assumed to be true and what has just been experienced, heard, or read." Social–ecological disturbances and personal proximity to a disturbance can represent an "activating" event that can alter one's mental model. However, participation in restoration activities may also represent an "activating event" that can help re-shape one's interpretation of disaster events, and potentially lead to the formation of shared thinking about the nature and response to present and future disturbances. These changes represent potentially significant learning outcomes that can shape subsequent action, management and governance (Zaksek and Arvai 2004), which is especially important where initially divergent perspectives converge to form a common framework for action (cf. Schusler et al. 2003). It is precisely here, where individuals' mental models converge with each other, and a larger group mental model emerges, that social learning can be identified. Moreover, the process of developing social ties and trust through these interactions may serve to help strengthen this convergence and the ability for groups to work together in the face of future events.

Following Habermas's (1987) *theory of communicative action*, we suggest that the process of individual and collective framing may occur through communication within the context of civic ecology practices. We pay special attention to the processes of information sharing, deliberation and critical reflection that can facilitate common understandings leading to shared normative outcomes, such as a restored ecosystem or ideas about ways to respond to future disturbances (Habermas 1987; Schusler et al. 2003). We concede that these forms of communication and interaction may not be the only determinants of changes to youth mental models; traditional forms of instruction and one-way information transfer may also serve to modify thinking and understanding. Yet, for our purposes of defining and measuring social learning processes, we focus

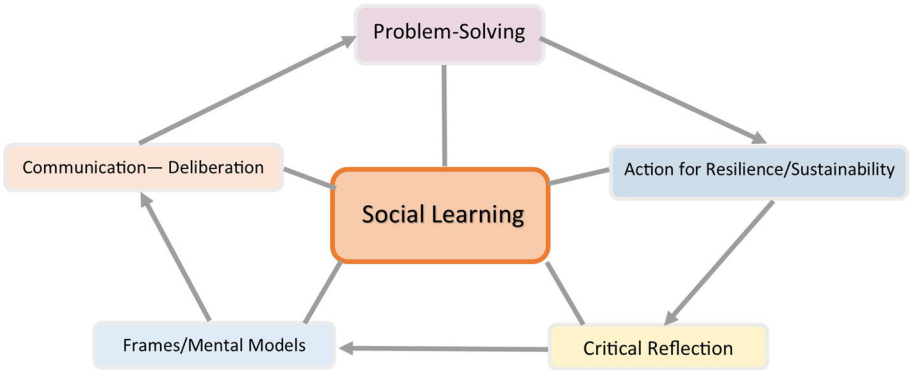

Fig. 1 Conceptual model of social learning

on the communicative aspects between two or more people engaged in communicative acts to solve problems.

Analyzing the impacts of CEE programs on social learning

The description of social learning presented above provides the basis for constructing identifiable attributes that can be empirically analyzed. Communicative processes that occur through critical reflection and collaborative problem solving all represent key indicators of social learning processes (Fig. 2), and individual and collective cognitive change represents a key indicator of social learning outcomes. These indicators have been identified and used extensively in previous studies that focus on "social learning as process," and they are used here to highlight the mechanisms through which changes in personal and collective frames occur (Pahl-Wostl et al. 2007; Wals et al. 2008). In particular, we emphasize attributes such as opportunities for open deliberation and critical reflection, the level of inclusion among participants in the deliberation and decision-making process, working towards shared goals through the process of deliberation, and the formation of mutual concern. The addition of *social–ecological systems thinking* reflects our assumption that the content of communication is similarly important to the character of communication. We suggest that through the iterative processes of communication and action, individuals and groups as a whole will experience change in thinking.

These indicators provide not only a means for analyzing social learning as both process and outcome, but also provide a structure for investigating the relationship between civic action and thinking, including in civic ecology practices. More specifically, this research addresses two questions:

1. To what degree do social learning processes take place among CEE programs operating in post-disturbance communities?
2. What are the impacts of these programs and social learning processes on individual and collective understanding of localized disturbance events?

We postulate that through a social learning process, CEE programs will lead to reconstruction of meanings attributed to environmental disturbance events among youth participants. This may include alteration, elevation and/or alignment of frames among both individuals and as a group. We also anticipate that the types and extent of deliberative/communicative processes will impact the character of both individual and collective thinking related to disturbance.

