DISSERTATION

# ENGAGING KEY STAKEHOLDERS IN CLIMATE CHANGE: A COMMUNITY-BASED PROJECT FOR YOUTH-LED PARTICIPATORY CLIMATE ACTION

Submitted by

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ABSTRACT

ENGAGING KEY STAKEHOLDERS IN CLIMATE CHANGE:

A COMMUNITY-BASED PROJECT FOR

YOUTH-LED PARTICIPATORY CLIMATE ACTION

Few studies have examined how youth think about, and take action on climate change and far fewer have sought to facilitate their engagement using participatory methods. This dissertation evaluated the impacts of *Science, Camera, Action!* (SCA), a novel after-school program that combined climate change education with participatory action through photovoice. The specific aims of this study were to: (1) Evaluate the impacts of SCA on youth participants' climate change knowledge, attitudes, and behaviors; (2) Examine how SCA participation served to empower youth agency; and (3) Explore SCA's influence on youths' science engagement.

Participants were 55 youths (ages 10 to 12) across three Boys and Girls Club sites in Northern Colorado. SCA's *Science* component used interactive activities to demonstrate the interrelationships between Earth's changing climate, ecosystems, and sustainable actions within communities. Photovoice, SCA's *Camera* component, was used to explore youths' climate change perspectives and to identify opportunities for their active engagement. Finally, SCA's *Action* component aimed to cultivate youth potential as agents of change in their families and communities through the development and implementation of youth-led action projects. Action projects included local policy advocacy, a tree-planting campaign, a photo gallery opening, development of a website, and the establishment of a Boys and Girls Club community garden.

To evaluate SCA impacts, a combination of survey and focus group methods were used. Following the program, youth demonstrated increased knowledge of the scientific and social

dimensions of the causes and consequences of climate change, as well as its solutions through human action. Though participants expressed a mix of positive (e.g., hope) and negative (e.g., sadness) emotions about climate change, they left the program with an increased sense of respect for nature, an enhanced sense of environmental responsibility, and a greater sense of urgency towards the need for climate change action. Further, participants reported increased engagement in personal pro-environmental behaviors, an enhanced sense of agency in the context of climate change, and provided strong evidence of their role as agents of change in family and community contexts. Through SCA, participants gained a deeper appreciation for science (e.g., in school, careers, and society) and reported increased interest, participation, confidence, and performance in school science.

Findings contribute to the vast and growing psychology literature on climate change perceptions and action, and from the understudied perspective of youth. Through a combination of innovative methods and interactive projects, the youth in this study gained a number of psychosocial and educational benefits, while tangibly contributing to the sustainable transformation of their families and communities. Findings of this dissertation have implications for educational programs, youth organizing, and interventions aimed to strengthen youths' active engagement with critical social and scientific issues that impact their lives.

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Action

Agency

Children

Climate change

Community

Education

Environment

Photovoice

Participatory

Program

Science

Youth

# CHAPTER 1: INTRODUCTION

## 1.1 Youth and Climate Change

Climate change is often said to be the defining issue of our time. In reality, however, climate change will exert increasingly greater impacts in the lives of young children today as well as future generations (Page, 2006). According to the latest report by the Intergovernmental Panel on Climate Change (IPCC, 2014), this is true even if all greenhouse gas emissions were to stop today, given lags in physical processes already set in motion. The seriousness of the issue is apparent when considering that today's ten-year-old, given an average U.S. life expectancy, will live to nearly the end of the 21st century—a time expected to be characterized by increased uncertainty and probability of disruption to socioecological systems. Therefore, the real key stakeholders in climate—those who stand to benefit or lose the most—are invariably our young people, their future families, and generations to come. To put it more accurately, climate change will exceedingly be the defining issue of their time.

In this light, empowering youth to understand and take action on climate change should be an important goal, both to support children's agency and to promote present and future community resiliency in the face of climate impacts (Schreiner, Henriksen, & Kirkeby Hansen, 2005; Spellman, 2015). However, youth are often under-engaged in climate change education and action, and understudied as agents of change within their families and communities. Despite increased efforts of social scientists to understand and promote individuals' and societies' capacities to mitigate and adapt to climate change, most research focuses on adult rather than youth actors (Corner et al., 2015; Tanner & Seballos, 2012). This vast and growing body of research has recognized the important role of human societies in contributing to—and therefore taking action to avert—catastrophic climate change. Psychological research in particular has

identified a number of individual and social factors that influence climate change-relevant cognitive, affective, and behavioral processes (Clayton et al., 2016; Fielding, Hornsey, & Swim, 2014; Gifford, 2011). In spite of this, and with notable exceptions (e.g., Dittmer & Riemer, 2013; Fisher, 2016), relatively little psychological research has examined how youth navigate the issue of climate change. One explanation for this is youths' lack of access to knowledge, resources, and opportunities that might encourage their participation.

### 1.2 Barriers to Youth Climate Change Engagement

In the U.S., a number of social, cultural, political, and educational barriers impede young people's active engagement with climate change. For example, climate education in the formal U.S. classroom is often neglected, misrepresented, or underemphasized (Mueller & Tippins, 2015; Plutzer et al., 2016), and few opportunities exist for youth to engage meaningfully in action related to their education (Lester, Ma, Lee, & Lambert, 2006; Roth & Désautels, 2002). This is the case for a number of reasons, most notably the controversial nature of climate change as a politicized issue (McCright & Dunlap, 2011), combined with the widespread perception of politics as an adult-only sphere (Wyness, Harrison, & Buchanan, 2004). Given pervasive policies and traditions that prevent children's engagement with critical and contentious societal issues in the classroom, many researchers argue that the formal education system has failed to empower children as citizens (Freire, 1972; Sadler, 2009).

In recent decades, researchers in community psychology and the sociology of childhood have called for viewing children not as "human becomings" (i.e., future citizens), but as "human beings" (i.e., citizens of today) who are active agents in their families and communities (Bandura, 2001; Langhout & Thomas, 2010; Qvortrup, 2009). From this perspective, even young children can and should benefit from informed and engaged citizenship (Byrne, Ideland, Malmberg, & Grace, 2014; Checkoway, 2003). For example, strengthening youths' awareness of

climate change and encouraging their active role in environmental stewardship may support well-being not only in the present (i.e., youth agency and empowerment), but also in the future (i.e., adaptive capacity) (Christens & Peterson, 2012; Rooney-Varga, Brisk, Adams, Shuldman, & Rath, 2014; Schreiner et al., 2005).

### 1.3 Rationale for Facilitating Youth Climate Change Engagement

Some scholars have argued that youths' under-engagement in climate change education, decision-making, and action is both a moral and ethical issue—that children have a right to be informed and engaged in issues that will impact their lives (Chawla & Heft, 2002; Hicks & Holden, 2007; Page, 2006). Critical, often rights-based, discussions of intergenerational climate justice have become commonplace in academic and policy circles, and often reference the most highly-ratified international treaty in history: The United Nations Convention on the Rights of the Child (UNCRC) (Gibbons, 2014). According to Tanner and colleagues (2009), the "four pillars" framing the UNCRC, which include children's protection, survival, development, and participation, together:

> …establish the fundamental rationale to create opportunities for children's voices to be heard in research, advocacy, and policy on climate change and Disaster Risk Reduction (DRR). Under this framework, children should be in the forefront of climate change policy, advocacy and research. It is their right to participate in all matters that affect them. The increasing frequency of disasters and projections of likely impacts of climate change indicate that today's children are especially vulnerable now and will bear the impacts of climate change over their lifetime. (p. 5)

Others have asserted that engaging youth makes sense as a pragmatic measure because today's youth are "tomorrow's leaders and stewards of the earth" (Ballantyne, Connell, & Fien, 1998, p. 285; see also Ojala, 2012a; Koger, 2013; Schreiner et al., 2005). More generally, this argument contends that it is imperative to prepare youth to adapt to climate change, given the inevitability—regardless of decisions made by today's policymakers—of centuries of continually-unfolding climate change impacts that today's youth will face (Boon, 2015; Eichler,

2015). Moreover, the present actions of all people, including children, have future implications. Strengthening the inclusion of young people in climate change decision-making and action may be a valuable avenue towards greater community resilience. As a result, youth have been welcomed into a number of local to global policymaking forums previously inaccessible to them, and opportunities for their active engagement are increasing (Keenan, 2010).

The immensity of the challenges to social systems and lifestyles that climate change presents is palpable in urgent calls for societal—and indeed global—transformation towards sustainability (Clarke, 2012). Young people can be critical actors in this transformation. Given that sustainable behaviors are easier to cultivate over a lifetime of learning beginning in childhood (Buttigieg & Pace, 2013), deliberate efforts to engage youth in climate change have the potential to inspire their interest and participation throughout their lives (Arnold, Cohen, & Warner, 2009). Moreover, with young people's openness to change and long history of taking leadership in social movements (Ginwright & James, 2002; Ho, Clarke, & Dougherty, 2015), they have the capabilities to be catalysts of sustainable transformation in their communities (Ballantyne et al., 1998; Fisher, 2016). As noted by Tanner and colleagues (2009), "Children who are aware, involved and empowered are potentially effective agents of change within communities to foster an appropriate approach to address climate change" (p. 5).

### 1.4 Statement of the Problem

Few studies within the extensive social science literature on climate change have examined how youth think, feel, or take action on climate change, and still fewer have explored how youth are affected by their climate change engagement (Corner et al., 2015; Fien, Neil, & Bentley, 2008). As discussed, this tendency to overlook young people extends to psychological research on climate change, which has disproportionately focused on adult environmentally-significant attitudes, behaviors, and choices (Shove, 2010). As critical actors and key

stakeholders in efforts to address climate change, youth perspectives and actions warrant greater consideration.

Existing studies of youth and climate change deal primarily with climate change education (Bofferding & Kloser, 2015; Dawson, 2015; Niebert & Gropengießer, 2014; Porter, Weaver, & Raptis, 2012; Pruneau, Gravel, Bourque, & Langis, 2003; Shepardson, Roychoudhury, Hirsch, Niyogi, & Top, 2014; Spellman, 2015; Visintainer & Linn, 2015). This research has illuminated the manifold benefits to youth of learning about climate change topics, including positive impacts on youths' climate change-relevant attitudes, values, and behaviors (Byrne et al., 2014; Karpudewan, Roth, & Abdullah, 2015; Littledyke, 2008; Stevenson, Peterson, Bondell, Moore, & Carrier, 2014). Fewer studies have examined how youth engage with climate change beyond the formal classroom (Ojala, 2012a; 2012b; 2015; Satchwell, 2013). At the same time, most of these investigations (e.g., of community programs) are primarily educational in nature, and emphasize the value of informal settings in overcoming common limitations of structured learning environments (Birmingham & Barton, 2014; Blythe & Harré, 2012; Stapleton, 2015). Still fewer studies have explored youths' participation in climate change action, either in relation to, or independent of their education (Lester et al., 2006; Malone, 2013; Percy-Smith & Burns, 2013; Roth & Lee, 2004). A common theme in this small literature is the significance of early environmental experiences and opportunities for action that spur youths' sustained involvement (Arnold et al., 2009; Buttigieg & Pace, 2013; Fisher, 2016).

In many ways, theorizing and research on youth engagement with climate change is a nascent field, particularly beyond climate pedagogy and among pre-teen youth (Corner et al., 2015). However, existing studies illuminate valuable methods and practices to meaningfully engage youth in climate change education and action. For example, by employing emancipatory educational techniques and youth-centered research methods (e.g., participatory action), it is

possible to conduct research exploring youth climate change engagement, while empowering their sense of agency to make a difference (Chadborn, Gavin, Springett, & Robinson, 2013; Dittmer & Riemer, 2013; Haynes & Tanner, 2015; Stratford & Low, 2013). Following these examples, the present study explored how youth were affected by their active engagement with climate change through an after-school program that sought to advance youth potential as critical actors towards sustainability within their families and communities.

