Journal of Sustainability Education
Vol. 8, January 2015
ISSN: 2151-7452

Learning and behavior change in a Girl Scout program focused on energy conservation: Saving energy to 'save the planet'

Gillian Puttick
TERC
gilly_puttick@terc.edu

Kim Kies
Garibay Group

Cecilia Garibay
Garibay Group

Debra Bernstein
TERC

Abstract: This study presents outcomes from the *Girls Energy Conservation Corps*, a research and development project that produced a series of six patch activity guides for girls age 8-14 who are members of the Girl Scouts of Eastern Massachusetts. The program focused on integrating engaging online and real world activities that involved girls in learning about climate change and their role in it, in saving energy, understanding the importance of collective goals and action to address climate change, and using new media creatively to educate peers and the community about energy conservation. Positive changes in knowledge, behavior, and attitudes pre to post suggest that a carefully designed program can address the challenges of educating children about energy conservation and climate change at this age, even if participant exposure to the program is brief. Findings also bring to light that developmental differences may be important to deconstruct in future studies when applying adult-tested behavior change models and theories to youth.

Keywords: informal science learning, climate change, energy conservation, behavior change, motivation, identity, girls

Gillian Puttick and Debra Bernstein are education researchers at TERC, a non-profit education research and development organization dedicated to improving hands-on mathematics and science learning and teaching, and to equitable access to education. Kim Kies, researcher, and Cecilia Garibay, principal, are at the Garibay Group which has 20 years of research and evaluation experience, and consults with a wide range of free-choice learning organizations to evaluate informal learning programs.

Introduction

Programs and materials addressing energy conservation in the context of climate change education are proliferating, designed for use in both formal and informal settings. Energy and climate change are two cross-cutting concepts that feature prominently in the Next Generation Science Standards (Achieve 2013), appearing in the frameworks as appropriate topics for middle school. However, evidence is needed on how youth learn effectively about these topics. This study describes an informal science education program, the Girls Energy Conservation Corps (GECCo), developed for Girl Scouts age 8 to 14, which was designed to connect knowledge about energy conservation and climate change to action. We report the results of a mixed-method qualitative and quantitative study, using quantitative measurement of knowledge, motivation, identity/belief, and behavior change in a pre/post design, and qualitative analysis that helped inform the overall impacts. We discuss the implications of our findings for how educators might reimagine the purposes of energy education as we collectively develop recommendations for education and conservation efforts.

Theoretical framework

Energy education

Concerns over lack of understanding of critical energy-related issues, such as the lack of sustainability of our reliance on fossil fuels (e.g., DeWaters and Powers 2011, Southwell et al. 2012, NEETF 2012), have motivated the proliferation of programs focused on energy education. Programs span all grade levels and focus both on formal and informal instructional settings. Examples of initiatives across this spectrum include the development of curricular frameworks, e.g. the Energy Literacy framework developed by the Department of Energy (DOE 2012), Energy Kids developed by the U.S. Energy Information Administration (eia.gov/kids/); programs to conduct energy audits in schools (greeningschools.org, nrel.gov/education/), curriculum materials (DeWaters and Powers 2006, 2011), teacher professional development programs (James, Robinson and Powell 1994), science fair projects (NEED.org) and competitions (innovatetomitigate.org, climateweek.com). Environmental impacts or sustainability are generally provided as the context for teaching and learning about energy (Southwell et al 2012), but a focus on these seldom appears to be integrated, with some exceptions, e.g., Demeo, Feldman and Peterson (2013).

Behavior change

Behavior change is a multidimensional construct that is increasingly being examined with respect to energy savings (Abrahamse et al. 2005, Osbaldiston and Schott 2012) and to action related to climate change (Dietz et al. 2009, Rabkin and Gershon 2007). Several theories of behavior change have been developed (e.g., Adjzen 1991, Prochaska et al. 1997, Kolmus and Agyeman 2002) and all include similar psychological and behavioral components. In particular, the trans-theoretical model of behavior change (Prochaska et al. 1997) theorizes that behavior change is a process that occurs over time through a sequence of stages that help determine the readiness for change. Stages begin with 'pre-contemplation' in which there is no intention to change, followed by 'contemplation' where people begin to think about changing behavior. Next, people engage with 'preparation' where they take steps towards action that will occur, followed by 'action' in which concrete steps are consciously taken around the planned action. Finally, the 'maintenance' stage refers to adhering to the actions for a longer time period, usually considered success if maintained for six months or more (Prochaska et al. 1997). Some criticisms of the transtheoretical model have been made; however it has been a dominant model in studying

and understanding change in the behavior of individuals in relation to health behaviors such as diet or smoking.

Climate change education

The cognitive and perceptual challenges to learning about climate change are well known (Grotzer and Lincoln 2007, MacCaffrey and Buhr 2008). Understanding climate change requires an understanding of complex earth systems (Sell et al. 2006). Students poorly understand many of the basic physical phenomena underlying these interactions (Gautier and Rebich, 2005), and may base their conclusions about the reality of global warming on weather events (Choi et al., 2010). The general lack of student understanding of the role of evidence, theory, and debate in scientific practice (Duschl et al. 2007, Kuhn and Reiser 2006), addressed in the Next Generation Science Standards (Achieve 2013), is another significant issue that impacts students' capacity to understand the basis upon which the scientific consensus about climate change is built.

Many of the concepts that taken together contribute to an understanding of climate change are taught at the high school and college level. However, at the middle school level, students are capable of learning about some of the foundational concepts, e.g., the carbon cycle (Dauer et al. 2013, 2014), the relationship between weather and climate or the local impacts of sea level rise (Holtshuis et al. 2012). Indeed, the Next Generation Science Standards explicitly include these concepts and others, such as being able to identify greenhouse gases, or analyze Earth's energy budget (Achieve 2013) for middle school students, who constitute a proportion of the participants in our study.

Theoretical framework for the GECCo program

Scholars in the fields of education (Bateson 2007, Grotzer and Lincoln 2007), pyschology (APA 2009, Saunders 2003), environmental science (Kolmus and Agyeman 2007, Leiserowitz et al. 2005), and communication (Moser and Dilling 2007 and references cited therein) among others have all proposed approaches for educating the public more effectively about climate change. We sought to integrate several of these approaches as we developed the GECCo program, as follows.

The program was built on the assumption that those who move to action now can raise awareness about climate change (Doherty & Clayton, 2011). In particular, for young people for whom realizations about the reality of climate change and resulting feelings of powerlessness can be overwhelming, taking action can combat a sense of paralysis (NRC 2011, AMA 2009). We conjecture that a sense of empowerment might ultimately result in young people enlisting others in behavioral changes that might move society into less dangerous trajectories (Leiserowitz 2005). The program is also guided by theories of behavior change (Adjzen 1991, Prochaska 1997, Kolmus and Agyeman 2002) and findings from conservation psychology (Saunders 2003, Brook & Clayton 2005). GECCo girls identify ways in which they use energy, and brainstorm and practice how they can save it. Through understanding the power of collective action (Goddard 2001) – how little things add up - they become agents of change in energy conservation.