Materials and methods

We used mixed-methods approach (Denzin 1994) to analyze three CEE programs addressing two disturbance events (hurricane and floods). We conducted participant

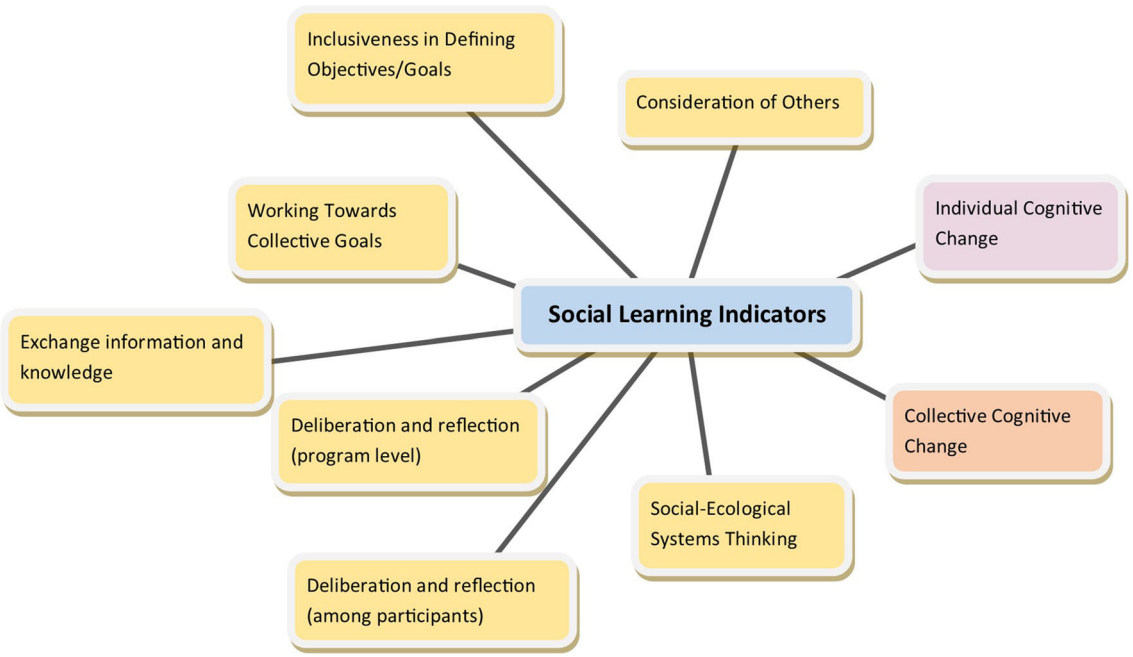

Fig. 2 Indicators of social learning

observations, individual and collaborative cognitive mapping exercises, and interviews with youth program participants to assess social learning process and identify individual and collective changes in thinking around disturbance events. Observations focused on the frequency and character of interactions among participants and with program leaders, and on social learning attributes (Fig. 2). Individual and collaborative mind-mapping was used (Buzan 1974) to measure cognitive changes among individuals, and the groups.

Our approach was chosen to provide an in-depth descriptions of programs, interactions, and social learning processes (Creswell 1998; Johnson and Onwuegbuzie 2004) and outcomes, as well as uncover convergent and divergent patterns (Yin 2013) among CEE restoration programs. Multiple methods enabled "triangulation," increased our ability to extrapolate emergent patterns, and provided a mechanism for external validation for each case (Jick 1979; Denzin 1994).

We addressed reliability by discussing the research protocol prior to commencing field work and by weekly discussions to review questions and resolve concerns about our field notes and ratings. While this process helped ensure a common approach across all sites, this did not resolve issues of intercoder reliability in observing social learning process. This presents limitations to the study by introducing the potential for error and eliminates our ability to interpret social learning processes in the same way across all sites. Thus, we treated each site as a separate case, occurring within a specific social context and susceptible to differences in results as a product of both context and individual researcher bias.

Data collection and analysis

We observed CEE programs on a weekly or bi-weekly basis for 4–6 weeks. Site visits lasted the duration of a normal program day (4–8 h). Observations were recorded and ranked based upon the seven indicators of social learning (Fig. 2) using a 5-point Likert scale, with 1 representing the lowest and 5 representing highest expression of each attribute. We categorized average scores where 1/2 were coded as low, 3 was coded as medium, and 4/5 was coded as high on the social learning indicator. Scores were tallied to represent social learning processes for each group for that day, with 35.0 being the highest possible score. We also collected data regarding specific activities to provide further context for understanding social learning.