### 1.5 Purpose and Research Questions

The purpose of this dissertation was to gain insight into youths' perspectives and actions on climate change following a fifteen-week after-school program called *Science, Camera, Action!* (SCA). SCA, an original program developed for this research, combined interactive climate change education with youth-led action projects using photovoice methodology. Beyond aiming to expand youths' climate change knowledge and enhance their pro-environmental attitudes and behaviors, SCA was intended to empower youth agency through collaborative action projects and to strengthen their science engagement through hands-on activities. In light of these program goals, this mixed-methods summative evaluation study was designed to address the following research questions:

1. What are the impacts of SCA on youth participants' climate change knowledge, attitudes, and behaviors?
2. How does participation in SCA serve to empower youth agency?
3. What are the impacts of SCA on youth participants' science engagement?

In the next chapter, I review the literature relevant to the intersection of youth and climate change education and action. Three primary topics are explored, including: dominant constructions of youth in society, youth-focused climate change education, and youth participation in climate change action. Following this focused review, I outline relevant gaps in

the psychological literature on climate change to date, describe the present study's contributions to expanding psychological theory and application in relation to this complex global problem, and elaborate on the theoretical frameworks that have shaped SCA program content and research methods.

In the third chapter, I provide an overview of the methods chosen for this research. This chapter begins with a summary of definitions for terms used in this research and continues with a description of the community partnership upon which this research is based, the climate and educational policy context in which this research is situated, and my own perspectives and experiences in relation to the focus of this study. Finally, I summarize SCA program content, procedures, and goals, before turning to a detailed overview of this study's data collection and analysis procedures.

This dissertation's fourth chapter begins with an overview of program implementation and youth participation, followed by a brief description of youth-led action projects. The bulk of this chapter is dedicated to findings stemming from this study's two primary forms of data collection and analysis. First, quantitative results are presented in relation to this study's use of survey methodology. Survey analyses begin to address each of this study's research questions. The final section of chapter four presents qualitative findings from this study's use of focus group methodology. In addressing each of this study's research questions, thematic analyses of focus group discussions serve to both clarify and expand on survey findings.

In this dissertation's fifth and final chapter, I offer a summary and synthesis of evaluation findings, which are later embedded within the broader literature on youth climate change engagement. After emphasizing and qualifying key findings from this study, I offer a critique of the present research by outlining a number of limitations to this study's design, methods, and findings. In response to this study's limitations, I present plans and directions for future research

to further understand and promote youth climate change engagement. Finally, this dissertation ends by emphasizing the significance of the research conducted in light of major societal challenges anticipated under a changing climate, with children as its key stakeholders.

# CHAPTER 2: LITERATURE REVIEW

The participation of social scientists in the study of climate change has increased steadily over the past twenty years (Clayton et al., 2016; Shove, 2010). This research recognizes that global climate change is not only an "environmental problem," but an indictment of social systems and collective human actions (Koger, 2013). The causes and consequences of climate change—as well as its solutions—are profoundly social and psychological. Addressing climate change necessarily involves multi-disciplinary efforts, and requires attention to all aspects of society as a means to understand and engage entire communities (Reser & Swim, 2011). Despite a landscape of increasingly integrated and inclusive climate change research agendas (Clayton et al., 2016), the perspectives and actions of children and youth—particularly as agents of sustainable change within their families and communities—are often overlooked.

In the following sections, I review the interdisciplinary research literature relevant to youth and climate change. I first explore dominant constructions of childhood and youth in Western societies, a framework that simultaneously provides insight into youths' under-engagement in climate change education and action, as well as the limited social science literature investigating these topics. Next, I provide a brief review of the most developed body of scholarship linking youth with climate change, which concerns the pedagogy of climate change and environmental sustainability. It is in this literature where most psychological studies of youth and climate change reside, including investigations of youth climate change knowledge, attitudes, and behaviors. I next review the relatively smaller literature on youth engagement in climate change action, in both institutional (e.g., formal policy negotiations) and extra-institutional (e.g., activist) contexts. Finally, I summarize a number of critiques of psychological approaches to climate change research to date (e.g., lifestyle and choice framework; adult-focus),

before turning to an overview of theoretical frameworks that have guided the formation of the present research.

## 2.1 Constructions of Childhood and Youth in Society

Dominant constructions of youth[1] in society, including "children as innocent" and "children as becoming," regard early life as fundamentally a period of preparation and socialization leading toward the full citizenship of adulthood (Durand & Lykes, 2006; Kellett, Robinson, & Burr, 2004). Such images of childhood in primarily Western societies, including the U.S., render adult-youth relations as inherently paternalistic, whereby youth are often neither consulted nor invited to participate in civil society (Langhout & Thomas, 2010; Mitra, Serriere, & Kirshner, 2014). This state of affairs inevitably leaves children and youth without a voice in important matters that impact their lives.

### *2.1.1 Implications for Youth Climate Change Education*

In the context of climate change, culturally-entrenched narratives of childhood innocence and vulnerability fuel opposition to teaching climate change in the formal U.S. classroom (Schreiner et al., 2005; Tanner & Seballos, 2012). From this perspective, the scientific and social dimensions of climate change are viewed as threatening topics, which necessarily violate the adult mandate of protecting children from harm (Nicholls & Whitehouse, 2013; Satchwell, 2013). Further fueling this opposition is the controversial nature of climate change as a politicized issue (Nisbet & Fahy, 2015), which largely divides U.S. adults along major political party lines (Jacquet, Dietrich, & Jost, 2014; Schuldt, Roh, & Schwarz, 2015). From this

[1] Given that age-based categories are not fixed across time and space, there is no universally agreed-upon age range associated with 'youth' (Corner et al., 2015; Fisher, 2016). However, for the purpose of clarity in this literature review, I define youth as under age 18. Although 'childhood' and 'youth' are often treated as distinct categories, whereby youth is a more inclusive term with regard to age, the present literature review uses the terms interchangeably with reference to dominant narratives, while maintaining the original language of cited sources.

perspective, claims of a different nature are made, this time regarding children's competence rather than their vulnerability. Specifically, perceptions of children as "adults in waiting" means they are not yet prepared for participation in the political sphere (Wyness et al., 2004). Hence, 'political' topics are unsuitable for the classroom.

A recent nationally-representative study of U.S. science educators found that many are under-informed and poorly-trained to teach about climate change, spend little time (i.e., approximately one to two hours) on the subject, and often send "mixed messages" (e.g., regarding the soundness of the science; scientific consensus) to students (Plutzer et al., 2016). By most accounts, ideological opposition to youth climate change education has 'succeeded,' either by limiting youths' exposure or by providing a (perhaps comforting) sense of uncertainty.

In advocating for forms of environmental education that develop youths' sense of "collective competence" through the promotion of youth engagement in collective political action, Chawla and Cushing (2007) have argued that:

> Engaging young people in democratic processes… means enabling them to come to their own decisions based on the information they gather and the discussions they share. It means helping them to seek the common good despite gaps in knowledge and diversity in perspectives, acknowledging that their decisions need to be responsive to consequences and open to revision. Defending young people's right to navigate these processes is equivalent to defending the role of schools to prepare students for authentic democratic citizenship. (p.448)

From their perspective, educational efforts—particularly those taking place with adolescents and older youth—should not shy away from the political dimensions of the issue. Rather, pursuing a political model of environmental education, and thereby cultivating youths' collective competence to address the issue, is both warranted and necessary.

*2.1.2 Implications for Youth Climate Change Agency and Action*

Within the climate change literature, children are most often characterized as potential victims of policy inaction and climate impacts (Coyle & Van Susteren, 2012). Emphases on

children's psychosocial and health vulnerabilities tend to undermine a view of children as agents of change within their families and communities (Mitchell, Haynes, Hall, Choong, & Oven, 2008; Tanner & Seballos, 2012; Voelker, 2009). Consequently, children's views and actions are seldom taken into account in climate-related policies and programs. Rather, the protection of children's present livelihoods and future well-being become the rhetoric of policy decisions made on their behalf.

In advocating for a child-centered approach to confronting climate impacts, Tanner and Seballos (2012) call for "greater resources [to] be channelled towards empowering children's agency, including enhanced efforts to incorporate children's perspectives, knowledge, and potential for action into community-driven development programmes" (p. 59). According to them, involving youth in research is a critical component in such efforts, not only to enhance the quality of data used to inform climate policies and plans, but also to "empower children to take actions that relate to their future lives" (p. 60). However, academic pursuits—within and beyond climate change scholarship—rarely pursue research 'with' children (Kellett, 2010).

*2.1.3 Implications for Climate Change Research with Youth*

Culturally-entrenched constructions of children and youth inevitably influence social science research agendas and methods. In particular, dominant narratives of childhood often give rise to investigations 'about' youth, as objects rather than agents, or 'on behalf' of youth, as passive recipients rather than active participants. At best, such research serves to perpetuate prevailing notions of youth. At worst, scholarly efforts mischaracterize youth potential. As articulated by psychologists Christens and Peterson (2012), "It is not unusual for scholarship on youth to account only for the impacts of social and political issues on young people, neglecting the reality that youth are often active participants in the sociopolitical domain" (p. 623). Transcending these critiques, however, is the challenging reality that children's perspectives and

actions are often overlooked altogether in the climate change psychology literature (for exceptions, see Dittmer & Riemer, 2013; Fisher, 2016), where efforts to theorize climate-related attitudes and behaviors have taken place almost exclusively with adult samples.

## 2.2 Youth and Climate Change Education

Given the pervasive view of childhood as a life stage defined by preparation and development, it is perhaps not surprising that the most extensive literature concerning youth and climate change is the education literature. While the majority of these studies focus on expanding students' climate change knowledge, others explore the impact of educational programming on children's climate change-relevant attitudes, skills, and behaviors. In this section, I review educational studies about youth climate change engagement, emphasizing the impacts of educational programs beyond supporting youths' knowledge. Finally, I review dimensions of school-based educational programming that pose barriers to youths' active engagement.

### *2.2.1 Climate Change Educational Impacts*

The literature on youth climate change education primarily investigates the impact of educational programming on youths' knowledge. These studies typically focus on pedagogical strategies, students' content-related (mis)conceptions, and students' learning outcomes related to a number of topics, namely: the climate system, including the carbon cycle and the greenhouse effect (Bofferding & Kloser, 2015; Dawson, 2015; Niebert & Gropengießer, 2014; Porter et al., 2012; Pruneau et al., 2003; Shepardson, Niyogi, Choi, & Charusombat, 2009; Shepardson et al., 2014; Visintainer & Linn, 2015), human impacts on climate change (Porter et al., 2012; Pruneau et al., 2003; Visintainer & Linn, 2015), diverse consequences of climate change (Pruneau et al., 2003; Shepardson et al., 2009), and climate change mitigation and adaptation strategies (Bofferding & Kloser, 2015; Pruneau et al., 2003; Visintainer & Linn, 2015). The majority of these studies have taken place with middle to high school students, and—given their focus on

climate change learning outcomes—have implications for curriculum development and effective teaching (e.g., Spellman, 2015).

A critique of climate change education as a mechanism for youths' meaningful engagement is that "educational programs assume that making sense of climate change is the crucial first step to changing behaviour, [insofar as they] embody the notion that responses to climate change are dependent on knowledge" (Satchwell, 2013, p. 299). As in other life domains, climate change knowledge does not necessarily translate into personal connection or action (Chawla, 2009). Few educational studies articulate explicit aims to connect climate change topics to students' own lives (Pruneau et al., 2003; Visintainer & Linn, 2015).

Facilitating youths' understanding of the connections between climate change concepts and issues beyond the classroom is necessary for attitude and behavior change (Littledyke, 2008). Research has shown that, when science topics are treated as parts of youths' everyday real-world experience rather than merely school subjects, science, environmental, and health issues take on expanded meaning and significance, which can inspire their increased engagement (Faria, Freire, Baptista, & Galvão, 2014; Sadler, 2009). For example, when students are encouraged to consider climate change topics in relation to their own lives, their concern for the environment grows (Karpudewan et al., 2015). In a study by Stapleton (2015), teens' environmental identity development was supported through interacting with people directly affected by climate change.