Social norm messages, which provide information about other people's behavior and beliefs, have been shown to affect conservation behavior change (Nolan et al. 2008, Schultz et al. 2007, Bernedo, Ferraro and Price 2014). GECCo harnesses the power of social norms by asking girls to set group goals and share their conservation efforts (Nolan et al. 2008, Puttick and

Bernstein 2014). GECCo program norms complement Girl Scout norms that emphasize social identity, care of the environment, and taking community action (Britner 2002).

Not only are GECCO activities designed to be fun and engaging – important attributes for a free-choice learning environment (Bell et al. 2009) - but they also support changes in attitude and behavior through experiential and analytic learning (Guiney and Oberhauser, 2009). In addition, opportunities for involvement in actions that make a difference nurture conservation skills and attitudes in the face of a pressing global problem (Leiserowitz 2005, Thogersen & Olander 2003).

While the GECCo program does not aim to identify the many constructs that have been defined in behavior change models, we addressed the five processes we conjecture that the project had the most potential to impact:

1. Raising consciousness about energy conservation and climate change including alternative actions to take (increased knowledge or understanding)
2. Motivation to change (a process that involves a weighing of the pros and cons of energy saving behaviors)
3. Identifying as someone who can and wants to save energy
4. Behavior management techniques such as creating and placing reminder signs, bracelets, etc.
5. Making a firm commitment: showing the intention to engage in the behavior such as writing a pledge, or logging energy saving actions online.

Program Design

GECCo consists of a 6-patch program following the patch structure used in Girl Scouts (GS). Patches, awarded for activities that are developed at and approved by individual GS Councils, are worn on the back of the vest or sash but otherwise are not different in substance or style from badge activities approved by the national GS council. Patches were designed for Juniors aged 8-11, and Cadettes aged 12-14.

Each GECCo patch included seven or eight activities carefully designed to engage young people in informal learning settings (Falk et al 2007). They were aligned with the kinds of activities that girls and troop leaders expect to find in a Patch program to maximize use of the program in the GS free-choice environment. These are activities that involve arts and crafts, games, and "up-and-moving" activities; types of activities that girl scouts typically find fun and engaging. Each patch included an arts-and-crafts activity, an "up-and-moving" activity, a computer, card or board game, an action in the community or taking leadership with younger girls, at least one science investigation and a field trip investigation. All activities addressed at least one of the intended outcomes of the program.

To earn a patch, girls are required to complete at least four activities. Completion involved an average of two-three hours of troop time over one or two troop meetings. In addition, some out-of-troop time was taken to complete additional activities such as tracking energy savings. The resulting six patches (Figure 1) are:

Junior patches

Going Green with GECCo: Juniors learn their "GECCo Color" which tells them how much energy is needed to support their lifestyle, make a pledge to save energy, and track their collective energy savings. An animated movie provides an introduction to greenhouse gases, global warming, and climate change. The goal is to use the connection between energy use and climate change as a rationale to save energy. Girls gain further information about how their energy use connects to climate change by playing a card game and completing an energy challenge. They also play an online game in which they help an online persona make personal

energy choices that present trade offs between saving energy and personal 'happiness.'

Be Cool: Juniors learn how to use less energy to heat and cool a home by acting out skits, making simple draft finders by attaching paper streamers to wooden dowels, gecko draft blockers consisting of gecko-shaped tubes filled with sand, and adjusting thermostats. They investigate the mechanism of passive home heating through hands-on investigations and adjusting window coverings, and construct and manipulate a mobile to learn about Earth's carbon balance.

Less Hot Water: Juniors use kill-a-watt meters to measure the amount of energy used to heat a cup of hot chocolate. They learn about how using water uses energy by running a water relay race, measuring water from a faucet, and playing a card game to learn that they are connected to climate change every time they use hot water. They time their showers and create playlists to time shorter showers.

Cadette patches

Power Down: Cadettes explore their own use of electricity, identify appliances that passively use energy, find ways to save energy, and share information about ways to save energy and fight climate change. The patch includes "Watts it Take?" kits which contain kill-a-watt meters, incandescent and cfl bulbs mounted on a stand, a hairdryer, and other supplies that will allow girls to compare the energy use of bulbs and small appliances. Cadettes play a fast-paced card game similar to Crazy Eights to learn the chain of events that connect their everyday activities to climate change via carbon emissions.

Travelin' Green: Cadettes explore their own travel habits, identifying ways they might save energy. They learn about energy consumption for transportation by competing to generate the least amount of carbon emissions in a board game focused on the concept of fuel efficiency. They conduct a physical simulation to explore the concept of miles per gallon and the fact that different vehicles have different fuel efficiencies. They share information about saving energy used for transportation and reducing greenhouse gases.

Tell the World: Cadettes focus on leadership by learning how to craft persuasive messages that "tell the world" how to save energy, and how energy use is connected to climate change. They plan, create, and share videos, e-cards or signs in the community. They choose and lead an engaging activity with younger Girl Scouts that aligns with the Girl Scout community action priority.

Figure 1. The six patches in the GECCo program.

In all of the patches, girls make a pledge to save energy. In three of the patches, girls were required to complete an Energy Challenge as one of the four activities chosen to earn the patch. In the Challenge, girls:

1. Select one of three conservation challenges – protecting geckos and their habitats, planting trees, or educating people about climate change

2. Choose a fundraising goal ($5, $10, or $25) for that challenge
3. Earn points toward that goal by practicing and reporting energy saving actions on the GECCo Challenge page of the website. Points accrue to the troop as they work towards their challenge goal, and visitors to the Challenge page can see how much money girls across all troops have earned toward their challenges.

Figure 2. Extensive use of the GECCo gecko created a unified program identity across all patches and activities.

Finally, we systematically and explicitly tried to emphasize the connection of individual actions to climate change throughout the patch guides. The introduction to and goals for each activity described the connection, and girls were asked to reflect on it at the conclusion of each activity through a group discussion of what they had learned. Additionally, patch activities at both the junior and cadette levels were specifically created to address this connection. In the junior patch guides, for example, the *Climate Change Connection* movie explains how energy use contributes to an increase in greenhouse gases, which directly impacts climate change. For cadettes, the U2CC game encourages players to understand the relationships between energy use, power plants, fossil fuels, greenhouse gases, and climate change, as they create sequences of cards a Crazy Eights-style card game.

The website (http://www.girlscoutseasternmass.org/gecco/) hosts the patches (including a downloadable Activity Guide for each patch), an online energy game and a video, and pages that feature new media products produced by girls. It supports the patch activities and offers a public face for the GECCo program through which all participating troops can aggregate their energy saving actions and see the power of collective action.

The GECCo program continues as part of the general offerings available to Junior and Cadette troops. It is included in the annual Girl Scouts of Eastern Massachusetts council catalog, which lists all of the authorized patch programs and from which troops select the activities they plan to conduct during the year. The materials are available to councils in other regions, who can find and access the program through the website.