We used mind-mapping (Buzan 1974; Buzan and Buzan 2000) to collect data on individual- and group-level thinking at the beginning and end of each program. This approach allowed participants to create an association of interrelated ideas, while creating a common structure for enabling later analysis of individual- and group-level thinking about ecological disturbances.

In the mind-mapping activity, the researcher asked participants to write the disturbance event in the center of a sheet of paper. Participants then articulated related concepts and drew connections to describe their thinking about the disturbance (Fig. 3). This produced relational text data

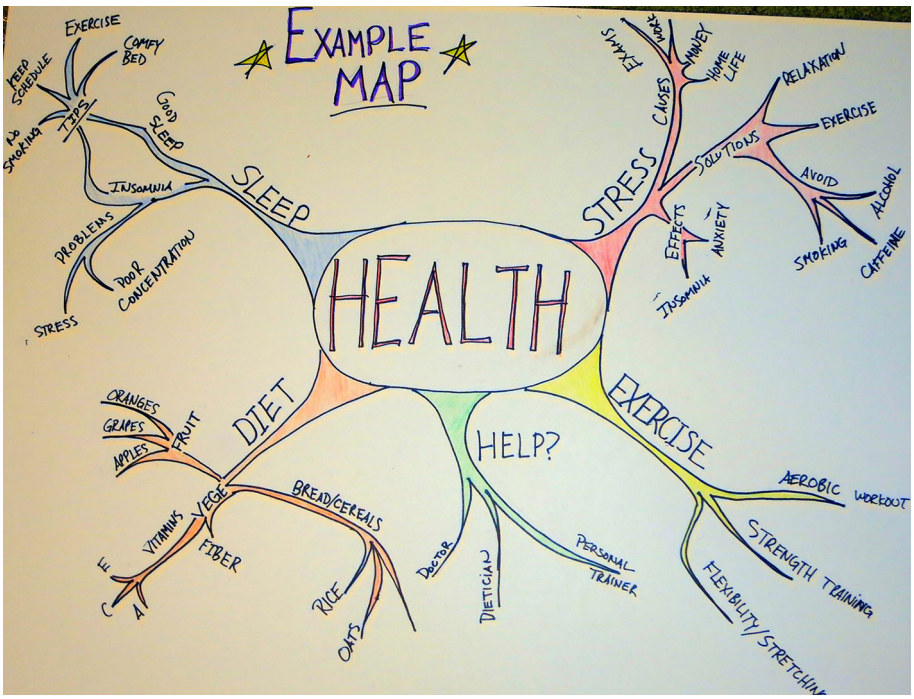

Fig. 3 Example provided during introduction to mind-mapping

Table 1 Social learning outcome concepts and measures

Concept	Measure
Elevation	Change in average maximum and minimum number of primary sub-themes for individual maps; change in number of individual concepts (nodes) for each group map primary sub-theme
Alteration and expansion	Changes in: (1) language used to describe each concept, and connections among concepts within primary sub-themes in individual and group maps; (2) stated connections among concepts in interviews
Frame alignment	Difference between mean number of matching concepts among pre-individual maps and the post-group map, mean number of matching concepts among post-individual maps and the post-group map

for analyzing changes in thinking, including: number and type of distinct sub-themes: number of connections between concepts, as well as number of conceptual layers extending out from the central disturbance conceptual depth (Table 1).

We used edge list analysis, an approach from social network analysis involving the construction of a dataset that lists relational data in column format (Wasserman and Faust 1994), to determine relationships between concepts. We then used these data to count connections between concepts, total number of concepts, and number of sub-themes extending from the central disturbance to determine conceptual depth. Comparing changes in pre and post-program maps allowed for us to measure elevation and alteration of thinking. Finally, the research team analyzed each individual map and grouped synonymous terms into a smaller set of unique themes to account for differences in individual vocabularies. Because of the immensity of the text and the complexity of the coding task that could have introduced coder error, we used Leximancer© (Smith and Humphreys 2006) to generate an automated content analysis to compare with our codes, and minimize coding error. Leximancer calculates occurrence of and relationships among concepts through programmatic rules based on semantic structures and linked dictionaries to identify unique and related concepts in a corpus of text. By comparing manual codes and the automated results, we were able to reduce the total number of distinct concepts per case. This provided our baseline for measuring alignment between individual and group mind maps.