Research exploring children's engagement with socio-scientific issues[2] (SSIs) has demonstrated that primary school students are willing and able to meaningfully participate in

[2] Socio-scientific issues (SSIs) are conceptualized as "factually and ethically complex and controversial issues of modern science … [with potential solutions that] typically involve diverse social, political, economic as well as value considerations" (Sakchewski, Eggert, Schneider, & Bögeholz, 2014, p. 2293). According to Bencze and colleagues (2012), SSIs share a similar meaning with science, technology, and society (STS) issues.

purposeful science-based discussions around complex, real-world issues (Naylor, Keogh, & Downing, 2007; Sadler, Barab, & Scott, 2007), including on climate change. In a recent study by Byrne and colleagues (2014), when provided the opportunity to engage with the environmental and social dimensions of climate change, nine- and ten-year-olds were able to discuss and negotiate this SSI by positioning themselves as active contributors to society, using their life experiences and limited knowledge to make sense of how the issue impacts their everyday lives. Less is known about whether and how young students (e.g., pre-teens) incorporate their climate change knowledge into practices beyond the classroom (Satchwell, 2013).

There is some evidence to suggest that increased knowledge and connection to climate change can lead to youths' increased motivation and willingness to engage in pro-environmental behaviors (Dittmer & Riemer, 2013; Rodríguez et al., 2011; Stevenson et al., 2014) as well as their greater efficacy to do so (Lin, 2016). For example, immersive educational experiences have led adolescents to improve their environmentally-significant behaviors (Blythe & Harré, 2012; Stapleton, 2015). In a recent study by Walsh and colleagues (2015), high school seniors reported high levels of personal agency and commitment to modifying their energy-intensive behaviors after learning about climate change in Earth Science class. However, few studies have explored how younger (i.e., elementary school) students connect with climate change (Byrne et al., 2014), or seek to account for potential supports or challenges to their agency (Satchwell, 2013).

### *2.2.2 Benefits of Youth Climate Change Engagement*

The educational literature on youth and climate change has described a number of benefits to youth from engaging creatively and meaningfully with climate change topics. First, evidence shows that engaging primary and secondary school students in critical discussion of SSIs, including climate change, can improve their reasoning and discussion skills (Naylor et al., 2007; Sadler et al., 2007; Sakchewski et al., 2014). In particular, Byrne et al. (2014) found that

diverse cultural norms and values among youth resulted in conflicting viewpoints, rather than consensus, which provided richer and more productive climate change discussions. Further, tensions and dilemmas that arose in the classroom promoted increased engagement and stimulated creative and diverse problem-solving (see also Clark & Button, 2011). As the authors note, such skills are valuable in a variety of contexts, within and beyond school settings.

Development of transferable skills is also characteristic of climate change education that fosters youths' systems thinking and critical thinking, which are useful competencies in countless other domains of learning and life (Dittmer & Riemer, 2013; Warren, Archambault, & Foley, 2015). After engaging in critical consciousness workshops as part of an environmental education program, Dittmer and Reimer (2013) found that youth engaged in reflective and empathic thinking, which demonstrated their capacity to engage with multiple dimensions of the problem (e.g., environmental and social justice). Sustainability-oriented education[3] aims to cultivate youths' 'futures thinking,' by encouraging learners to consider the multiple outcomes of their own decisions and actions, and to visualize and reflect upon the potential elements that make up their own future lives. In this way, teaching climate change as grounded in youths' lived realities has the potential to inspire them in the realization that they wield the power to modify their future (Pruneau et al., 2003; Warren et al., 2015).

*2.2.3 Challenges of School-based Climate Change Education*

School-based climate change education has a number of limitations concerning youth engagement, particularly for younger students. For example, in the U.S., climate change

[3] Sustainability education is not synonymous with climate change education, but rather is considered "a change of educational culture, one which develops and embodies the theory and practice of sustainability in a way which is critically aware. It is therefore a transformative paradigm which values, sustains and realises human potential in relation to the need to attain and sustain social, economic and ecological well being, recognising that they must be part of the same dynamic" (Sterling, 2001, p. 22).

education is not a requirement in most states, which leaves many educators without a standardized curriculum and many young people without a formal mechanism for gaining climate change knowledge (Goldberg, 2013; Plutzer et al., 2016). Moreover, for those regions requiring it, substantive climate change content is recommended for use with middle to high school students, despite evidence to suggest that upper elementary is a more appropriate age at which to introduce climate change topics (Ojala, 2012a). For example, younger students are typically more receptive to learning about climate change in the classroom by interpreting scientific information relatively independently from ideological constraints, which may otherwise pose interference due to conflicting worldviews (Stevenson et al., 2014).

A further critique is that "the traditional, science-oriented approach," most characteristic of climate change education offered within school settings, "[leads] to knowledge about the existence of environmental problems, about their scope and size, but still not … to action competence" (Jensen & Schnack, 2006, p. 480). That is, rigid school-based policies can prevent educators from facilitating youths' deeper engagement (Satchwell, 2013). In light of these and other limitations of formal educational contexts, informal settings have taken on great significance in strengthening youth engagement with climate change and environmental sustainability.

*2.2.4 Climate Change Education in Informal Settings*

Beyond the classroom, successful science learning outcomes are commonly attributed to increased flexibility (e.g., of content, level of participation), connection of science concepts to concrete, real-world issues, and youths' exposure to science careers that stimulate STEM interest and engagement (Birmingham & Barton, 2014; Blythe & Harré, 2012; Hall, Howard, Easley, & Halfhide, 2013). Moreover, informal educational spaces have shown greater potential in engaging youth in informed action related to climate change. According to Birmingham and

Barton (2014), informal educational opportunities provide expanded learning opportunities that:

> …transcend the canonical view of science literacy and enter areas of motivation and social action through experiences with science in the informal sector. This is a view of learning science that incorporates both *knowing* and *doing*, which values different aspects of participation, ways of knowing, and intended outcomes. These experiences allow learners to take on identities that otherwise may not be available to them through traditional normative science education. (p. 310-311, [emphases added])

Taking action on learned concepts is key to youth agency and empowerment in the context of climate change (Riemer, Lynes, & Hickman, 2014). In addition to supporting youths' knowledge and pro-environmental attitudes, climate change education in informal (e.g., extra-curricular, program, faith-based) settings has shown greater potential for developing youths' sense of self-efficacy and action competence (Blythe & Harré, 2012; Stapleton, 2015). In the next section, I review youths' engagement in climate change action, within and beyond educational settings.

### 2.3 Youth and Climate Change Action

Compared with the literature on youth climate change education, research exploring youths' participation in climate change action[4] is limited. However, there is substantial evidence to suggest that youth engagement in climate change action is growing, both in institutional (i.e., educational, policymaking) and extra-institutional (i.e., activist, community) contexts. In this section, I summarize the diverse spaces where youths' active engagement is taking place, and the corresponding interdisciplinary scholarship investigating youths' experiences.

[4] Following Jensen and Schnack (2006), in this study, the term 'action' refers to activities that are intentional or consciously undertaken with reference to a problem—in this case, climate change. Guided by motives and reasons, actions are most often targeted at solutions. Given that climate change is a multifaceted phenomenon, it is difficult to categorically define which actions constitute climate action. As articulated by Fisher (2016), "other environmental and social issues are intimately connected to climate change, so an action targeting another issue may also have implications for addressing climate change…[However], climate change must also be considered as a distinct phenomenon from other environmental and social issues because of its ecological and political uniqueness and complexity" (p. 2). While recognizing that climate change is a complex global phenomenon requiring diverse responses at varied sites and scales (Rootes, Zito, & Barry, 2012), the present literature review is focused on youths' actions addressing climate change, as explicitly stated by cited sources' authors.

### *2.3.1 Climate Change Education for Action*

A number of educational programs have sought to engage youth in various forms of climate change action related to their education. Recognizing that knowledge about climate change does not necessarily translate into caring about, or taking action on the issue (Jensen & Schnak, 2006), these educational initiatives have sought to move "from *transmissive* towards *transformative* learning" (p. 3), and typically take place outside the formal classroom (Percy-Smith & Burns, 2013). Climate change-related educational initiatives that seek to engage the 'whole person' by emphasizing knowledge, values, and action have been advocated under a variety of terms, including environmental education for empowerment (Palmer, 1998), science education for action (Hodson, 2003; Jenkins, 1994), and education for sustainability (Singleton, 2015).

A primary goal of action-based educational initiatives is to empower youth as agents of change within their families and communities. In the context of climate change, youth who are "environmentally empowered" are confident in their own abilities to "make a difference in the world, both by daily, personal choices related to lifestyle and by influencing [others]" (Schreiner et al., 2005, p. 8). Research emphasizing the potential role of young people as agents or catalysts of change in their families and communities often points to the efficacy of intergenerational influence as a means for youths' active, influential, and critical position in the transformation of their environments (Ballantyne et al., 1998; Percy-Smith & Burns, 2013). More generally, youth who are empowered by their engagement with climate change feel capable of taking action to minimize harms.

Studies of youth action emphasize that when youth are given opportunities to explore their voice and communicate their concerns, they can develop competencies often linked to empowering, participatory outcomes (Checkoway & Richards-Shuster, 2003; Foster-Fishman,

Nowell, Deacon, & Nievar, 2005; Malone, 2013; Roth & Lee, 2004). For example, in a study by Johnson and colleagues (2013), after participating in a youth development program "designed to increase knowledge and capacity for leadership and action in response to climate change" (p. 29), Ugandan youth reported increased self-efficacy, social and political awareness, commitment to civic action, and leadership.

### *2.3.2 Youth Climate Change Action through Policies and Programs*

Outside the educational realm, youths' involvement in climate change decision-making and action has been increasingly supported by programs and organizations recognizing the key role of youth in understanding and addressing climate change. For example, since 2008, the United Nations Joint Framework Initiative on Children (UNCYCC, 2013) has coordinated efforts by sixteen intergovernmental entities and numerous youth-led and youth-focused organizations to "empower youth to take adaptation and mitigation actions and enhance effective participation of youth in climate change policy decision-making processes" (p. 1). In 2009, the United Nations Framework Convention on Climate Change (UNFCCC) extended constituency status to youth-based non-governmental organizations, allowing youth to fully participate (e.g., request speaking slots) in conferences.

In efforts to support youth engagement in mitigation and adaptation, the Food and Agriculture Organization (FAO), Girl Scouts, and the UN Global Alliance collaborated in the creation of the "Climate Change Challenge" badge, which has been earned by more than ten thousand youth. These programs are intended to empower youth agency in the context of climate change by promoting youths' active participation (Keenan, 2010). However, there do not appear to be published research articles or publicly-available evaluation reports of the efficacy of these initiatives.

### *2.3.3 Youth Activism and Community-based Climate Change Action*

Outside of structured contexts, youth participation in climate change activism, as well as in community-based climate action, has grown in recent years. Studies with young climate activists tend to highlight the significance of youths' early environmental experiences, peer and family influences, and access to resources and opportunities that support their sustained engagement (Arnold et al., 2009; Buttigieg & Pace, 2013; Fisher, 2016). Studies of youth activism offer insight into the motivations of young people for their climate change engagement. Specifically, Fisher (2016) found that concerns for nature, social justice, or both spurred youths' climate activism. Interestingly, Arnold and colleagues (2009) found that formal educational contexts were at times perceived by young climate activists as "stifling" or "irrelevant," although extra-curricular school opportunities, camps, and youth groups could promote their engagement (p. 3). These studies provide important insights about climate change activism from primarily teenage (i.e., high school age) and older youth. No studies of sociopolitical climate change activism have taken place with younger actors.

Youth participation in climate change action extends to the involvement of young people in disaster risk reduction and recovery in community contexts. Recent research in this area has taken steps to shift the focus away from children as the passive victims of climate change and disasters, and towards advancing the role of children as active participants capable of minimizing harms. According to Tanner and colleagues (2009), "Disaster preparedness, response and adaptation strategies need to be both child-centred and child-led" (p. 5). This literature urges the increased participation of children in climate change adaptation efforts, disaster risk reduction, and emergencies and rehabilitation efforts following disasters. Findings from this research suggest that "children are effective risk communicators and agents of social change within their

households and their immediate communities" (Tanner et al., 2009, p. 15; see also Mitchell et al., 2008; Tanner, 2010).

## 2.4 Psychological Approaches to Climate Change Engagement: What's Missing?

The social psychology of climate change is a rapidly developing field with much room to grow and expand (Clayton et al., 2016). In the following sections, I briefly review two significant trends in the social psychology of climate change, which together have informed the development of the present research. Specifically, these trends include the literature's disproportionate focus on: (1) Individual, private behaviors; and (2) Adult perceptions and action.