Methods

The summative evaluation was based on a mixed-method qualitative and quantitative design (Greene and Caracelli 2003). Collecting key information about the same constructs in different ways, e.g., from girls, troop leaders and parents, allowed researchers to seek convergence or corroboration of information that confirmed and/or further explained the outcomes (Graham 1989). In addition, using a variety of quantitative measurements in a pre/post design, and qualitative measurements, allowed researchers to include both the rigor of statistical

analysis and the depth and breadth of thematic and/or content analysis that helped inform the overall impacts.

Instruments

Data were collected using the following instruments:

Girl Scout Surveys. Pre/post surveys were administered in person to participating girls to assess how the patch activities affected girls' knowledge, attitudes, motivation, behaviors, confidence in saving energy, and spreading the word about conserving energy. Surveys were completed during troop time; pre-patch surveys were completed at the start of a troop's involvement, while post-patch surveys were administered after each patch. We took great care to introduce the survey as a way for the girls to understand how they felt about climate change and energy before and after they did their patch. We emphasized that there were no right or wrong answers and that no one else would see their answers. Troop leaders were trained to read a scripted introductory paragraph for the survey so all girls received the same message. Overall, 356 girls completed both the pre- and post-patch surveys. The completion rate for all girls combined was 78%. This is about the expected rate for this data collection method. The survey included 2 multiple choice, 1 open-response, and 5 true/false knowledge questions (see Table 3 for examples); 2 true/false and 12 likert-scale attitudinal questions (Tables 5, 6, 8), and 3 likert-scale behavior questions (Tables 9 and 10).

Troop Leader Surveys. Troop leader surveys provided a deeper understanding of: 1) the patch experience; 2) patch effects on troop leaders (to be reported elsewhere); and 3) perceptions of impacts on the girl scouts. Surveys were administered online after troops had completed post-patch surveys. A total of 63 troop leaders (90%) completed the survey.

Parent Surveys. We used parent surveys to better assess how the patch activities influenced participating girls' energy-related behaviors at home. By asking them to report on their daughter's energy saving actions, we were able to triangulate self-report data from the girls themselves. Parent surveys were administered online after girls' post-patch surveys were completed. A total of 243 parents (69%) completed surveys. Most parents were mothers (95% for Juniors and 88% for Cadettes). Some were also troop leaders (16% for Juniors and 25% for Cadettes).

Observations. We observed girls during patch activities to obtain a general understanding of the girls' experiences and interactions. We were especially focused on engagement as well as evidence of deepening awareness of energy conservation and climate change topics. We observed a total of 12 meetings to allow us to collect observations from all 6 patches. We selected medium sized troops (8 to 16 girls), which allowed us to keep a low girl to observer ratio and systematically observe group dynamics and interactions. Observations were scheduled based both on when troops were meeting and the activity/patch scheduled for that session. We found representative troops to meet our stratification needs, even though schedule shifts, winter storms and sometimes last-minute troop leader communications challenged observation scheduling and optimum troop selection.

Energy Challenge Logs. Junior patches required the girls to complete the "Energy Challenge" activity, which asked girls to enter their energy saving actions on the GECCo website. Taking part in this activity was optional for Cadettes. Data were downloaded from the website, and final points based on energy savings were summed.

Girls' Media Products. Girls completing the "Tell the World" patch created a media message. These provided additional data to examine the extent to which girls developed conservation

messages.

Participants

Participating troops were recruited during the summer and fall of 2010. Initially, 65 troops were recruited. Of those, 44 troops (38 Juniors and 26 Cadettes) completed the patches (Table 1). Most troops who dropped out did so due to competing activities rather than because of a lack of interest. A total 483 girls (326 Juniors and 157 Cadettes) participated. Troops were expected to complete at least one patch, but had the option to complete all three patches for their level. The majority (84%) completed one patch.

The summative evaluation of Junior patches began in Fall 2010, while the Cadette summative evaluation occurred during the Spring and Fall of 2011. The majority of participating girls from Junior troops were between the ages of 9-11, and from Cadette troops between 12-14. The majority (60% of Juniors and 76% of Cadettes) self-identified as Caucasian. A fair number of girls (26% of Juniors and 14% of Cadettes), however, chose not to share their ethnic background.

Recruitment	Number of troops	Completed	Retention rate (%)
Juniors	38	24	63
Cadette (Year 3)	18	14	78
Cadette (Year 4)	9	6	67

Table 1. Number of troops participating, and retention rates.

Survey completion rates (Table 2) varied due to typical spotty attendance patterns at troop meetings.

Survey Type	Number completed	Completion rates (%)
Junior pre/post survey	235	79
Junior troop leader survey	37	90
Junior parent survey	134	44
Cadette pre/post survey	121	78
Cadette troop leader survey	26	90
Cadette parent survey	109	69

Table 2. Survey completion rates by survey type and girl scout level.

Analysis

Quantitative data were analyzed using basic descriptive statistics that were summarized in tables or charts. Researchers examined frequency and percentage distributions, using statistical analysis to test for significance. All pre-post comparisons presented here include only those participants for whom we had both pre- and post- survey data, as indicated by different sample sizes in each table in the results section. The main statistical tests included:

• Pearson Chi Square tests for differences in pre/post-patch nominal variables and Fisher's Exact tests when some categories had small numbers.

• Related or paired sample Wilcoxon signed-rank tests for ordinal variables assessing differences in pre/post-patch answers.

To assess behavior change, we analyzed the pre/post psychological and behavioral stages of change identified above as having potential for impact by the program. Questions examined participants' readiness for saving energy with progressively broader circles of influence: themselves, their families, other troops, and their towns. The girls were also asked to identify how often they were willing to or currently saving energy in several common energy use areas.

We used content analysis of open-ended survey questions to develop response categories and descriptions. Observation data consisted of written field notes, photo documentation, and summaries from team debriefs. Research team debriefs involved review of documentation to discuss evidence of engagement, awareness/knowledge building, and motivation as well as to identify contextual issues of importance. Data were coded and analyzed using thematic analysis.

Each "Tell the world" product was reviewed using four criteria: Girls used technology to create their message, conveyed an accurate energy conservation message, made an explicit connection between energy use and climate change, and conveyed why the viewer should follow the prescribed action. Results were summarized with examples from the girls' media.

Results

Knowledge about Climate Change

Junior girl scouts deepened their understanding of climate change through the patch activities, increasing the percentage of questions they answered correctly on the knowledge questionnaire (Figure 3). Statistical tests show significant increases in Juniors' scores after completing one patch (n=235, Fisher's Exact test (2 sided), p=0.003), and after completing a second patch (p=0.021) (Figure 3). The change from patch 2 to 3 was not significant. Cadettes' scores (not shown) increased modestly but not significantly after completing one patch, and scores did not change after the second and third patches were completed.