We conducted semi-structured interviews with four randomly selected participants from each program (12 total) to learn more about their mental maps. In these interviews, participants were shown their individual maps and were asked to explain the map in more detail, to talk about the most important aspects of the map, to discuss what they learned during the group mapping exercise, and to describe disturbances that they had experienced. The second author transcribed the interviews. He also coded the interviews based on emergent themes and used a theoretically focused coding strategy based on social learning constructs (Braun and Clarke 2006; Saldaña 2009). The first author then coded the interviews separately and together they discussed these themes until consensus was reached.

Site descriptions

CEE programs and site locations were identified through peer referral among a network of environmental educators across North America. Our search criteria emphasized programs that worked with youth participants aging 9–17, lasted 4–6 weeks, and focused on environmental restoration or stewardship activities in places that had been effected by a significant ecological disturbance event within the last 24 months. Based on these criteria, we identified three separate programs operating in two different communities: the Rockaway Waterfront Alliance (RWA; New York City), which emphasized sand dune and coastal restoration, Youth Services Initiative through Wildlands Restoration Volunteers (WRV; Boulder, CO), which focused on wetland restoration and invasive species management, and Open Space and Mountain Park's Jr. Rangers program (Jr. Rangers; Boulder, CO), which works on trail restoration and habitat restoration along trail sites.

Study Site 1: New York, NY On October 29 2012, metropolitan New York suffered one of the worst storm events in the area's history. Hurricane Sandy decimated coastal communities by significant wave inundation and flooding that led to 38 deaths, significant property damage, and the loss of electricity and the inability to communicate for days to weeks after the storm. Over a year and a half since the storm, the coastal community in Rockaway, NY was still in the recovery process. RWA helps to restore and create new coastal dunes that were severely impacted by the storm.

Study Site 2: Boulder County In September 2013, one of the most significant rainfall events in history inundated much of the Front Range region of Colorado. Over a 6-day period, nearly 17 inches of rain fell feeding massive flooding along streams and rivers running off the Rocky Mountains and into lower foothills and plains. Eight people were killed and over $1 billion in damages were reported. In Boulder County alone, over 1,600 homes were

evacuated, with 262 homes destroyed and nearly 300 more damaged. Clean-up and restoration efforts continue and were ongoing throughout the Boulder and Larimer Counties when this research was conducted. WRV and Jr. Rangers are two groups operating in Boulder County that are actively working to restore outdoor recreation areas in the County.

Results

We present a narrative description of each program followed by results of social learning process indicators and outcomes.

Social learning process

Case 1—Rockaway Waterfront Alliance (RWA) RWA Shore Corps program participants learn about the natural and social aspects of the Rockaway peninsula (New York), and conduct service learning projects. Learning activities are embedded in field work and also include short lectures on topics related to coastal ecosystems. Participants include youth aged 14–18 from low- to middle-income households in nearby Rockaway and Broad Channel neighborhoods. Through the program, youth were introduced to tree identification, GIS mapping, and dune grass planting techniques. They also worked in groups assigned to particular areas in their stewardship site and took part in additional activities, such as community planning, surfing, and design charrettes.

During the 6-week program (July–August 2014), we conducted a total of 7 site visits to observe the program's social learning processes and participated in sand dune stewardship and other program activities. Observations of RWA social learning process showed a high degree of *working towards collective goals* ($\mu = 4.43/5$), *exchanging information and knowledge* ($\mu = 4$) especially about *social–ecological systems* ($\mu = 4.29$), and *consideration of others* ($\mu = 4$). *Deliberation and reflection* among participants ($\mu = 3.43$) mirrored the *deliberation and reflection (program level)* opportunities offered by RWA program leaders for the group as a whole ($\mu = 3.71$). Finally, the highly structured nature of the program limited participant *inclusiveness in defining objectives and goals* ($\mu = 2$). Over all, RWA's practices reflected high to moderate social learning processes, but allowed few opportunities for participants to define goals and objectives.

Case 2—Jr. Rangers This program serves youth aged 14–17 from primarily white middle-class families in the Boulder County, Colorado. The youth help maintain parks and assist with clean-up and restoration projects. The program is designed to provide hands-on experience in environmental stewardship, promote team work, develop leadership skills, and give youth employment during the summer months. Following the 2013 flood, the Jr. Rangers shifted into flood recovery, focusing on restoring damaged trails and riparian zones.