### *2.4.1 Climate Change Behavior in the Public Sphere*

An important critique of the social psychology of climate change is that the specific behaviors and actions investigated and, in essence, advocated by the field are typically those that fall under the umbrella of individual lifestyle and consumer choices (Stern, 2000). More specifically, psychology research has tended to focus on private behaviors rather than on publicly-directed behaviors or forms of collective action aimed at broader social change, such as climate change activism or policy advocacy (Fielding et al., 2014; Mazur, 2011; Rees & Bamberg, 2014). This focus on personal volitional behavior change has been criticized as the "ABC approach" (i.e., attitudes, behaviors, choices), which is thought to contribute to a rhetoric of individual responsibility for addressing climate change (Scheele & Papazu, 2015; Shove, 2010). As articulated by Shove (2010):

> The popularity of the ABC framework is an indication of the extent to which responsibility for responding to climate change is thought to lie with individuals whose behavioural choices will make the difference. (p. 1274)

A limitation of research on small, specific behavior changes is that its implications fall short of the level of transformative change necessary to prevent the worst effects of climate change.

Further, there is evidence to suggest that engaging in minor behavioral changes, by reducing actors' guilt, "may serve to defer, or even undermine, prospects for the more far-reaching and systemic behavioral changes that are needed" (World Wildlife Fund [WWF], 2008, p. 5).

As a means to shed light on the most efficient methods for promoting environmental action by children and youth, Chawla and Cushing (2007) advocated the pursuit of *strategic environmental behavior*, or actions that represent the most adequate response to environmental degradation. Educational efforts that encompass behavior change objectives most often promote youth environmental action in the "private sphere" (e.g., saving electricity), rather than in the "public sphere" (e.g., collective action) (Stern, 2000). Their review article contends that although individual, small-scale behavior changes are a significant factor in developing a sense of personal competence—especially in younger children—adolescents and older youth must also gain a sense of collective competence as citizens whose collective actions are relevant to the health of the environment. As Chawla and Cushing (2007) put it, "behaviors with the largest potential benefits for the environment require political engagement" (p. 437). In this light, they contend that both individual and collective senses of competence are important:

> …Because people are more likely to get engaged politically if they have a personal sense of competence and a belief in their collective competence (their ability to achieve goals working together with a group). (p. 440)

Moreover, the 2015 Climate Education and Literacy Initiative set forth by the White House Office of Science and Technology Policy (OSTP) endorses the view that collaborative climate change action will be central to achieving emissions reductions targets over the coming decades. In reference to achieving goals set by the twenty-first meeting of Council of Parties (COP 21) in Paris, the White House stated:

> Ensuring that the outcomes of COP 21 are lasting and effective will require the support of a public that understands the fundamentals of the changing climate and *what can be done*

> *through collective action* to mitigate and prepare for climate change. (para. 3, [emphasis added])

Thus, in examining climate change perspectives and action—by adults as well as youth—social psychological research should begin to expand its repertoire of 'what counts' under the banner of pro-environmental behavior.

### *2.4.2 Youth Perspectives on Climate Change*

Another limitation of psychology research on climate change is that very few studies have sought to understand the climate change attitudes and behaviors of children and youth. Further, those that exist appear to have less impact compared to climate change studies with adult samples. Evidence of the field's inattention to—or little regard for—youth-focused studies is apparent in both the quantity and categorization of relevant publications. More specifically, studies of youth climate change engagement rarely appear in mainstream social psychology journals (for exceptions, see Blythe & Harré, 2012; Johnson, Johnson-Pynn, Lugumya, Kityo, & Drescher, 2013), and most are published as contributions to environmental education, rather than social or developmental psychological theory or application. This tends to be the case even for youth-focused psychology studies investigating climate change attitudes and behaviors (Dijkstra & Goedhart, 2012), emotional coping (Ojala, 2012a; 2012b) and life trajectories of climate change activism (Fisher, 2016). Exceptions include community and ecopsychology publications, which appear more likely to feature youth-based research studies relevant to climate change topics (e.g., Blythe & Harré, 2012; Dittmer & Riemer, 2013).

This relegation of youth-focused studies to specialty journals contrasts sharply with psychological research of climate change engagement among adult (Zaval, Markowitz, & Weber, 2015), college student (e.g., Masson & Fritsche, 2014), and age-unspecified (e.g., Feinberg & Willer, 2010) samples, which appear in mainstream and flagship journals in psychology and its

sub-disciplines. In contrast, high-impact interdisciplinary climate change journals have published psychology research with adult (e.g., Broomell, Budescu, & Por, 2015; Devine-Wright, Price, & Leviston, 2015; Whitmarsh, 2011) as well as youth participants (e.g., MacDonald et al., 2013; Markowitz, 2012). To more fully understand how individuals navigate the issue of climate change, as well as to strengthen youth agency and community resilience, greater attention and higher regard for youth perspectives is warranted.

## 2.5 Guiding Theoretical Frameworks

Given its scientific, environmental, economic, and social dimensions, the challenges of climate change are inherently interdisciplinary, as are the means to address them. The present research draws from theories and practices that span multiple disciplines—including psychology, sociology, education, and ecology—towards the development, implementation, and evaluation of SCA, a program designed for this research that combines climate change education with participatory action through photovoice. In the following sections, I outline several theoretical frameworks that guided the formation of the program and present research.

### *2.5.1 Participatory Action Research*

The present research draws on the principles and practices of action research (Lewin, 1946), also sometimes referred to as engaged research, in the sense that this project aims to "[address] practical concerns and [enrich] theory while identifying points of intersection between research, policy, and practice" (Maruyama & Ryan, 2014a, p. 83). More specifically, the present research incorporates elements of participatory action research (PAR), which is committed to collaboration with community members throughout the research process.

> Cycles of a PAR project may engage participants in any or all of the following: helping to formulate the problem definition, assessing the problem, determining an intervention, implementing the intervention, and assessing the intervention. Multiple methods are often used with PAR, including surveys, focus groups, interviews, Photovoice projects, observations, and community mapping. (Langhout & Thomas, 2010, p. 61)

PAR is both a theoretical standpoint and collaborative methodology that is designed to ensure a voice for those who are affected most by a research project (Nelson, Ochocka, Griffin, & Lord, 1998). As such, the process serves to co-construct and democratize knowledge and reduce power hierarchies (Grace & Langhout, 2014; Nygreen, 2009-2010). Often, PAR is oriented towards bringing about social change (Maruyama & Ryan, 2014a).

The present research is further guided by an understanding of PAR as involving researchers and participants working collaboratively to investigate a problematic situation or action in order to improve conditions (Kindon, Pain, & Kesby, 2007; McIntyre, 2008), and the notion that in pursuing such investigations, "the point is to change the world, not only study it" (Maguire, 2001). Although researchers often seek to engage adults and older youth in the PAR process, few—particularly U.S.—PAR-based studies have incorporated youth as social actors, change agents, collaborators, or co-researchers (Langhout & Thomas, 2010). Given that PAR methods are understood to be more successful (i.e., in terms of intervention effectiveness and validity) when all stakeholders are involved, the inclusion of youth is necessary where the focus of the research is an issue that impacts them. Using the theoretical framework of PAR with children has the potential to strengthen research findings, interventions, and social action.

A related field, influential to the present study, is the sociology of childhood or childhood studies, which has raised important questions about how children are viewed within many communities, especially Western societies (Rasmussen & Smidt, 2003). The primary critique within this field is that by viewing children and youth as "adults in waiting," they are excluded from playing an active role in decisions that affect them. Adopting an empowerment perspective in youth-based PAR methods challenges the researcher to "listen to children's perspectives and view children as experts in their own lives" (Langhout & Thomas, 2010, p. 61).

*2.5.2 Photovoice: Bridging Science Learning with Participatory Action*

A PAR method with the potential to engage youth in meaningful climate change education and action is photovoice. Photovoice methodology is based on several theoretical perspectives, including empowerment theory, feminist theory, and documentary photography (Wang & Burris, 1994; 1997). The main goals of photovoice methodology are to enable citizens to record and reflect community strengths and concerns, to promote critical and reflexive group dialogue on important issues using photographs, and to promote social change (Vaughan, 2014).

In brief, research facilitators of the photovoice technique ask participants to photograph images that convey their feelings about a topic. Subsequently, photovoice participants engage in group discussions about the content and meaning of their photographs. Finally, researchers and participants identify emerging themes revealed by the photovoice sessions and translate these themes into plans for action (e.g., communication with policymakers). In doing so, photovoice process "expands the forms of representation and the diversity of voices who help define, and improve, our social, political, and health realities" (Wang et al., 2004, p. 911).

Photovoice is a PAR strategy designed to understand participants' needs and perspectives, with the ultimate goal of empowering participants. Empowerment has been defined as a mechanism by which people, groups, and communities gain control over their affairs (Rappaport, 1987; Rappaport, 2000). As such, empowerment has been theorized at several levels of analysis (e.g., micro, macro), and continues to be a contested concept (Speer, 2000). At the psychological level, empowerment is conceptualized as a latent construct with intrapersonal, interactional, and behavioral components (Christens, 2011). Much of the empirical research on empowerment has focused on the intrapersonal component of psychological empowerment, which refers to self-perceptions of efficacy and control within the sociopolitical domain (Christens & Peterson, 2012). Photovoice methodology, in its focus on reaching policymakers

and initiating grassroots social change, aims to empower individuals in this way (Becker, Reiser, Lambert, & Covello, 2014). More generally, empowerment includes access to resources, access to knowledge, access to networks, and access to decisions. As we have seen, the literature on youth and climate change reveals that their under-engagement in educational contexts often leads to a lack of resources and knowledge, while their exclusion from the public life (e.g., the political sphere) impedes opportunities for participation in decision-making (e.g., voting). In short, youth are often disempowered in the context of climate change.

Photovoice is a useful methodology to engage children in particular, as the act of taking and explaining photographs gives them agency in the research process (Johnson, Pfister, & Vindrola-Padros, 2012; Quigley, Rodriguez, Cook, & Buck, 2010). Moreover, using PAR methods with children can be conceptualized as a form of "solidarity with" youth, rather than merely acting "for [their] empowerment" (Durand & Lykes, 2006). Although photovoice has traditionally been used as a research method, it has also been developed as a pedagogical technique (e.g., Schell, Ferguson, Hamoline, Shea, & Thomas-Maclean, 2009), connecting students to science and empowering them to make improvements to the environmental conditions of their communities. According to Cook and Quigley (2013):

> Applied as a pedagogical tool in science education, photovoice puts cameras into the hands of students in order to document and address scientific issues from their position and point-of-view. This technique offers students new and reflective ways to perceive their own world and the science around them, as well as the potential to generate change in their own community. (p. 340)

In science education, photovoice methodology has received increasing attention in recent years for engaging participants in a way that democratizes the research and learning process (Cook, 2015; Cook & Buck, 2010).

*2.5.3 Climate Change Education for Sustainability and Empowerment*

In the present study, educational program content is guided by a number of complementary theoretical frameworks, including climate education for empowerment (CfE) and education for sustainability (EfS). According to Schreiner and colleagues (2005), "climate education for empowerment involves fostering in young people an integrated understanding of the many aspects (scientific, ethical, political…) of the climate issue, hopeful visions of the future and a conviction that it lies in their power to shape the future" (p. 43). EfS is a transformative educational framework based on "principles of critical inquiry, empowerment, participation, democratic decision-making, [and] action-taking that supports sustainable living and aims for social change" (Davis, 2015, p. 18).

Specifically, the SCA program is framed by the "Head, Heart, and Hands" model of transformative EfS learning, which views knowledge as inextricably linked to action (Sipos, Battisti, & Grimm, 2008). In this framework, transformative sustainability learning takes place through transdisciplinary study ('Head'), that engages values ('Heart'), and is translated into behavior ('Hands') consistent with sustainability principles (Orr, 1992). Applications of this model have engaged youth in experiential and action-based learning, for example, through community gardening.

Sustainability, like empowerment, is a contested concept with ongoing debate in policy and academic circles regarding its definition (Atkinson & Wade, 2015). However, a commonly used definition comes from the World Commission on Environment and Development's (1987) Brundtland Report, also known as "Our Common Future," which describes sustainable development as that which "meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (p. 8). In alignment with the aforementioned guiding frameworks, the concept of sustainability itself "emphasizes the linkages

and interdependencies of the social, political, environmental, and economic dimensions of human capabilities" (Davis, 2015, p. 10).