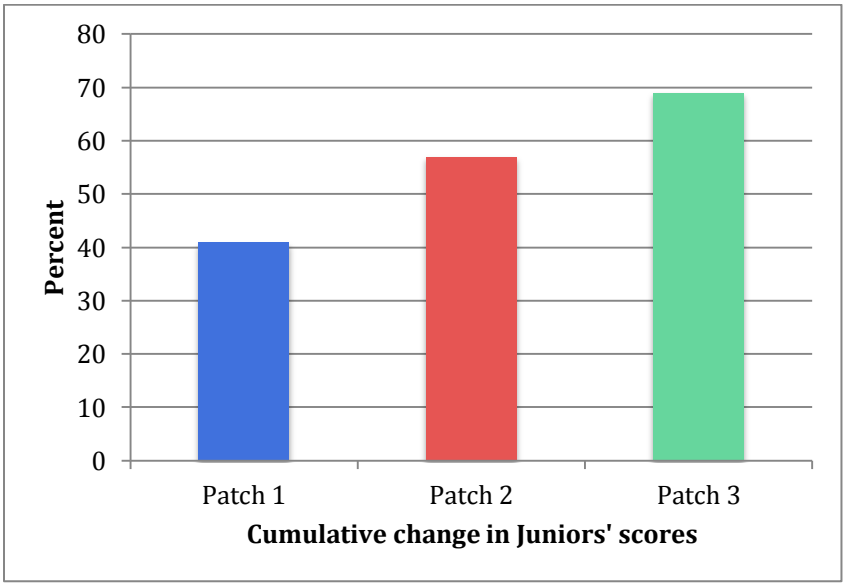

Figure 3. Percent change in Junior knowledge about climate change from pre to post patches 1, 2 and 3.

As expected, the younger Juniors came into the patch activities with less knowledge about climate change than Cadettes (Table 3).

Question	Girl scout level	Pre-patch	Post patch 1	Post patch 2	Post patch 3*
Why is the climate changing?	Junior	40	59	68	77
	Cadette	67	73	69	83
Greenhouse gases keep the planet warm enough to live on. If we add more greenhouse gases, more plants and animals will grow.	Junior	42	41	61	85
	Cadette	64	68	69	17
When people use energy made from burning natural gas and other fuels, they add greenhouse gases to the air.	Junior	35	42	54	77
	Cadette	54	61	69	50
Which of the following actions help to reduce climate change?	Junior	67	82	73	85
	Cadette	90	94	100	100

Table 3. Change in knowledge about climate change (percent of correct responses). *Cadette n for post-patch 3 (*Tell the World)* = 2 troops (16 girls).

Not surprisingly, the extent to which activities integrated climate change information appeared to influence knowledge change scores. Age-related differences are associated with a stronger focus on climate change learning in Junior patch activities than Cadette activities (Table 4). Thirteen Junior activities included climate change information – either integrated directly or mentioned in the goals and wrap-up discussion - while only eight Cadette activities did. The rest of the activities focused on conserving energy and did not mention climate change.

	Climate change information strongly integrated	Climate change information included but not integrated	Focus on energy; no climate change information	Total number of activities in all three patches
Junior patch activities	6	7	13	26
Cadette patch activities	3	5	10	18

Table 4. Extent to which individual patch activities integrated climate change information across all patches.

Girls who engaged in activities that integrated climate change information showed more increases (44%, n=312) in correct answers post-activity than girls who participated in activities that did not (25%, n=44). The differences are moderate and are statistically significant (Pearson Chi Square =0.019).

Knowledge about the power of working together

One indicator for this understanding goal was for girls who engaged in at least one collective action activity to rate the importance of collective action higher at the end of the

program than at the start. Accordingly, we analyzed results for girls who only completed patch activities that focused on collective action. As a whole, girls' awareness and understanding of how working together to make small energy savings can have a large impact on climate change increased slightly but statistically significantly, as indicated by their ratings of the importance of collective action (Wilcoxon related sample signed-rank significant tests, n=356, p=0.028). In addition, both Junior and Cadette troop leaders felt that understanding the concept that small changes can have a big impact on the planet was one of the top three most significant areas of learning for their girls.

Motivation

We measure girls' level of motivation by means of their response to a likert-scale statement on how much they want to make a difference in climate change ("I really really want/Iwant/I sort of want/ I'm not sure if I want"). After one patch, the percentage of Juniors reporting that " I really really want" or "I want" dropped ten points from 85 to 75%, a significant difference (Wilcoxon related sample signed rank test, p=0.009). Cadettes showed no differences.

The level of participation in the energy challenge is also an indicator of motivation. Of the eleven Cadette troops (55%) that entered the Challenge, nine were not *required* by the specific patches they completed to enter data but they did nevertheless. Fifteen Junior troops (63%) entered the Challenge. Further, the reported level of participation is lower than it might have been if more Juniors had had access to the internet during troop time – these girls reported to their troops on paper.

In order to better understand motivation at home, we asked parents to report on girls' interest and motivation. They provided ample evidence that girls' interest in conserving energy increased. They reported that girls asked questions about energy bills, ways they could conserve energy at home, how much energy appliances used, and how to winterize the home. Parents also reported girls' increasing awareness about how much water was left running, unused electrical appliances or lights that were left on, or emissions occurring when idling the car. Some parents cited girls' increasing understanding of how energy use is linked to climate change and increasing interest in environmental stewardship overall. Examples included girls becoming interested in alternative energy sources like wind power, thinking about how transportation can occur without using gas, and talking about recycling and reducing product packaging.

Identity/Belief

High proportions of both Juniors and Cadettes began their patch activities agreeing with a statement that "I can make a difference in reducing climate change." While the percentage of girls agreeing with this statement after completing the patch activities increased (79% pre vs. 89% post for Juniors; 89% pre vs. 93% post for Cadettes), the gains were not statistically significant.

To further measure shifts in girls' beliefs with regard to making a difference, surveys included four identity statements. Generally, a high proportion of girls began the program already envisioning themselves as being able to save energy (Tables 5). Post-patch outcomes were mixed. Both Juniors and Cadettes showed a statistically significant increase in "yes" responses after one patch, indicating an even stronger belief in their identity as energy conservers. For all other statements, Juniors showed statistically significant decreases in "yes" responses post-patch. Cadettes on the other hand showed statistically significant increases post-

patch on statements related to helping their troops save energy, but no differences to helping their family or their town save energy. Note that the significant result for Cadettes for the town statement was not due to an increase in "yes" responses, but to an increase in "no" responses.