Work crews typically met 4–5 days per week for five weeks. After receiving instruction in trail maintenance, ecology, hydrology, and work crew safety during the first week, crews began field work. Each day, a 12-member team would meet as a group to stretch, discuss things going on in their lives, share safety tips, and discuss the day's work plan, and then travel to urban, suburban and peri-urban trail sites throughout the city of Boulder. Participants worked in pairs to remove invasive species management and restore trails. At the end of the day, participants engaged in group discussions, journaling, swimming, and ice cream outings. The explicit purpose of these activities was to support social ties among participants and encourage personal reflection.

Observation of social learning processes found that *working towards collective goals* was the highest rated indicator ($\mu = 5$), followed by *consideration of others* ($\mu = 4$). *Exchanging information and knowledge* was moderate ($\mu = 3.5$) due in part to the two-person work model, as were *social–ecological systems thinking* ($\mu = 3.5$) and *deliberation and reflection (participant level)* ($\mu = 3.5$). Less common were program level engagement attributes, such as *deliberation and reflection (program level)* ($\mu = 2.75$) and *inclusiveness in defining objectives and goals* ($\mu = 1$). Jr. Rangers' social learning process was typified by a collaborative working environment; participants shared some knowledge and information, but there was little opportunity for guiding and redefining program goals.

Case 3—Wildlands Restoration Volunteers (WRV) WRV provides low-income and Latino youth aged 9–16 years with environmental education and leadership training through volunteer stewardship and restoration programs. It seeks to integrate youth into the community, provide job skills, and increase social ties among low-income youth residing in Boulder, CO.

Participants worked once a week on restoration projects, including trail and riparian habitat restoration, for 6 weeks during the summer. Each day began with a 15–30-min environmental education lesson relevant to the day's work (e.g., native and invasive species, disturbance regimes, hydrology, ecology). Youth would then work together, alternating through tasks such as retreading trails, removing debris, collecting native grass seed, and reseeding disturbed stream banks. Hiking provided opportunities for play and an exploration of "wild spaces." The day ended with a group discussion focused on ecological processes as applied to the restoration activities.

Observation of social learning processes revealed a relatively high occurrence of participants *working towards collective goals* ($\mu = 4.5$), as well as *exchanging information and knowledge* ($\mu = 4.25$) between WRV staff and participants. Participants showed a high level of *consideration of others* ($\mu = 4$) ensuring everyone had water, food and a good time. *Social–ecological systems thinking* was moderate ($\mu = 3.5$), as was *deliberation and reflection* at both the *program and participant level* ($\mu = 2.75$). Program leaders defined daily work plans, with participants having little input, leading to relatively low scores for program level *inclusiveness in defining objectives and goals* ($\mu = 2.25$).

Summary of social learning process

For all groups, program goals and restoration objectives were generally prescribed for the youth, rather than through *inclusiveness in defining objectives and goals*. However, specific activities offered significant opportunities for *deliberation and reflection among participants*. Additionally, all programs included activities that helped cultivate a sense of *working towards collective goals*, *consideration of others*, and *exchanging information and knowledge* (see Table 1). *Social–ecological systems thinking* regarding disturbance events was also fostered to some degree across all programs.

Social learning outcomes

Social learning outcomes were determined by measuring the *elevation*, *alteration* and *alignment* of individual- and group-level frames of disturbance events (Table 2).

Frame elevation

Over all programs, there was little change in the number of sub-themes or average number of concepts used to describe disturbance events in pre-program mapping versus post-program mapping (Table 3). Jr. Rangers was the only group to show an elevation in conceptual thinking (defined as the mean number of concepts) at the individual level, with an increase of 2.6 concepts from the pre–post mapping session.

Related to frame elevation, individual mind maps in all three programs showed an increase in conceptual depth, indicating an elevation or refinement in thinking. At the group level, all programs showed elevation in thinking, as evidenced by reducing the number of primary sub-themes, but while increasing the depth of nodes in each primary sub-theme (Table 4).