Moreover, sustainability is commonly recognized as an issue of social justice, in that the causes and consequences of unsustainable living are unevenly distributed, and it is often the poorest nations and the poorest within nations who are most at risk (Bigelow & Swineheart, 2014). Engaging youth in sustainability therefore should involve an ecojustice perspective to education (Martusewicz, Edmundson, & Lupinacci, 2015). In contrast to federal and state policies that define the purpose of schooling in terms of the preparation for work and the need for the U.S. to be economically dominant on a worldwide scale, an ecojustice approach views education primarily as a means to:

> …develop citizens who can actively work toward a democratic and sustainable society, one that values cultural diversity for what it offers to community problem solving and for the essential role that biodiversity plays in the very possibility of living systems. (p. 22)

In combination with participatory methods, the present project takes an emancipatory approach to environmental education (Wals, Geerling-Eijff, Hubeek, van der Kroon, & Vader, 2008), which seeks to engage participants in active dialogue to cultivate their own objectives and plans for action (D'Amato & Krasny, 2011).

# CHAPTER 3: METHODOLOGY

## 3.1 Overview of Methodology

The purpose of the present study was to explore youths' perspectives and actions related to climate change by evaluating the impact of *Science, Camera, Action!* (SCA), an after-school program developed for this research, that aimed to facilitate youths' active engagement. Specifically, this summative evaluation was designed to address the following research questions:

1. What are the impacts of SCA on youth participants' climate change knowledge, attitudes, and behaviors?
2. How does participation in SCA serve to empower youth agency?
3. What are the impacts of SCA on youth participants' science engagement?

This evaluation used a combination of qualitative and quantitative methods to gain insight into the various ways that SCA influenced youth participants. In particular, data acquired using both survey and focus group methodology was used to address each research question. Findings will inform the development and implementation of future programs, interventions, and empirical investigations related to youth climate change perspectives and behavior.

This chapter defines the terms and details the methodologies used in this project, describes the community partner and program participants, and provides a brief overview of the climate change-relevant educational and policy context in the region where this study took place. Later, I reflect on my own positionality in relation to this research before turning to a detailed overview of SCA's program design, content, and goals. This chapter ends with a description of the present study's data collection and analysis procedures.

### 3.2 Summary of Definitions and Methods

This study's first research question concerned the impact of SCA on youths' climate change knowledge, attitudes, and behaviors before and after program participation. In this study, *climate change knowledge* was operationally defined as youths' understanding of the scientific and social dimensions of the causes and consequences of climate change, as well as potential ways of addressing climate change (e.g., through mitigation and adaptation), henceforth referred to as "solutions." Pre- and post-program surveys as well as focus group discussions were used to explore participants' climate change knowledge before and after program participation. While surveys allowed for direct comparisons on specific items of interest, focus groups were useful in exploring youths' general perceptions and sources of information about climate change prior to program participation. Further, focus groups allowed for a more general and holistic assessment of participants' climate change knowledge, providing insight into specific SCA content as it was absorbed and communicated by participants.

The first research question also explored the influence of SCA on youth participants' climate change-related attitudes. For the purposes of this study, *climate change attitudes* were considered those where the attitude object was climate change (e.g., attitudes towards the urgency of climate change), as well as those related to nature (e.g., connection with nature) and caring for the environment more generally (e.g., environmental responsibility). While survey analyses offered insight into shifts on pre-determined attitudes of interest, focus groups allowed more flexibility and generated complementary and, at times, unexpected information about SCA's attitudinal effects.

The impact of SCA on participants' climate change behaviors was an additional focus of this evaluation. *Climate change behaviors*, in this study, were defined as actions undertaken to address climate change. For example, decreasing one's energy (e.g., electricity) consumption,

where the energy source is a power plant burning fossil fuels (e.g., coil, oil, natural gas), would in turn reduce greenhouse gas emissions, which drive climate change. Climate change behaviors related to energy consumption extend to transportation use (e.g., walking, biking), water use (e.g., shorter showers), and waste management (e.g., recycling, composting) and production (e.g., reuse). Climate change behaviors also include carbon sequestration activities, such as planting trees, which absorb carbon dioxide (a greenhouse gas) from the atmosphere. Finally, climate change behaviors encompass awareness-raising activities, such as communicating to others about the issue and actions needed to address it.

To examine the impact of SCA on youths' climate change behaviors, two separate surveys were used in addition to focus group discussions. The first survey was this study's primary pre- and post-program survey. The second was a brief survey administered during the program, before and after a five-week energy-saving competition called the Carbon Footprint Contest. The global survey offered baseline and follow-up data examining youths' environmentally-significant behaviors before and after SCA, whereas the energy-saving survey allowed for the quantification and comparison of youths' specific climate change behaviors over a month-long period, in the metric of carbon emissions. Focus groups offered further insight into specific behavior changes as well as the impact of behavior changes on youth and their families.

This study's second research question assessed the effectiveness of SCA in empowering youths' sense of agency in the context of climate change. In this study, *sense of agency* is conceptualized as youths' belief in their own capacity to take informed action on climate change through a sense of ownership of the issue (Marcel, 2003). The subjective awareness of agency encompasses feelings of control over one's desires, plans, and actions (Lewis, 1990). In this way, youths' sense of agency is closely related to their perceived self-efficacy, or youths' belief in their own agentic capabilities or power to affect situations, complete tasks, or reach goals

(Bandura, 1977). The influence of SCA on youths' sense of agency was explored in post-program survey items and, in greater depth, during focus group discussions.

The final research question of this study concerned the impact of SCA on youths' science engagement. For the purposes of this study, *science engagement* was considered to encompass youths' attitudes and behaviors related to science. Science attitudes included the extent to which youth viewed science as interesting, appealing, and important in school, career, and societal contexts. A behavioral measure of science engagement included youths' science grades. Survey measures allowed for direct comparisons of youths' science attitudes and grades before and after their participation in SCA. Focus groups offered deeper insight into the influence of SCA on youths' global perceptions of science, perceived science competency, and school science participation. A more detailed overview of this study's data collection and analysis procedures are provided below (see *Data Collection and Analysis*).

### 3.3 Community Partner and Participants

The present study was carried out in partnership with three Boys and Girls Club (BGC) units in Larimer County, Colorado: Wellington, Fort Collins, and Loveland. The BGC is one of the longest-standing and largest community-based youth development organizations in the U.S., founded in 1860 and currently serving over four million youth annually across 4,200 Clubs in urban and rural areas, in public housing communities, and on Native lands (BGC, 2014). As a non-profit organization funded by government grants, corporate donations, and private philanthropy, the BGC offers out-of-school youth services year-round, with annual membership fees as low as five U.S. dollars (Anderson-Butcher, Newsome, & Ferrari, 2003). As an approximation of members' socio-economic status, 60% of BGC youth receive free or reduced-price school lunches, for which eligibility is based on federal poverty guidelines.

BGC core programming encompasses five focal areas (i.e., character/leadership, education/career, health/life skills, the arts, and sports/fitness/recreation), though the 'typical' Club experience is defined by 'unstructured, drop-in, recreational' activities (Anderson-Butcher et al., 2003, p. 52) and having fun with friends (Fredricks, Hackett, & Bregman, 2010). The mission of the BGC is "to enable all young people, especially those who need us most, to reach their full potential as productive, caring, responsible citizens" (BGC, 2014). The present study aimed to contribute to this mission by engaging the Larimer County BGC's ten- to twelve-year-old members in the SCA program.

Pairing climate change science education with photovoice methodology aligned with the BGC's STEAM-focused programming. STEAM stands for science, technology, engineering and mathematics (STEM) education, combined with the arts (A). Throughout the program, participants engaged with topics of global climate change (e.g., ecosystems; the greenhouse effect) and sustainable solutions (e.g., energy use; teamwork and leadership) as well as digital photography (i.e., photovoice), while being encouraged and assisted as they developed and implemented action plans in their families and communities. SCA was fully funded through a combination of small grants from the National Oceanic and Atmospheric Administration (NOAA) and two professional society divisions of the American Psychological Association: the Society for the Psychological Study of Social Issues (SPSSI, Division 9), and the Society for Community Research and Action (SCRA, Division 27).

Participants were recruited during BGC site visits, through flyers, and via letters to parents (see Appendix A). Participation was voluntary, and parental consent and youth assent were obtained for all interested youth. This study's methods and procedures were approved by the Institutional Review Board (IRB) of Colorado State University (CSU). Compensation for regular participation throughout the program was ownership of a digital camera.

A total of 59 youth participated in SCA, but four left the program prior to its completion. Group sizes varied widely by research site, with 9 participants in Wellington, 19 in Fort Collins, and 27 in Loveland (see Table 1). Participants were 55 youth, approximately half girls ($n$ = 29; 52.7%) and boys ($n$ = 26; 47.3%), ages 10 to 13 ($M_{age}$ =11.05) at the time of program completion[5]. Across research sites, 23 participants (41.8%) were age 10, 11 (20%) were age 11, 16 (29.1%) were age 12, and the remaining 5 (9.1%) had turned 13 by the end of the program. During SCA, participants were in the spring term of school grades four through seven, with 18 (32.7%) in fourth grade, 15 (27.3%) in fifth grade, 17 (30.9%) in sixth grade, and 5 (9.1%) in seventh grade. Participants attended 18 different schools in Larimer County, with 34 (61.8%) attending elementary school and 21 (38.2%) attending middle school.

More than half of participants were White/European American ($n$ = 31; 56.4%) and more than a quarter were Hispanic or Latino ($n$ = 14; 25.5%), followed by youth of multiple ethnicities ($n$ = 8; 14.6%) and Asian or Pacific Islander youth ($n$ = 2; 3.6%). Among participants indicating multiple ethnicities, the proportional representation of each was 56.1% White/European American, 28.8% Hispanic/Latino, 7.6% Asian or Pacific Islander, 4.5% American Indian or Alaska Native, and 3.0% African American. Overall, participants were more ethnically and racially diverse compared to Larimer County as a whole, which in 2015 consisted of 83.2% White residents, not of Hispanic origin, 11.2% Hispanic/Latino residents, and 5.6% residents with other (including multiple) ethnicities. In this study, the distribution of participant race/ethnicity roughly corresponded with 2015 Larimer County BGC membership, which was 58% White/European American, 24% Hispanic/Latino, 10% Multi-racial, 2% African American, and 6% other.

[5] All participants were between ages 10 and 12 during program recruitment.

Participants' family and socio-economic backgrounds varied widely. Based on 2015 federal poverty level guidelines, and drawing on family income and household occupant data from each participant, 24 youth (43.6%) were living below the poverty line. The same number (*n* = 24; 43.6%) were living in single parent households. Most participants (*n* = 34; 61.8%) were eligible for free or reduced price school lunches. It is unclear from BGC public reports the proportion of BGC membership living in poverty, though in 2015, 65% of Larimer County members were eligible for free or reduced price lunch—slightly more than in this study's sample, and 37% lived in single parent households—slightly less than in this study's sample. See Table 1 for participant demographic information by research site.

## 3.4 Local Policy Context

### *3.4.1 Climate Policy*

City governments have emerged as trailblazers of climate change adaptation and mitigation policies and practices (Betsill & Bulkeley, 2007). For decades, local municipalities have translated global rhetoric into local practice, in tangible pursuit of a sustainable future for the world's young people and generations to come. The unique power of cities in confronting climate change lies, first, in their capacity for attentiveness to place-based and context-specific opportunities and challenges, as well as in their potential to influence neighboring communities by serving as exemplars for effective alternatives (Bulkeley & Betsill, 2003).

In March of 2015, the Fort Collins, Colorado City Council unanimously approved a comprehensive Climate Action Plan (CAP), with goals to achieve net-zero carbon emissions by 2050, and to reach 80% carbon emissions reductions within the next fifteen years (by 2030). Such aggressive goals place Fort Collins on the world stage—alongside cities such as Melbourne and Copenhagen—as a leader in efforts to address climate change at the local level. Successful

implementation now relies upon public outreach, community education, and meaningful action by a diverse constituency, including youth. This project aimed to contribute to this need and to broaden regional potential by engaging youth from Fort Collins and two neighboring cities in climate change education and sustainable action. At present, neither Wellington nor Loveland have developed CAPs.