		Juniors			Cadettes		
		Yes	**No**	**Unsure**	**Yes**	**No**	**Unsure**
I think of myself as someone who can save energy myself.[1]	Pre	80	6	14	81	5	14
	Post	83	5	12	89	2	9
I think of myself as someone who can help my family save energy.[2]	Pre	86	4	10	79	6	15
	Post	79	8	14	75	7	18
I think of myself as someone who can help another troop save energy.[3]	Pre	50	12	38	43	16	40
	Post	41	26	32	54	13	32
I think of myself as someone who can help my town save energy.[4]	Pre	47	15	38	41	17	43
	Post	34	32	35	39	26	36
Fisher's Exact Test for differences: pre- to post-patch Juniors: n=234; [1] 1=0.011, [2]1=0.001,[3]1=0.000,[4]1=0.000 Cadettes: n=121; [1] 1=0.024, [2]1=0.540,[3]1=0.000,[4]1=0.000							

Table 5. Girls' pre/post percent agreement with identity/belief statements with respect to saving energy.

Readiness to save energy

Several statements measured how ready girls participating in GECCo were to save energy themselves (Table 6).

	I'm already doing it	**I'm ready to start**	**I'm thinking about it, but not ready yet**	**I'm not ready yet**
Pre	35	39	18	9
Post	54	23	16	7

Table 6. Percent change in Juniors' readiness to save energy pre/post Patch 1 (n=235).

Juniors showed statistically significant increases in their individual readiness to save energy after one patch, but not on the other three statements (helping family, helping other troops, helping town). In addition to showing a significant increase in readiness to save energy themselves, Cadettes showed statistically significant increases in readiness to save energy themselves, and helping their family and another troop save energy, but not their town (Table 7).

		I'm already doing it	**I'm ready to start**	**I'm thinking about it, but not ready yet**	**I'm not ready yet**
How ready Cadettes are to save energy themselves[1]	Pre	42	38	17	2
	Post	61	25	11	3
How ready Cadettes are to help their family save	Pre	28	47	20	6
	Post	43	36	14	7

energy[2]					
How ready Cadettes are to help another troop save energy[3]	Pre	2	37	38	24
	Post	17	33	35	15
How ready Cadettes are to help their town save energy[4]	Pre	7	32	26	35
	Post	18	22	26	33
Wilcoxon related sample signed-rank significant tests for differences pre- to post-patch [1]=0.003, [2]=0.013,[3]=0.000,[4]=0.090					

Table 7. Percent change in Cadettes' readiness to save energy (n=121).

Intention to take action

We included four statements to assess what girls were willing to do to conserve energy. These questions provide another measure of intended energy saving actions, a pre-cursor to action (Table 8). Baseline data showed a moderate level of readiness to engage in energy conservation; ratings after one patch indicated mixed results. Juniors showed statistically significant increases in their willingness to use less hot water while bathing, but showed a decrease in willingness to pass out information, and no differences for the other two statements. Cadettes showed statistically significant increases in their willingness to use less hot water while bathing and by riding the bus, but not in using less air conditioning or passing out energy conservation information.

		Juniors			**Cadettes**		
		Very/ mostly true	**Not sure**	**Mostly/ very false**	**Very/ mostly true**	**Not sure**	**Mostly/ very false**
To save water, I would be willing to use less water when I bathe.[1]	Pre	67	20	13	66	15	20
	Post	75	15	10	81	12	8
I would be willing to ride the bus to more places in order to reduce air pollution.[2]	Pre	42	27	32	64	22	14
	Post	44	28	28	70	22	8
I would be willing to save energy by using less air conditioning.[3]	Pre	65	25	10	62	25	13
	Post	62	24	13	68	19	13
I would go house-to-house to pass out information about saving energy.[4]	Pre	41	35	24	34	28	38
	Post	20	30	40	29	36	35
Wilcoxon related sample signed-rank significant tests for differences pre- to post-patch Juniors: n=234; [1] 1=0.042, [2]1=0.132,[3]1=0.299,[4]1=0.000 Cadettes: n=121; [1] 1=0.000, [2]1=0.018,[3]1=0.593,[4]1=0.920							

Table 8. Percent change in girls' intentions to save energy.

Taking action – Saving energy

Overall, the largest impact of the GECCo patch activities appears to be an increase in energy conservation behaviors (Tables 9 and 10). We asked girls three questions about their actual energy saving actions before and after each patch. Both Juniors and Cadettes showed statistically significant increases in responses about turning off lights and talking with parents

about saving energy at home. There were no significant shifts in responses to turning off water. However, both Juniors and Cadettes reported high proportions of girls who were already engaging in this behavior prior to doing any GECCo patches.

		Very or mostly true	**Not sure**	**Mostly or very false**
I turn off the water in the sink while I brush my teeth to conserve water.[1]	Pre	93	4	3
	Post	91	4	5
To conserve energy, I turn off lights at home when they are not in use.[2]	Pre	84	10	6
	Post	91	5	4
I have talked with my parents about how to help with saving energy.[3]	Pre	35	26	38
	Post	48	21	31
The related sample Wilcoxon signed-rank test for significance, [1] 1=0.470, [2] 1=0.004, [3] 1=0.001				

Table 9. Junior increase in energy conserving behaviors reported. (n=235)

		Very or mostly true	**Not sure**	**Mostly or very false**
I turn off the water in the sink while I brush my teeth to conserve water.[1]	Pre	92	3	4
	Post	94	3	3
To conserve energy, I turn off lights at home when they are not in use.[2]	Pre	89	6	5
	Post	97	2	1
I have talked with my parents about how to help with saving energy.[3]	Pre	29	25	46
	Post	50	25	25
The related sample Wilcoxon signed-rank test for significance, [1] 1=0.173, [2] 1=0.018, [3] 1=0.000				

Table 10. Cadette increase in energy conserving behaviors reported. n=121.

Reporting energy savings online was another measure of girls' energy conserving behaviors. Girls over the course of the field test earned thousands of points towards their causes by saving energy through turning off electronics, conserving hot water, conserving heating or cooling energy, getting around using less energy, or sharing information with other people about how to save energy. The most points were earned by spreading the word about energy conservation (14,439 points), with turning off electronics (14,057 points) at a close second.

Data from parents/guardians about whether they observed increases in the girls' energy saving behaviors at home after patch participation confirmed the data from girls themselves (Table 11). From troop leader report in interviews and observations, we found that learning about "how" to conserve energy was another core asset of the GECCo program.

To what extent has your child…	**No more than usual**	**More**	**Not sure**
…expressed more interest in finding ways to conserve energy since working on this GECCo patch?	14	85	2
…taken specific action to conserve energy since working on this GECCo patch?	10	89	2
…shared information with either you or someone in your household about conserving energy since working on this GECCo Patch?	20	77	3

Table 11. Parent report of the increase of energy saving behaviors (%) observed by them at home after their daughter's participation in GECCo activities.

We also observed ways experiential learning at troop meetings transferred into action at home. For instance, building a draft finder and finding drafts in the room combined with a craft project that empowered the girls to stop drafts was effective in helping them take action at home. At the next meeting, we heard that the girls, liking the gecko draft blockers they had made in troop time and wanting to use them, all found drafts at home and put their draft blockers to use.

Figure 4. A GECCo draft blocker.

Other activities resulted in information that moved girls to make some changes in their home energy use. For example, after investigating how much water comes out of a faucet in one minute, one troop talked about ways they could conserve water, and inspired girls to make reminders to shut faucets and make plans for where to hang them (e.g., bathroom door) so they could remember to save water "in the moment."