Frame alteration

Frame alteration was measured by conducting a thematic analysis of individual and group maps (Table 5) in conjunction with coding in-depth interviews. While the number of concepts related to the *causes* of the disturbance decreased, RWA and WRV participants connected more ideas about *impacts* after the programs (Table 5). Further, the total number of connections to the sub-theme "community response" increased for all groups, and the RWA group map showed an increase in the total number of concepts linked to the sub-theme *preparation*. Overall, the total number of concepts used to define each event increased for all programs, while number of primary sub-themes decreased for WRV and RWA. Following a content analysis of each cognitive map, we interpreted this as a refinement in the thinking and communication used to describe each disturbance event.

While structural changes in mind maps implied changes in thinking, thematic analysis of maps and interviews with participants (Table 5) highlighted the content of this change. When asked to describe their maps at the

Table 2 Social learning process indicators

Program	*n*	Inclusiveness in defining objectives and goals		Working towards collective goals		Deliberation and reflection (program level)		Deliberation and reflection (among participants)		Exchanging information and knowledge		Social–ecological systems thinking		Consideration of others		Total score[a] (min = 0) (max = 35)
		μ	95 % CI	μ	95 % CI	μ	95 % CI	μ	95 % CI	μ	95 % CI	μ	95 % CI	μ	95 % CI	
RWA	7	2	[1.57, 2.43]	4.43	[4.03, 4.82]	3.71	[3.15, 4.27]	3.43	[3.03, 3.82]	4	[3.57, 4.43]	4.29	[3.57, 4.85]	4	[3.57, 4.43]	**25.86**
Jr. Rangers	4	1	[1, 1]	5	[5, 5]	2.75	[1.81, 3.69]	3.5	[2.52, 4.48]	3.5	[2.52, 4.48]	3.5	[2.93, 4.07]	4	[4, 4]	**23.25**
WRV	4	2.25	[1.76, 2.74]	4.5	[3.93, 5.07]	2.75	[1.81, 3.69]	2.75	[1.81, 3.69]	4.25	[3.76, 4.74]	3.75	[3.26, 4.24]	4	[4, 4]	**24.25**

[a] Social learning "process" indicator scores are average scores over all observations, by a single observer in each program

Table 3 Mean number of descriptive concepts—individual mind maps

Group	Session	Main concept	n	Total primary sub-themes		Average sub-theme tangent depth		Total concepts	
				μ	SD	Min	Max	μ	SD
RWA	Pre	Hurricane	17	4.12	2.39	1.88	2.94	15.65	8.05
	Post	–	16	4.13	1.31	1.94	3.13	15.06	8.14
Jr. Rangers	Pre	Flood	12	3.83	0.83	1.75	2.83	13.5	5.74
	Post	–	10	3.6	1.07	2.1	3.5	17.1	7.85
WRV	Pre	Flood	23	4.38	2.14	1.38	2.04	7.5	4.15
	Post	–	21	3.57	1.43	1.52	2.24	7.52	4.04

Table 4 Conceptual elevation—group-level mind maps

Group	Session	Main concept	n	Total primary sub-themes	Sub-theme tangent depth		Total concepts
					Min	Max	
RWA	Pre	Hurricane	17	6	2	5	28
	Post	–	16	4	3	6	41
Jr. Rangers	Pre	Flood	12	3	3	5	35
	Post	–	10	3	4	5	37
WRV	Pre	Flood	23	4	2	4	23
	Post	–	21	3	3	6	37

Table 5 Frame alteration—group-level mind maps

Group	n	Primary Sub-themes							Total
		Causes	Destruction	Community response	Preparation	Government	Infrastructure	Personal experience	
RWA									
Pre	17	6	3	2	2	2	7	–	22
Post	16	2	10	6	25	–	–	–	37
Jr. Rangers									
Pre	12	11	11	9	–	–	–	–	32
Post	10	7	13	14	–	–	–	–	34
WRV									
Pre	23	3	8	6	–	–	–	2	23
Post	21	3	15	13	–	–	–	–	34

beginning for the programs, participants focused on problems associated with the disturbance they had experienced.

> Well I put a new section of risks, so it would be like economic downfall, there was no gas, so there was no electricity to pump the gas so people had to go into different neighborhoods. There was a lot of closed businesses, stuff like that (RWA Participant 11, July 2014, Pre-program).

Reflecting thematic changes in individual and group mental maps, in post-program interviews participants described solutions and actions that they could take in response to future disturbances.