Table 1

*Socio-Demographic Characteristics by Research Site*

| | | Wellington ($n$ = 9) | | Fort Collins ($n$ = 19) | | Loveland ($n$ = 27) | | Total ($N$ = 55) | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristic | | Total | % | Total | % | Total | % | Total | % |
| Gender | Girls | 7 | 77.78 | 12 | 63.16 | 10 | 37.04 | 29 | 52.73 |
| | Boys | 2 | 22.22 | 7 | 36.84 | 17 | 62.96 | 26 | 47.27 |
| Age | 10 | 4 | 44.44 | 6 | 31.58 | 13 | 48.15 | 23 | 41.82 |
| | 11 | 1 | 11.11 | 3 | 15.79 | 7 | 25.93 | 11 | 20.00 |
| | 12 | 3 | 33.33 | 7 | 36.84 | 6 | 22.22 | 16 | 29.09 |
| | 13 | 1 | 11.11 | 3 | 15.79 | 1 | 3.70 | 5 | 9.09 |
| Average Age | | 11.11 years | | 11.37 years | | 10.81 years | | 11.05 years | |
| School Grade | 4 | 2 | 22.22 | 4 | 21.05 | 12 | 44.44 | 18 | 32.73 |
| | 5 | 2 | 22.22 | 7 | 36.84 | 6 | 22.22 | 15 | 27.27 |
| | 6 | 5 | 55.56 | 4 | 21.05 | 8 | 29.63 | 17 | 30.91 |
| | 7 | 0 | 0.00 | 4 | 21.05 | 1 | 3.70 | 5 | 9.09 |
| Race/Ethnicity | White | 3 | 33.33 | 9 | 47.37 | 19 | 70.37 | 31 | 56.36 |
| | Hispanic/Latino | 3 | 33.33 | 6 | 31.58 | 5 | 18.52 | 14 | 25.45 |
| | Multiple Ethnicities | 3 | 33.33 | 4 | 21.05 | 1 | 3.70 | 8 | 14.55 |
| | Other | 0 | 0.00 | 0 | 0.00 | 2 | 7.41 | 2 | 3.64 |
| Below Poverty Threshold | | 3 | 33.33 | 13 | 68.42 | 8 | 29.63 | 24 | 43.64 |
| Free/Reduced Price Lunch | | 4 | 44.44 | 17 | 89.47 | 13 | 48.15 | 34 | 61.82 |
| Single Parent Household | | 3 | 33.33 | 10 | 52.63 | 11 | 40.74 | 24 | 43.64 |

*3.4.2 Educational Policy*

The state of Colorado is among the majority of U.S. states not to require anthropogenic climate change to be taught in the classroom through adoption of the Next Generation Science Standards (Goldberg, 2013). Colorado's science educational standards are based on statewide grade-level expectations known as "Colorado Achievement Plan for Kids" or CAP4K (Colorado Department of Education [CDE], 2013). This plan calls for eighth grade teachers of Earth systems science to cover "inquiry questions" about climate change, such as, "What evidence supports and/or contradicts human influence on climate change?" and, "How has Earth's climate changed over time?" (CDE, 2009, p. 92). CAP4K does not prevent science teachers from emphasizing human causes or incorporating climate change concepts into their curriculum earlier (i.e., before 8th grade). In Fort Collins, city officials have encouraged climate change education in elementary through high school science classrooms. For example, the City of Fort Collins' 17th Annual Educator's Workshop, held in August of 2015, was themed "Climate Change in the Classroom" and aimed to motivate science educators to teach climate change by providing useful tools for doing so.

The BGC units of Larimer County that were this study's research sites span two school districts. Fort Collins and Wellington, Colorado reside within the boundaries of Poudre School District, and Loveland, Colorado is part of Thompson School District. Although climate change is not required course curriculum in either district, topics touched upon in SCA programming appear in state standards for students younger than those served by this program (e.g., 3rd grade standard: living systems' interaction with the biotic and abiotic environment), as well as SCA's target age group (e.g., 4th grade standard: interdependence between and among living and non-living components of ecosystems; 6th grade standard: environmental changes impact the survival of organisms, populations and entire species) (CDE, 2009). Therefore, it was anticipated that

most participants would have some familiarity with SCA topics prior to program participation. For younger participants, portions of SCA content prepared them for later grades' science standards. For older participants, program content supplemented current learning, and/or provided a review and novel application of their existing knowledge. For all participants, SCA introduced science topics (e.g., 8th grade: weather vs. climate) to be learned in later grades. SCA program content aligned with a number of the CDE's "21st Century Skills and Readiness Competencies in Science," including critical thinking and reasoning, information literacy, and collaboration.

### 3.5 Researcher Reflexivity

Growing up on the Gulf of Mexico and later the Great Lakes, I was very much raised to appreciate nature. By the age of ten, I aspired to one day become a naturalist. My concern for climate change grew rapidly as a graduate student, likely influenced by the climate science and love for the outdoors that seemed so much a part of my academic and social environments. An esteemed climate scientist and public climate change advocate was a committee member for my Master's thesis, which examined women's underrepresentation in his field. By the winter of 2014, I actively searched for ways to transform my academic pursuits to contribute to understanding and strengthening the social dimensions of addressing climate change. I attended public forums organized by the City of Fort Collins on updating their CAP, attended the first meeting of 350 in Fort Collins (a global organization for climate activism), and was present at the first convening of the League of Women Voters' Climate Interest Group.

My interest in engaging youth comes from many places, but perhaps most strongly from my own childhood. Seeing that children were very rarely part of the conversation in local advocacy groups or at the city level, I began to wonder why, and proceeded in the present direction. Prior to implementing SCA, I had little experience with children—my teaching

experience only at the post-secondary level—but due to my privileged identities as a young, White woman, I was readily welcomed into a community partnership with the local BGC and encouraged without hesitation by my academic mentors and peers. My embeddedness in the academic and local policy communities, even prior to program implementation, led to an invitation to speak at an Educator's Workshop, organized by the City of Fort Collins Utilities Department, on the importance of incorporating climate change content into school science curriculum. In these ways, my identities and relationships undoubtedly facilitated the development of my project.

For all of the reasons listed above, and likely more, my approach to my dissertation has not been value-free. My commitment to engaging youth, particularly those from underserved backgrounds, in understanding and taking action on climate change is a product of my commitment to environmental and social justice. In this way, I am drawn to Chein and colleagues' (1948) notion of collaborative research, "…a field which developed to satisfy the needs of the socio-political individual who recognizes that, in science, he [sic] can find the most reliable guide to effective action, and the needs of the scientist who wants his [sic] labors to be of maximal social utility as well as of theoretical significance" (p. 43). In conducting critical climate change research, I agree with White (2011) that such inquiry:

> … is not a socially neutral exercise but is inherently values-based and involves a series of vital ethical questions, especially as these pertain to matters of social power, political decision-making, and ecological well-being. (p. 18)

My research background in diversity in science education influenced SCA program content to include hands-on activities that bring science to life, embedding science concepts in real-world issues. My arts and qualitative methods backgrounds led to my choice of photovoice methodology, which was intended to encourage science-learning, engage participants, and combine the arts and sciences in a way that complemented BGC programming. Finally, my

perspective as an advocate for climate change policy and social justice issues more broadly influenced the research design. Specifically, this study's methods were selected to provide youth participants with agency and ownership of the project's process and outcomes.

In analyzing data yielded from this study, I have attempted to minimize bias and the impact of my personal values on study results, while recognizing that my personal experiences and perspectives have shaped the development of this project. In this way, I acknowledge my role in shaping the research process, while committing to rigorous and trustworthy data collection and analysis. Throughout the duration of the project, I regularly reflected on the ways in which my identities, experiences, and values have intersected with the program's participants and process. My choice of PAR methods was methodological as well as epistemological. In this sense, I sought to attend to issues of power and privilege, as well as how they may impact knowledge construction in collaboration with youth (Langhout & Thomas, 2010). Further, I compiled reflexivity notes and audio recordings before, during, and after the program to document my observations of participants, as well as to identify any preconceived notions and personal subjectivities that might influence data collection and analysis (Morrow, 2005). This documentation has served as an additional data source, and an added mechanism to triangulate key findings that have emerged from this study.

Finally, in designing, implementing, and evaluating SCA, the program had an indelible impact on me, both personally and professionally. In stepping into the role of educator, I sought and absorbed new knowledge about climate change throughout the duration of the program. In facilitating youths' collaborative action projects, I became more confident in my own role as an agent of change, while also becoming ever more assured of the critical role of youth as change agents. Finally, and perhaps most significantly, the energy and enthusiasm with which youth approached and addressed this global problem strengthened my resolve and gave me hope. In

other words, the numerous program impacts that I had intended for youth, in many and mostly unexpected ways, became my own experience.

### 3.6 *Science, Camera, Action!* Program Content and Procedures

*Science, Camera, Action!* (SCA) was developed by the author as a fifteen-week after-school program combining hands-on, interactive climate change education with photovoice methodology to empower youth as agents of sustainable change within their families and communities. The SCA program was designed to support youths' climate change knowledge through carefully-designed weekly science activities that were also intended to strengthen their engagement with science by enhancing youths' awareness of the value of science in addressing real-world issues. A primary aim of SCA was to empower youth to feel a sense of agency in the context of climate change through participatory action. In particular, photovoice methodology was implemented as a means to bridge educational program content with youth climate change action. By participating in SCA, youth were encouraged to spearhead sustainable solutions, both through family action plans aimed at reducing household energy use and waste, as well as by designing and implementing collaborative, sustainability-targeted action projects to engage the wider community. The SCA program integrated diverse and complementary techniques, framed by the 'Head, Heart, and Hands' model for sustainability education, and guided by photovoice methodology for purposes of science learning, community-based inquiry and connection, and youth-led participatory action (Orr, 1992; Cook & Buck, 2010; Hergenrather et al., 2009; Strack, Magill, & McDonagh, 2004).

#### 3.6.1 *Science: Educational Activities*

Existing relationships with university STEM departments, CSU's STEM Center, and NOAA's Climate Stewards Education Project contributed to the compilation of six hour-long hands-on activities demonstrating connections between Earth's changing climate, ecosystems,

and sustainable actions within communities (see Appendix B). Programming was intended to introduce participants to important 'bigger picture' concepts related to climate change, under the theme of "Making the Invisible Visible" (see Table 2). In the framework of 'Heads, Hearts, Hands,' the science component of SCA engages "heads" (i.e., cognition) through interactive activities to enhance climate change knowledge through experiential learning. Educational program content explored the scientific and social dimensions of climate change, while providing a platform for youth to take informed action on learned concepts.

All activities were modified versions of pre-existing and freely-available games, lessons, and exercises offered by organizations such as CSU's Little Shop of Physics, the Environmental Protection Agency, the National Aeronautics and Space Administration (NASA), and NOAA. Games were modified to emphasize local ecosystems and local climate change impacts, as well as for age-appropriateness, small and large groups, and available time. Particular activities were selected for their simplicity, in terms of depth of content and material requirements, as well as their utility in: (1) Covering a range of fundamental climate change topics (e.g., the difference between weather and climate [*Climate vs. Weather*]; the greenhouse effect [*Greenhouse Gas Tag*]); (2) Focusing on ecosystem impacts (e.g., the food web [*Weaving the Web*], see Figure 1; the well-being of animals [*Oh Deer!*]), and; (3) Emphasizing human actions to address climate change (e.g., sustainable solutions by individuals [*Energy* Bingo] and groups [*Young Voices for the Planet*], see Figure 2). Further, activities corresponding with each program goal (above) respectively touched upon climate change causes, consequences, and solutions, with the first four activities being problem-focused, and the final two activities being solutions-focused.

In addition, SCA's science component introduced youth to various STEM disciplines, including ecology, climatology, meteorology, engineering, and social science. Specific STEM fields related to SCA content were described in the program, with particular emphasis on how

STEM careers can make a difference in people's lives. SCA program emphasis on communal goals (i.e., how science helps people) was intended to support science interest and identification by underrepresented groups (Diekman, Clark, Johnston, Brown, & Steinberg, 2011).