Some activities also helped girls reflect on what they personally were willing to do. "Down the Drain" resulted in girls examining their shower time, thinking about how much time they were willing to cut, and creating playlists to time shorter showers. The "Reminder Bracelet" activity resulted in many, but not all, girls saying they would use their bracelets to help start a conversation with others about conserving energy. Overall, the high energy and social interaction from the activities helped increase the intention and will to take action in the majority of troop members observed.

Taking action - Sending conservation messages

Researchers assessed the general availability of computers and internet for GECCo activities when the troops signed up for the field test. Access during troop time was generally higher for Cadettes than Juniors – 90% of Cadette troops vs. slightly less than one-half of Junior troops. The most common way scouts shared energy conservation messages during the *Tell the World* patch was to talk with others (63% of Juniors 52% of Cadettes). Overall, the most popular technology-based activity involved the creation of a video, which involved a high level of social interaction to create, followed by email and texting (Table 12).

Mode	Percent
Emails	30
ECards	4
Videos	70
Animations	11
Text messages	26
Powerpoint	4

Table 12. Modes of sharing energy conservation messages by Cadettes. (Total does not equal a hundred because girls created and sent up to three different products.)

All presentations contained unique ideas of how to communicate energy-saving messages, often around themes:

• One troop did a take-off of the well-known energizer bunny to create a bunny that focused on turning off electronics that were wasting energy rather than how long they could run.

• Two troops used "mother nature" or "daughter nature" roles to voice the environmental impact of energy use, while some troops exaggerated wasteful energy habits to point out how one can easily conserve energy by being mindful in everyday actions.

Only two troops made a connection to the environmental impact of energy use, and none to climate change, for example, stating that wasting energy would negatively impact gecko habitats, or driving cars "pollutes the air" and affects the survival of humans and animals. All but a few of the messages effectively communicated why the viewer should take the prescribed energy conservation action. Weaker messages had slight references to a high energy bill, failed to explain why the viewer should conserve energy beyond being wasteful, or failed to mention any reason to conserve energy at all. While some girls created very simple, effective messages, others wrote and acted out elaborate skits, or even wrote and sang their own song about conserving energy.

Discussion

Choice environments are notoriously difficult educational settings for which to design programs and, importantly, in which to assess effectiveness (for example, see discussion by Means, House and Llorente 2011). Thus, the "enacted" curriculum in informal learning settings usually differs in often surprising ways from the developers' intentions. The GECCo program was no different. Troops differed in size, had unpredictable scheduling and levels of attendance, and variable levels of troop leader skill and style in facilitation. Further, due to the informal and variable nature of the troops, several factors affected our ability to assess the effects of the patch activities. Girls were free to choose patches, or patch activities within patches, and how many patches to complete. In addition, observations revealed varying troop leader facilitation styles and skill levels and likely affected the ways girls experienced activities. However, the large sample of girls that we were able to recruit for participation in the study mitigates the high level of variability due to these contextual factors.

We believe that several factors in the design of our program contributed to its success. These included i) the integration of climate change information into key elements of the program, for Juniors at least, ii) stressing the importance of collective action, iii) opportunities for hands-on learning, iv) an emphasis on empowerment to take action, and v) eliciting social norms.

It is noteworthy that despite relatively small exposure (typically 2 hours plus some small additional time at home), Juniors' level of knowledge about climate change increased

significantly, while Cadettes, who entered the program with a high level of knowledge initially nevertheless showed an increased trend in their scores, albeit not a significant one. Knowledge gains are especially noteworthy because troop leaders frequently did not introduce climate change as the motivating context for patch activities. For those activities in which climate change was an integral part, there were higher knowledge gains on the related questions in the survey.

Baseline data revealed that girls did not understand the connection between their own energy use and climate change. Therefore, one goal of the program was to integrate some basic information about climate change into the program to motivate learning about energy conervation, and to motivate action (Saunders 2003, Brook and Clayton 2005) to address it. The percentage of girls who understood the connection between their own energy use and climate change after participation increased among Juniors by 15% and among Cadettes by 10%, which suggests that this approach was effective. Demeo, Feldman and Peterson (2013) advocate the integration of energy education with education about ecology and the environment as an effective model for education about energy, though the positive outcomes they report are informal. Our findings suggest that more research will confirm the effectiveness and utility of this approach in supporting energy education.

Taken together, our knowledge and behavior findings both seem to confirm the suggestion that educating young people about climate change from perspectives of empowerment to take action (Doherty and Clayton 2011) – in this case by learning how energy is used and learning how to save it - is an effective strategy. Further, our findings affirm Goddard's view (2001) that collective action is a construct that can play a valuable role in supporting the achievement of young people. We believe that a focus on the importance of individual action and the significance of collective efforts empowered the girls to take action. This was confirmed by troop leaders, who rated this as a significant area of learning for girls.

The program also affirms the power of experiential learning to affect attitudes and behavior (Guiney and Oberhauser 2009). Thus, hands on activities during troop time translated into changed motivation and behavior to bring about several actions at home. Girls talked to family members about saving energy, changed behavior to save energy themselves, and posted reminders about the house to engage the whole family in their efforts. Some girls also chose to make presentations to the youngest girl scouts, and over half of all participating troops "spread the word" about saving energy through other means, for example through public displays such as chalking messages on sidewalks or creating banners, or creating videos that they posted on YouTube. In addition, the extent to which both Juniors and Cadettes attempted to enlist others in their efforts to save energy through their outreach efforts seems to affirm a sense of empowerment (NRC 2011, Koger and Winter, AMA 2009), though results were mixed with respect to our measures of motivation and self-efficacy, at least for Juniors. Since Cadettes showed no differences in reported levels of motivation, we conjecture that the reported drop in this affective dimension may be developmental; we discuss this possibility further below.

We believe that the success of the Energy Challenge and the high numbers of conservation messages communicated by girls is indicative to the power of social norms (Nolan et al. 2008), especially those related to Girl Scout norms, namely, social identity, collaboration, and caring for the environment (Puttick and Bernstein 2014). These findings suggest that explicit appeal to social norms can enhance the effectiveness of behavior change programs, as others have also found (e.g., Perkins et al. 2011, Bernedo, Ferraro and Price 2014).

By examining at least some of the dimensions of behavior change, for example, gathering data on knowledge, motivation to change, identity, intention to act and making a commitment to

act (Prochaska et al. 1997), we can identify the strengths and weaknesses that may impact girls' long-term behavior change. Our findings show that the program had a measurable impact on motivation, readiness to act and self-efficacy. It appears that program activities helped many girls move from 'readiness' to 'action' stage; after completing one patch, the proportion of girls who said they were 'already saving energy' increased from a third to a half.