> …because in general the work that we have done this summer has gotten me to think of different possibilities, like mitigation possibilities.—increasing the number of plants, and their ability to absorb the water, and that has me thinking about all the potential things we could do I didn't know before. … Even though you can't stop mother-nature or prevent it, you can reduce its impact (RWA Participant 11, August 2014, post-program).

RWA participants demonstrated a collective and personal shift in thinking from impacts to response and mitigation efforts. Similarly, individual mind maps from Jr. Rangers

generally transitioned from a focus on flooding impacts to flood recovery and response to future flooding. Although individual mind maps from WRV changed minimally, participants demonstrated a shift from flooding impacts to a more descriptive portrayal of personal experiences of the flood, and of the role of participation with WRV as a learning opportunity for future employment.

Frame alignment

Alignment was analyzed by comparing the relationship between individual and collectively constructed group maps pre- and post-program. The mean number of matching concepts between individual and group pre-program maps served as the baseline for calculating an expected match average for post-program maps. Programs that had little or no impact on collective thinking would be equal to the expected percentage. The relationship between individual thinking and group-level thinking increased for both RWA (2.67 %) and the Jr. Rangers (2.11 %) beyond what was expected, but decreased for WRV (−5.06 %, Table 6).

Learning outcomes summary

Participants presented a shift in the ways they conceptualized disturbance events in their communities. Youth began by defining hurricanes and floods from a place of personal experience. After the programs, participants focused on ways to respond to and mitigate the impacts of future events. This change occurred at both the individual and group level among both the Jr. Rangers and RWA, and at the group level for WRV. It suggests that participants may feel empowered to act as embodied in the previous quote from RWA Participant 11, "there is so much more that we can do. Even though you can't stop mother-nature or prevent it, you can reduce its impact."

Discussion

Our findings suggest that CEE programs focusing on disaster response may foster social learning process attributes, including those associated with resilient communities (cf. Adger et al. 2005; Norris et al. 2008; Pahl-Wostl et al. 2007; Fernandez-Gimenez et al. 2008). In particular, practices of cooperative problem solving and information sharing among participants and program leaders were evident in all three programs. Additionally, all three programs appeared to support a social environment conducive to team work, environmental learning, and a sense of concern for others, factors which can contribute to capacity for collective action (Preece 2004) in the context of social–ecological disturbances (Aldrich 2012).

Further, by employing individual and collective cognitive frames as a means to measure the outcomes of social learning, this study expands on ongoing research on social learning within an adaptive co-management framework, as well as research on the positive youth development outcomes of programs that embed learning in environmental action (Schusler and Krasny 2010). We explore our results on cognitive outcomes of social learning within the context of cognitive framing and action.

The youths' cognitive maps provide evidence that participants in all three programs made a cognitive transition from passive bystanders, or victims, towards active participants in ecosystem restoration. Thus, our findings reveal a connection between CEE restoration activities and the emergence of action framing, which connects problem identification with specific actions that individuals and groups can pursue. One possibility is that group leaders and visiting experts were responsible for this change in youth cognitive maps; these individuals served as key information conduits linking ideas about disturbance as social–ecological problems with the relevance of collaborative restoration within the context of the youths' lived experience. Work in social learning and social–ecological systems resilience suggests the process of constructing collective action depends on the flow of information (Schusler et al. 2003; Tompkins and Adger 2004; Adger et al. 2005), but that this information must resonate with existing interpretative schema of individuals and their social group (Goffman 1974; Snow and Benford 1988; Lakoff and Johnson 2008). Engagement in cooperative action to address disturbance events that the youth had personally experienced may have provided that interpretive schema. Further, engagement in specific restoration tasks, which required participants to align their interpretative schema to communicate and coordinate with peers and

Table 6 Frame alignment between group and individual number and mean of matching concepts in mind maps

Group	*n*	Pre-map match			Expected post-map match	Post-map match		
		μ	SD	%	μ	μ	SD	%
RWA	20	2.88	2.18	10.29	4.22	5.31	2.65	12.96
Jr. Rangers	13	6.17	2.37	17.62	6.52	7.3	2.91	19.73
WRV	23	2.35	1.56	10.21	3.78	1.90	1.67	5.15

programs leaders, may have contributed to their reframing the disturbance from problem to something they could address through restoration action.