Table 2

Science, Camera, Action! (SCA) *Program Overview*

| Week | Component | Topic | Activity |
|---|---|---|---|
| 1 | N/A | Introduction | Gallery Walk |
| 2 | S | Ecosystems | Weaving the Web |
| 3 | S | Climate vs. Weather | Little Shop of Physics - Skittles |
| 4 | C | *Photovoice #1* | *Photo-printing and Discussion - Topics 1-2* |
| 5 | S | The Greenhouse Effect | Greenhouse Gas Tag |
| 6 | S | Climate Change & Ecosystems | Oh Deer! & Glaciers: Then & Now |
| 7 | C | *Photovoice #2* | *Photo-printing and Discussion - Topics 3-4* |
| 8 | S | Sustainable Solutions #1: Energy & Waste | Energy Bingo & Carbon Footprint Contest |
| 9 | S | Sustainable Solutions #2: Teamwork & Leadership | Young Voices for the Plant Videos |
| 10 | C | *Photovoice #3* | *Photo-printing and Discussion - Topics 5-6* |
| 11-16 | A | Action Projects | Various |

*Note.* S = Science: Educational activity; C = Camera: Photovoice process; A = Action: Collaborative action project. Each science activity was paired with a photovoice prompt. For example, following Topic 1, participants were asked to find evidence of ecosystems in their own lives: "This week, we thought about how people, plants, and animals depend on one another for survival. In your own life, what examples of this can you find? What does this make you think about? How does it make you feel? Take a few photos of these ideas." Photovoice sessions followed each pair of SCA activities.

### *3.6.2 Camera: Photovoice Process*

Following each science activity, participants engaged in photovoice process (Hergenrather et al., 2009). Specifically, youth were asked to photograph images conveying their views and feelings about program topics (see Figure 3; Appendix C). During each of three photovoice sessions (see Figures 4 and 5), participants were encouraged to narrate their photos and reflect on what they learned, while also making connections between their own and others' photographs and experiences (Wilson et al., 2007).

*Figure 1.* SCA Activity 1: “Weaving the Web,” exploring ecosystems.

*Figure 2.* SCA Activity 5: “Energy Bingo,” exploring energy-saving behaviors.

After three photovoice sessions, youth together identified common themes that emerged across photovoice sessions and translated them into action plans. In this sense, photovoice methodology was implemented both as a data collection and analysis technique, allowing the researcher to navigate youth perspectives and evaluate program content, as well as a youth-centered learning activity, encouraging youth to explore their communities while connecting scientific concepts to their own and others' everyday lives (Foster-Fishman et al., 2005). The "Camera" component of SCA aligns with the "Hearts," or caring, focus of EfS. Specifically, photovoice was intended to enhance youths' awareness of the interconnectedness of the natural world (see Figure 6). As a pedagogical technique, photovoice was intended to facilitate youths' ability to make connections between their own lives and SCA's science content, simultaneously making abstract science concepts more concrete as well as personally relevant.

*Figure 3.* Photovoice youth digital photography.

*Figure 4.* Photovoice session.

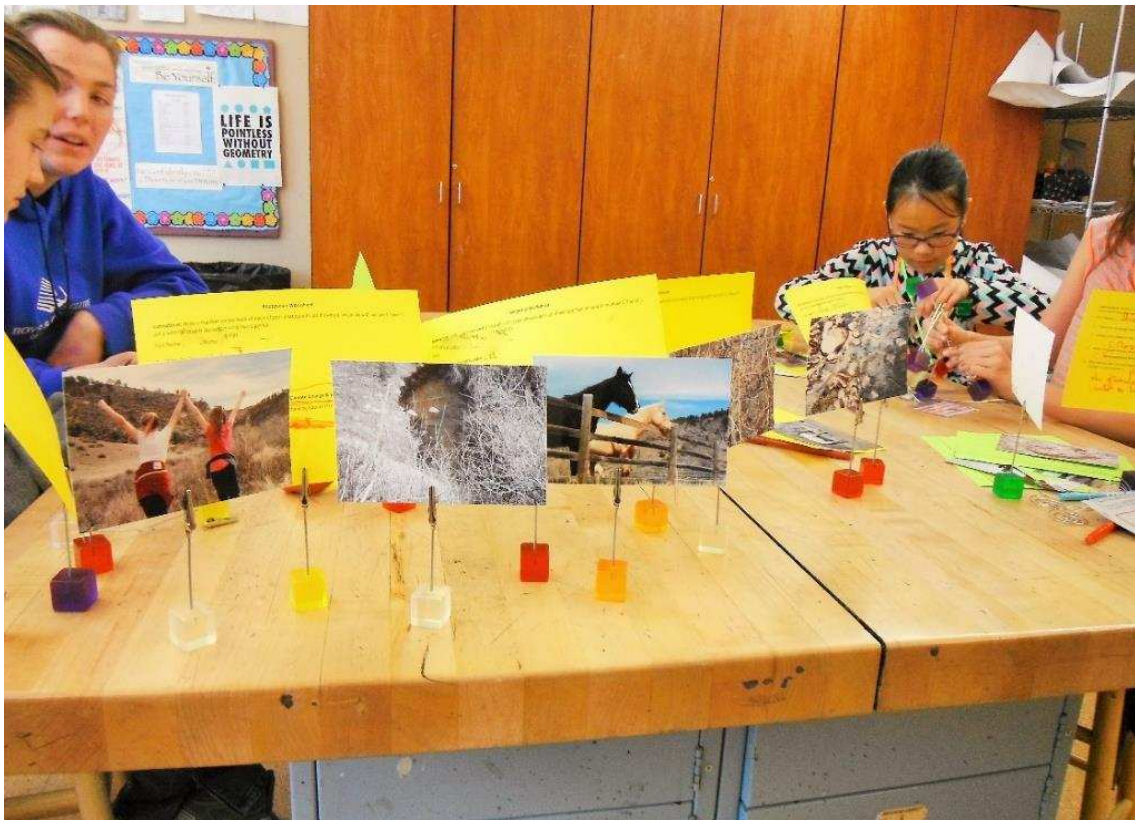


*Figure 5.* Photovoice discussion.

*Figure 6.* Photovoice in the field.

*3.6.3 Action: Carbon Footprints and Collaborative Action Projects*

In the final phase of SCA, youth contributed to sustainable change in their families and communities by: (1) Developing family action plans to promote understanding of, and engagement in small-scale, everyday sustainable solutions to reduce their carbon footprints (see Figure 7), and (2) Designing and carrying out a larger collaborative action project. In the latter, youth were supported in realizing their visions for a community-focused sustainability initiative. Both action projects were aimed to advance youth potential as agents of change.

**Carbon Footprint Contest.** Halfway through the program, youth participants estimated their 'carbon footprints' by filling out a 20-item survey. Items focused on youths' environmentally-significant behaviors (e.g., energy use), and were summed into a total number of pounds of carbon dioxide emissions per year associated with their daily routines. Carbon

dioxide-equivalent ($CO_2e$) calculations, or scores, were then given to youth, providing individual-level recommendations for lowering their carbon footprint. Youth then developed and implemented 'Family Action Plans' to engage in personal pro-environmental behaviors and reduce their environmental impact. In the process, youth were encouraged to take on a leadership role within their families, sharing knowledge and promoting sustainable solutions in the areas of household energy and waste. After a month, participants again estimated their carbon footprints (in lbs. of $CO_2e$ per year).

A site-based competition was held, whereby BGC sites placed first, second, or third, depending on their average carbon footprint reductions (total $CO_2e$ reductions/number of participating youth). An individual-level reward system was also in place to recognize youths' individual accomplishments implementing their Family Action Plans (see Figure 8). This blend of reinforcement and healthy rivalry was intended to simultaneously promote consistent program participation and environmentally responsible behavior by the youth.


*Figure 7.* Photovoice prompt: Sustainable Solutions - Energy.

*Figure 8.* Carbon Footprint Contest awards ceremony.

**Collaborative Action Projects.** During the final six weeks of the program, participants, as decision-makers and co-researchers, engaged in photovoice with the goal of translating knowledge into action (Strack et al., 2004). After reflecting on themes derived from previous weeks' activities and photovoice sessions, youth engaged in a brainstorming and consensus process to formulate a plan for collaborative climate change action specific to their shared interests and goals. The process of deciding on youth-led projects was open-ended, but limited in terms of focus (i.e., climate change), time (i.e., five weeks), and funds (i.e., $500 or less). The role of the SCA research team was to assist youth in translating their ideas into concrete action and to support youth as agents of change within their families and communities. In the framework of 'Head, Heart, Hands,' both action projects promoted youths' active engagement ("Hands") with SCA concepts through everyday practices and innovative projects (see Figure 9).

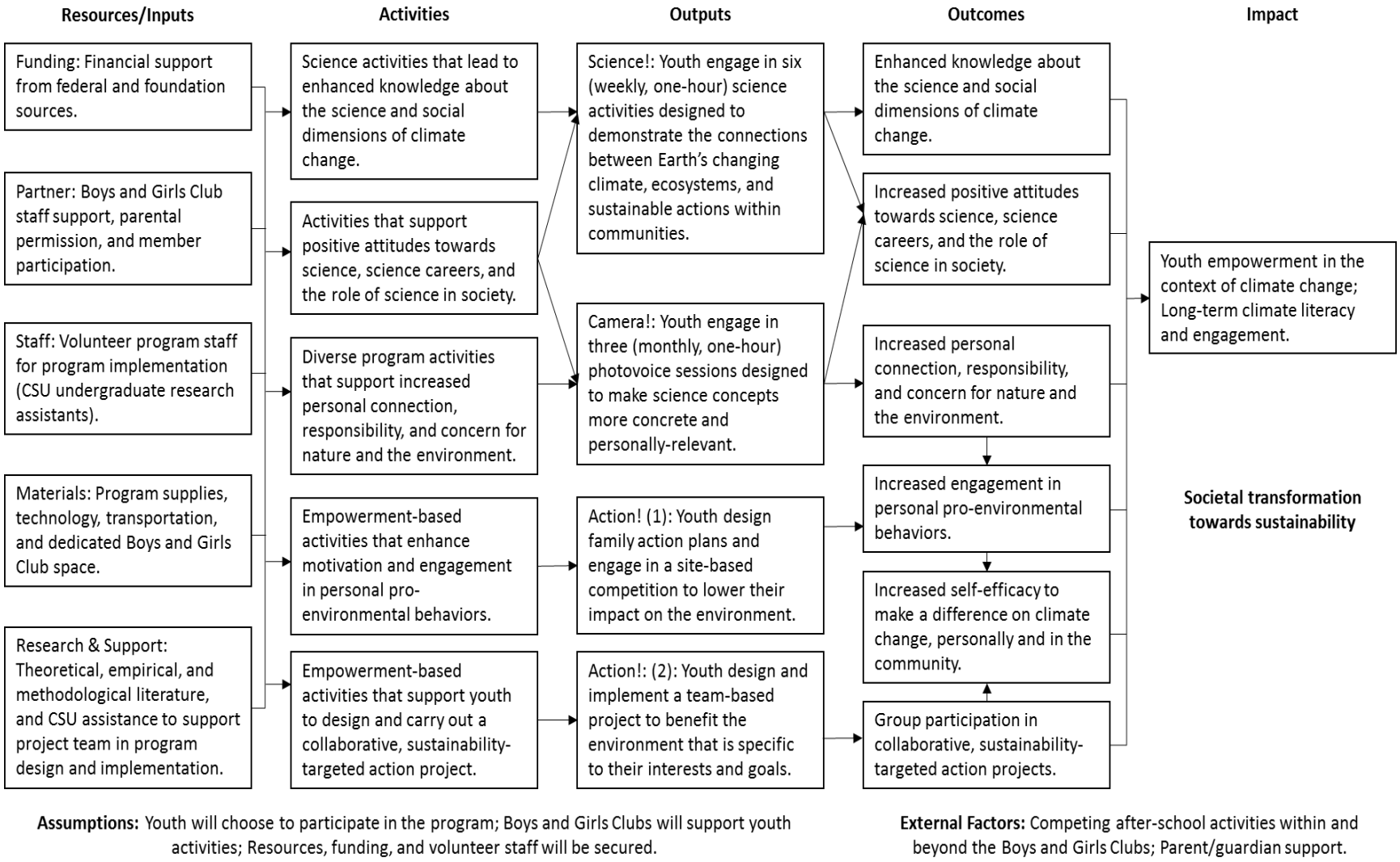


*Figure 9.* SCA's conceptual model.