As far as the predictive value of behavior change models goes, our goal was not to model behavior change but rather to build on these constructs to develop the program. For example, we evoked self-efficacy, a core value of Girl Scouts in general, through education about the power of collective action. The patches also stressed the importance of making pledges, another core Girl Scout value, which we conjecture helped move the girls from 'readiness' to 'action.' The utility of behavior change models is in predicting how long behavior change will be sustained (Prochaska et al.1997). From our findings, we cannot predict how long girls' conservation efforts will last. However, outcomes do suggest that a promising approach for a behavior change program is to take at least some of the individual constructs into account during development of the program. Our study was limited to the time period during which the program was conducted; follow-up research to determine the impact of the program after a 6-month period would have strengthened the study considerably.

Our findings emphasize the important role that maturational development played in influencing the motivation, readiness to act, and self-efficacy of Juniors compared with Cadettes, not surprising since self-efficacy and identity are quite plastic during adolescence, as discussed for example by Tsang, Hui and Law (2012a, b). The Cadette girls were developmentally more ready than the Juniors to help others shift their behaviors. Results showed that the patch activities expanded the Cadettes perceived sphere of influence, while it contracted the Juniors' perceived sphere of influence. For example, while Juniors increased their personal effectiveness in saving energy, their self-reported readiness to "go house-to-house" to share information about energy conservation dropped after completion of the program. This suggests that Juniors' sense of identity may still be forming, which may cause them to mis-judge ratings until they have enough experience to answer in a way that is more aligned with their reality. However, since we were not able to follow up this finding in this study, further interpretation would be speculative.

The differences between Juniors and Cadettes illuminate how developmental differences may be seen when using adult-tested behavior change models and constructs for youth. Young people may not respond in the same ways to behavior change interventions due to these differences. While we are unable to fully explain the effects of age, it is worth pointing out that the constructs developed for adult behavioral change models may need to be adapted to guide future behavioral research studies for youth.

Since climate change content was integrated at different levels in different patches, small revisions of the patch requirements and program materials would increase learning around climate change across the patches and Girl Scout levels. For example, most information exchanges around climate change were observed during the Energy Challenge discussions. Therefore, the Challenge could be revised to more explicitly incorporate key climate change learning points. In addition, the Energy Challenge could be required for all patches, not just for Junior patches, to maintain consistent access of climate change information across all patches. Strengthening this component of the program would not only have raised girls' knowledge, but it would also have helped them justify their actions and communicate more effectively why others should join them in conserving energy.

In addition, professional development could further improve the effectiveness of the program. At least some of the program's efficacy in learning can be attributed to the troop leader's facilitation skills and perceptions. Events with trained facilitators mentoring the girls through activities would be one way to overcome troop leader differences, and some form of troop leader training would be another.

Finally, we believe that the program has relevance for formal educational settings, especially since program activities are carefully aligned with the NGSS. The U2CC card game in the Power Down patch is an engaging tool for teaching students about how their own energy use is connected to climate change through the electricity supply chain from appliance to carbon dioxide generation. For younger students, two activities involve movement - Jumping Jack Fuel is an activity that focuses on fuel consumption and fuel efficiency, and Fuel Stomp Theater focuses on differentiating fossil and renewable sources of energy. There are several creative arts-related activities for raising public awareness (e.g., Wind Words in Power Down, Chalk-A-Walk in Travelin' Green) or for creating conservation reminders (e.g., Remind-Me Bracelets in Going Green and Green-Saver in Power Down). Carbon Balance Mobile and CO_2 Race, both in Be Cool, are modeling activities that focus on different aspects of the carbon cycle. Last, examples of relevant science investigations include Watts It Take in Power Down, measuring the wattage required by different small appliances, and Sunny Side Up in Be Cool, measuring how passive solar heating works at home. School programs are common that engage elementary and middle school students in campaigns related to energy conservation. For example, students may conduct energy audits, create awareness campaigns for the school community, or research and make recommendations for school-wide "green energy" implementation. Although designed for informal learning, GECCo activities could enhance student engagement and learning if used to supplement such school-based programs.

Acknowledgments

We acknowledge the skill and creativity of Teon Edwards and Meaghan Donovan who developed the activities. Marian Grogan, project director, and Rachel Hayes, research assistant, kept the project on track, freeing developers and researchers to focus on implementation research. Polly Hubbard, formative evaluator, contributed not only evaluation findings but also creative recommendations to improve the program. Joan Reilly, co-Principal Investigator at Girl Scouts of Eastern Massachusetts, advised us on all aspects of development and implementation, and successfully recruited participating troops. Our advisory board gave invaluable guidance in the beginning stages of the project: Scot Osterweil, Eric Klopfer, Eric Davidson, Carol Saunders, Scot Traylor, Cleti Cervoni, Shaileen Pokress and Joe Hackler. The National Science Foundation provided funding under grant #DRL-0813434. Any opinions, findings, and conclusions or recommendations expressed in this article are those of the authors and do not necessarily reflect the views of the National Science Foundation. Any correspondence about this article should be addressed to the Principal Investigator, Gillian Puttick, gilly_puttick@terc.edu.

References

Abrahamse, W., Steg, L., Vlek, C. and Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. Journal of Environmental Psychology 25, 273-291.

Achieve (2013). Next Generation Science Standards. Achieve.org.

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50, 179–211.

American Psychology Association. (2009). Psychology and global climate change: Addressing a multifaceted phenomenon and set of challenges. http://www.apa.org/science/climate-change accessed August 2011.

Bateson, M. (2007). Education for social responsibility, In Creating a Climate for Change, Moser, S. and Dilling, L (eds) pp. 281-291 , Cambridge UK: Cambridge University Press.

Bell, P., Lewenstein, B., Shouse, A.W. & Feder, M.A. (Eds.) (2009). Learning science in informal environments: People, places, and pursuits. Washington, D.C.: The National Academies Press.

Bernedo, M., Ferraro, P. and Price, M. (2014). The Persistent Impacts of Norm-Based Messaging and Their Implications for Water Conservation. Journal of Consumer Policy 37, 437-452

Britner, S. L. (2002). Environmental ethics in middle school students: Analysis of the moral orientation of student responses to environment dilemmas. Research in Middle Level Education Online, 26(1). http://www.nmsa.org/Publications/RMLEOnline/tabid/101/Default.aspx accessed Aug 2011.

Brook, A. & Clayton, S. (2005). Can Psychology Help Save the World? A Model for Conservation Psychology. Analyses of Social Issues and Public Policy, 5, 87–102.

Dauer, J., Miller, H. & Anderson, C. W. (2014). Conservation of energy: An analytical tool for student accounts of carbon-transforming processes. In R. Chen, A. Eisenkraft, D. Fortus, J. Krajcik, K. Neumann & A. Scheff (Eds.), Teaching and Learning of Energy in K-12 Education. New York: Springer, pgs 47-61.

Dauer, J., Miller, H., and Anderson, C.W. (2013). Students' inquiry and argumentation about carbon transforming processes, National Association for Research in Science Teaching, Rio Grande, Puerto Rico, April 2013.