Previous work has linked action to the framing of environmental problems and injustice in social movement mobilization (Snow and Benford 1988; Tarrow and Tollefson 1994), civic action (Sirianni and Friedland 2001), and sustainable lifestyles choices (Barr and Gilg 2006). Similarly, Bardwell (1991) suggests the framing of environmental problems helps create the context for defining and negotiating decisions and action around environmental problem solving. In the case of CEE programs, actively engaging in recovery efforts following disturbance, along with related content learning and discussions, provided the context for framing and reframing the need for and efficacy of cooperation and ecological restoration. Thus, by examining how frames evolve among participants in restoration actions, this study adds to previous studies wherein frames are created by movement or program organizers.

This also highlights the importance of thinking about program designs that consider the interdependent relationship between new information and collaborative action in altering individual and collective thinking. Lakoff (2008, 2009) argues that frames are "active" in that they seek out similar frames, but they also reject contradictory ones. The internal cognitive goal of the individual appears to be the maintenance of a coherent network of thinking and action that fits within a person's internal and social landscape. Yet, through relevant "activating events" in terms of environmental restoration activities, these events require a rethinking, and outward communication to coordinate efforts to be successful. From this perspective, social learning through CEE requires an ongoing negotiation both internally and outwardly among individuals and groups that can lead to the formation of collective cognitive frames and group identity. In this study, individual and group frames exhibited greater alignment at the end of two of the three programs. This alignment suggests the emergence of a common framework of understanding that Schusler et al. (2003) consider critical for decision-making and action.

The smaller shifts in framing among WRV relative to participants in the other two CEE programs may be attributed to the fewer number of activities at WRV, and fewer meetings per week (cf. Lakoff and Johnson 2008), or to differences in social and economic status or context (cf. Goffman 1974; Snow and Benford 1988; Fiske and Taylor 1991; Lakoff and Johnson 2008). While CEE programs appear to offer a space in which participants can expand their social and potentially form a new identity, existing identity may also explain the differential outcomes among WRV and the other program participants. Kahan et al. (2012, 2014) indicate that social identity and group affiliation are critical to determining the ways in which information is accepted, rejected and integrated in one's existing cognitive schema as well as to engagement in political action.

Finally, despite the generally positive results related to social learning processes and outcomes in the CEE programs, certain features of the social learning process were missing and may have attenuated cognitive change. For instance, sense of broader ownership and self-determination and the opportunity for critical self-reflection are essential factors in social learning (Keen et al. 2005; Wals et al. 2008), yet program leaders defined the restoration problem and program activities in all three programs. While at the individual-level participants did actively communicate, problem-solve, and reflect, at the level of the groups participants were bound by a predetermined structure. Thus, it appears that these programs did not inherently confront issues of power in the same ways that social learning scholars would suggest (Blackmore 2007; Wals et al. 2008). Whereas enabling youth to participate in defining program agendas may prove to increase learning outcomes and leadership skills needed for future action, providing such opportunities is a challenge for youth programs leaders, who constantly balance needed mentoring and setting limits with opportunities for youth to take responsibility and demonstrate leadership (Schusler et al. 2009).

Conclusion

This study presents a novel conceptualization and set of methods for investigating social learning. The introduction of framing as both an individual and group process opens a window for analyzing the way collaborative action over time can influence the character and structure of thinking about ecological disturbance events. Thus, the combination of cognitive mapping with direct observations of social learning processes provides a framework for addressing gaps in our ability to assess individual and collective learning, and for understanding social learning and collective action.

Results from our three cases indicate that cooperative action can serve to modify personal and group-level cognitive models used to make sense of the world around us, and to form the basis for possible future action. Moreover, CEE programs appear to be important to improving a sense of well-being and understanding for youth in times of ecological crisis. Similar to many who live through such events (Orom et al. 2012), participants expressed feelings of loss, fear, and powerlessness at the beginning of our programs. By the end of the program, these narratives all

but disappeared. As Tidball and Krasny (2014) suggest, immersion in nature as well active participation in community greening following disaster may be restorative both psychologically and ecologically. Thus, CEE programs in disaster zones may represent important social adaptations in themselves that can help communities cope with, and recover from, external shocks. This has important implications for the development of future initiatives that seek to improve learning and resilience in the face of climate change.

Finally, while the introduction of frames proved useful to identifying what works with CEE programs, it is important to recognize that class, race, age and social identity may significantly alter outcomes. Understanding the broader social context along with the dynamic individual and group processes is critical to better understanding ways to overcome limitations in our ability to mitigate and adapt to environmental disturbances.

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