Demeo, A., Feldman, D. and Peterson, M. (2013). A human ecological approach to energy literacy through hands-on projects: An essential component of effectively addressing climate change. Journal of Sustainability Education, 4.

DOE. (2013). Energy 101 – Science, Technology, and Society. United States Department of Energy, Office of Energy Efficiency & Renewable Energy. http://www.eesi.org/files/Energy-101-Course-Framework-Summary.pdf accessed Jun 2014.

DeWaters, J. E., & Powers, S. E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. Energy Policy, 39, 1699–1710.

DeWaters, J. and Powers, S. (2006) "WIP: A Pilot Study to Assess the Impact of a Special Topics Energy Module on Improving Energy Literacy of High School Youth." In

Proceedings of the 36th ASEE/IEE Frontiers in Education Conference, San Diego, CA, October 28-31, 2006.

Dietz, T., Gardner, G., Gilligan, J., Stern, P. and Vandenbergh, M. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. Proceedings of the National Academy of Sciences, 106, 18452–18456, doi: 10.1073/pnas.0908738106

Doherty, T. and Clayton, S. (2011). The psychological impacts of global climate change. American Psychologist, 66, 265–276.

Duschl, R.A., H. A. Schweingruber, and A. W. Shouse (eds). (2007) Taking science to school: learning and teaching science in grades K-8. Washington, D.C.: National Academies Press.

Falk, J.H.; Reinhard, E.M.; Vernon, C.L.; Bronnenkant, K.; Deans, N.L.; Heimlich, J.E., (2007). Why Zoos & Aquariums Matter: Assessing the Impact of a Visit. Silver Spring, MD: Association of Zoos & Aquariums.

Gautier, C., and Rebich, S. 2005. The use of a mock environmental summit to support learning about global climate change. Journal of Geoscience Education, 53:5-16.

Goddard, R. D. (2001). Collective efficacy: A neglected construct in the study of schools and student achievement. Journal of Educational Psychology, 93, 467–476.

Greene, J.C., Caracelli, V.J. and Graham, W.F. (1989) Towards a conceptual framework for mixed-method evaluation designs. Educational Evaluation and policy analysis, 11: 255.

Grotzer, T., and Lincoln, R. 2007. Educating for "Intelligent Environmental Action" in an Age of Global Warming. In Creating a Climate for Change, Moser, S. and Dilling, L (eds) pp. 266-280, Cambridge UK: Cambridge University Press.

Guiney and Oberhauser (2009) Conservation volunteers' connection to nature. Ecopyschology 1, 187-197.

Holthuis, N., Lotan, R., Saltzman, J., Mastrandrea, M., Gray, S., Bofferding, L. and Sullivan. S. (2012). The Stanford Global Climate Change Education Project: Classroom Implementation, Student Achievement, and Project Evaluation. Paper presented at AERA, Vancouver, April 2012.

James, E.O., Robinson, M. and Powell, R. (1994). Beyond STS: An Energy Education Curriculum Context for the 21st Century. Journal of Science Teacher Education 5, 6-14.

Kolmus, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research, 8(3), 239–260.

Kuhn, L. & Reiser, B. (2006, April). Structuring activities to foster argumentative discourse. Paper presented at the annual meeting of the AERA, San Francisco, CA.

Leiserowitz, A.A. (2005) American risk perceptions: is climate change dangerous? Risk Analysis 25, 1433-1442.

McCaffrey, M. S., and Buhr, S.M. 2008. Clarifying climate confusion: Addressing systematic holes, cognitive gaps, and misconceptions through climate literacy. Physical Geography, 29: 512–518.

Means, B., House, A. and Llorente, C. (2011). Challenges in designing and conducting research on afterschool programs. Paper presented at AERA, New Orleans LA, April 2011.

Moser, S.C. and L. Dilling (eds) (2007). Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change. Cambridge, UK: Cambridge University Press.

National Research Council. (2010). Limiting the magnitude of climate change. Washington DC: National Academies Press.

NEETF (2012). Americans' Low "Energy IQ:" A Risk to Our Energy Future/Why America Needs a RefresherCourse on Energy , in 10th National Report Card: Energy Knowledge, Attitudes, and Behavior , N.E.E.T. Foundation, Editor. Washington DC: NEETF.

Nigbur, D., Lyons, E., & Uzzell, D. (2010). Attitudes, norms, identity and environmental behavior: Using an expanded theory of planned behaviour to predict participation in a kerbside recycling programme. British Journal of Social Psychology, 49, 259-284.

Nolan, J.M., Schultz, P.W., Caildini, R.B., Goldstein, N.J., & Griskevicius, V. (2008). Normative social influence is under-detected. Personality and Social Psychology Bulletin, 34, 913-923.

Osbaldiston, R. and Schott, J. (2012). Environmental Sustainability and Behavioral Science: Meta-analysis of proenvironmental behavior experiments. Environment and Behavior 44, 257-299.

Perkins, H.W., Craig, D.W., & Perkins, J.M. (2011). Using social norms to reduce bullying: A research intervention among adolescents in five middle schools. Group Processes & Intergroup Relations, 1-20.

Prochaska, J.O., Redding, C.A., Evers, K.E. (1997) Transtheoretical model and Stages of change. Pp. 60-84 in Glanz, K, Lewis, F.M and Rimer, B.K. (Eds). Health behavior and health education theory, research and practice. San Francisco CA: Jossey Bass.

Puttick, G. and Bernstein, D. (2014). Seeding social norms about energy conservation among girl scouts. Applied Environmental Education and Communication 13 (4).

Rabkin, S. and Gershon, D. (2007). Changing the world one household at a time: Portland's 30-day program to lose 5,000 pounds. In Creating a Climate for Change, Moser, S. and Dilling, L (eds) pp. 292-302, Cambridge UK: Cambridge University Press.

Saunders, C. (2003) The emerging field of conservation psychology. Human Ecology review 10, 137-149.

Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. Psychological Science, 18(5), 429-434.

Sell, K., Herbert, B., Stuessy, C., and Schielack, J. 2006. Supporting student conceptual model development of complex earth systems through the use of multiple representations and inquiry. Journal of Geoscience Education, 54:396-407.

Southwell, B. G., Murphy, J. J., DeWaters, J. E., & LeBaron, P. A. (2012). Americans' perceived and actual understanding of energy (RTI Press peer-reviewed publication No. RR-0018-1208). Research Triangle Park, NC: RTI Press.

Thogersen, J., and Olander, F. (2003). Spillover of environment-friendly consumer behaviour. Journal of Environmental Psychology, 23, 225-236.

Tsang, S., Hui, E. and Law, B. (2012a). Positive identity as a Positive Youth Development Construct: A Conceptual Review. The Scientific World Journal, 2012, doi:10.1100/2012/529691

Tsang, S., Hui, E. and Law, B. (2012b). Self-Efficacy as a Positive Youth Development Construct: A Conceptual Review. The Scientific World Journal, 2012, doi:10.1100/2012/452327