## 3.7 Program Goals

It was anticipated that, through participation in SCA's hands-on, interactive science activities, photovoice process, and translation of knowledge to action, youth would demonstrate enhanced climate change knowledge, improved climate change-related attitudes, and increased engagement in small-scale, everyday sustainable behaviors. Additionally, it was expected that SCA participation would benefit youth by enhancing their science engagement. It was further expected that youth-initiated family action plans, as part of SCA's Carbon Footprint Contest, would contribute to active climate change mitigation practices at the household level. Finally, a key goal of SCA was to empower youths' sense of agency by supporting them in their efforts to carry out a collaborative climate change action project. More generally, SCA aimed to strengthen youths' confidence in their own capabilities to make positive changes in their lives, as well as in their families and communities. See Figure 9 for SCA's full conceptual model.

## 3.8 Data Collection and Analysis

A combination of survey and focus group methods were used to evaluate SCA program impacts. In the below sections, a detailed overview of this study's data collection and analysis procedures is provided. This section is organized by methodology and discusses how each method was used to address this study's primary research questions.

### *3.8.1 Survey Methodology*

Surveys were administered to youth before and after their participation in SCA. To address this study's first research question, which aimed to assess the impact of SCA on youths' climate change knowledge, attitudes, and behaviors, a diverse and complementary set of pre-existing scales were included in pre- and post-program surveys (see Appendix D). Specifically, this survey included measures of youths' *general perceptions about climate change* (3 items), as well as their *climate change knowledge* (14 items), such as youths' understanding of Earth's

climate system, the causes and consequences of climate change, and actions to reduce climate change (Leiserowitz, Smith, & Marlon, 2011).

To assess *climate change attitudes*, the survey included measures of youths' attitudes about the urgency of climate change (6 items; $\alpha_{pre} = 0.57$; $\alpha_{post} = 0.67$; Dijkstra & Goedhart, 2012), endorsement of an ecological worldview (10 items; $\alpha_{pre} = 0.58$; $\alpha_{post} = 0.60$; Manoli, 2007), connection with nature (7 items; $\alpha_{pre} = 0.64$; $\alpha_{post} = 0.61$; Stern, Powell, & Ardoin, 2008) and feelings of environmental responsibility (6 items; $\alpha_{pre} = 0.66$; $\alpha_{post} = 0.76$; Powell, Stern, Krohn, & Ardoin, 2011). Finally, to evaluate the impact of SCA on *climate change behaviors*, the survey measured youths' engagement in pro-environmental behaviors and environmental stewardship (10 items; $\alpha_{pre} = 0.81$; $\alpha_{post} = 0.82$; Dijkstra & Goedhart, 2012; Stern, Powell, & Ardoin, 2008).

A separate survey, administered during weeks 8 and 13 of the program, included 20 author-compiled items assessing participants' environmentally-significant behaviors as part of SCA's Carbon Footprint Contest. This survey was comprised of 13 items assessing energy use (e.g., through transport, food, electricity, and water consumption) and 7 items assessing the production and treatment of waste (e.g., reuse and recycling behaviors). Items selected for use in this survey were chosen for their ease of conversion into the metric of pounds of carbon dioxide-equivalent ($CO_2e$). Items were not intended to be exhaustive of participants' environmental impact.

To begin to address this study's second research question, which aimed to assess the impact of SCA on youths' *sense of agency* in the context of climate change, two questions were included in this study's post-survey. First, youth were asked to respond, yes or no, to the following question: "Did *Science, Camera, Action!* help you to feel like you can make a

difference in the world around you?" In a second, open-ended survey item, participants were asked to explain their response.

Finally, to explore the impact of the program on youths' *science engagement*, pre- and post-program surveys included scales measuring youths' attitudes towards school science (7 items; $\alpha_{pre} = 0.88$; $\alpha_{post} = 0.82$), attitudes towards the societal implications of science (3 items; $\alpha_{pre} = 0.73$; $\alpha_{post} = 0.60$), and attitudes towards a career in science (5 items; $\alpha_{pre} = 0.79$; $\alpha_{post} = 0.81$; Dijkstra & Goedhart, 2012), as well as one item to measure youths' most recent grade in science class. In the post-survey, participants were asked to respond, yes or no, to whether SCA helped them to "like science more," and to write about why. Also in the post-survey, one open-ended item explored youths' career aspirations.

Scales used in this study were selected for their appropriateness for completion by youth participants. All scales were previously validated with youth participants under age 12, with the exception of Leiserowitz and colleagues' (2011) climate change knowledge and perceptions questionnaire, which was administered to U.S. teens (ages 13 to 17), and Dijkstra and Goedhart's (2012) scales, which were validated with participants ages 12 to 21 ($M = 15.6$). As a result, some items were adapted to the target age group (see Appendix D). Due to the number of survey items, which also included demographic questions, surveys were administered in two phases prior to the start of the program and in two phases following the end of the program. The pre-survey was 70 total items (Part 1, 37 items; Part 2, 33 items). The post-survey was 80 total items (Part 1, 40 items; Part 2, 40 items).

To examine differences in youths' climate change knowledge, attitudes, and behaviors, as well as their science engagement, following SCA participation, a series of dependent samples *t*-tests were conducted (Maruyama & Ryan, 2014b). For items appearing in either the pre- or post-program survey only, descriptive analyses (e.g., frequencies, averages) were conducted. To

analyze open-ended survey items, thematic analysis was used to identify, group, and describe responses according to their shared thematic properties (Braun & Clarke, 2006).

*3.8.2 Focus Group Discussions*

Focus groups were conducted following the end of SCA to further explore this study's research questions, as well as to clarify and expand on survey findings (Gibson, 2007; Millward, 2012). The focus group guide developed for use in this study had four foci: (1) *SCA's climate change and science impacts*, examining participants' thoughts and feelings about climate change and science before and after program participation; (2) *SCA program feedback*, exploring which program components were most liked by participants and which should be modified and improved; (3) *SCA action projects*, focusing on what was enjoyable and what was difficult about youths' collaborative action projects; and (4) *SCA's impact on youths' confidence, agency, and relationships*, exploring participants' views and experiences of how SCA affected how they felt about themselves, their capabilities, their influence, and their relationships with others (see Appendix E).

Focus groups were conducted during a single program week (i.e., week 14) with the majority of participants, and make-up focus groups were conducted with youth at each research site the following week (i.e., week 15). In total, 11 focus groups were conducted (2 in Wellington; 4 in Fort Collins; 5 in Loveland), averaging between four and five participants each (Lewis, 1992), and lasting an average of 38 minutes. In Wellington, the small group size allowed for one scheduled and one make-up focus group discussion with myself as the facilitator. In Fort Collins and Loveland, where group size required greater management, focus groups were conducted with multiple facilitators stationed at separate tables in the same room. Participants, in small groups, were instructed to cycle to each table on a pre-determined schedule and to discuss facilitator questions, which each explored a portion of the focus group guide. In addition to

myself, facilitators were five undergraduate research assistants (RAs; 4 female; 1 male) who were familiar to youth through their assistance with program activities throughout SCA, and one male CSU graduate student unfamiliar to youth participants.

Due to the disproportionate reliance on focus group discussions in addressing this study's second research question, regarding SCA's impact on youth agency, I chose to facilitate this area of questioning across research sites. Undergraduate RA facilitators explored focal areas 1 and 3, exploring climate change, science, and action project-related impacts, while the graduate student facilitated group discussions around focal area 2, SCA program feedback. Having an outside facilitator for this question was intended to encourage youths' true and sincere feedback, both positive and negative, on the SCA program. Prior to focus groups, all facilitators were given an overview and training of the purpose and methods of focus group facilitation as well as the unique procedures used in this study. Individual station-based discussions lasted between 10 and 12 minutes each.

Focus group discussions followed a semi-structured format in which facilitators guided group discussions towards addressing key research questions, while allowing flexibility to explore ideas related to each topic. Focus group discussions were audio-recorded, transcribed verbatim, and edited prior to analysis using NVivo 10 software. Transcriptions were analyzed using thematic analysis (Brawn & Clarke, 2006). In this multi-phase process, (1) Initial codes were generated to identify relevant segments of text in relation to the research questions; (2) Codes were collated into potential themes, based on shared properties, to later cross-reference with other coded segments as well as the full data set; (3) Themes were revised and refined in order to identify and describe "the overall story the analysis tells" (p. 87); and (4) Clear names, definitions, and descriptions for each theme were generated in preparation for producing a final report to elaborate on each theme in relation to this study's research questions.

# CHAPTER 4: RESULTS

## 4.1 Overview of Program Implementation

Program recruitment through BGC site visits took place beginning in December of 2015, following IRB approval, and continued through the third week of January 2016. Recruitment ended when the total number of youth enrolled in the program matched the number of spaces available, which was 60. The program began during the last week of January 2016 and ended the final week of May 2016. SCA was carried out with the assistance of five CSU undergraduate RAs majoring in psychology, early childhood education, communications, and engineering. Two RAs assisted in Wellington and Fort Collins, and three RAs assisted in Loveland. All SCA staff, including myself, were trained and oriented as BGC volunteers prior to the program start date.

The SCA program took place for one hour per week after school, from 4pm to 5pm, on Mondays in Wellington, Tuesdays in Fort Collins, and Wednesdays in Loveland. Across research sites, SCA was implemented in BGC art rooms and outdoors whenever possible. As a minimum approximation of time spent at the BGC, through clocking in and out at the door more or less regularly, registered volunteer hours for all program staff between January and May of 2016 totaled 345.7 hours. RAs' documented volunteer time ranged from 27.0 to 44.3 ($M$ = 34.0) total hours over the course of the program, and my documented hours totaled 175.5. The BGC was occasionally closed for snow days and BGC training throughout the program, which required modifications to SCA programming. For example, four photovoice sessions were originally planned, as was a seventh activity, which focused on the relationship between waste (e.g., recycling, composting) and climate change. In all, six activities and three photovoice sessions were carried out.

Participation in SCA varied from week to week, and the total number of participating youth during a given week ranged from 30 to 48 ($n$ = 40.5; 73.6%) of 55 participants. Out of 15 weeks, participants attended as few as five and as many as all 15 sessions ($M$ = 11.33). The majority of participants ($n$ = 29; 52.7%) attended 12 to 15 weeks (80 – 100%) of the program. An additional 16 participants (29.1%) attended 8 to 11 weeks (53.3 – 73.3%) of the program, and the remaining 10 participants (18.2%) attended five to seven weeks (33.3% - 46.6%) of the program. Weeks with the lowest participation took place in late March and April (weeks 7, 8, and 10), while weeks with the highest attendance were spread throughout the beginning, middle, and end of the program (weeks 3, 6, and 14). Reasons for non-attendance included illness, doctor and dentist appointments, family plans (e.g., birthday party, travel), custody arrangements, and competing activities (e.g., sports).

Participants' motivations for joining the program were varied. When asked in an open-ended pre-survey item what made them want to join SCA, the most common response category, endorsed by 23 participants (41.8%), was SCA's digital photography component (e.g., taking pictures, keeping the camera), followed closely by participants' fondness for science ($n$ = 21; 38.2%). Other reasons for joining SCA included participants': belief that SCA would be fun or interesting ($n$ = 15; 27.3%), love for nature ($n$ = 5; 9.1%), eagerness to learn ($n$ = 5; 9.1%), interest in action ($n$ = 3; 5.6%), and desire to be around friends ($n$ = 3; 5.6%). In this chapter, results of the SCA program (i.e., action projects) and its evaluation (i.e.., via surveys and focus groups) are provided. Below, a brief overview of each youth-led action project is given.

### 4.2 Overview of Collaborative Action Projects

During the final five weeks of SCA, youth-led collaborative action projects were undertaken by groups at each research site. Rooted in SCA program content—activities and photovoice process—each of the three groups formulated team-based, sustainability-targeted

action projects specific to their interests and goals. Though unanticipated at the outset of the program, this participatory process resulted in a diverse array of youth-led action projects in which two of three groups carried out more than one major project.

*4.2.1 Wellington: Town Meeting and Tree-Planting*

In Wellington, a small agricultural town, participants were motivated to design and deliver a speech (entitled *"Climate Change: Operation Do Something!"*) to local officials and community members during a town meeting (see Figure 10). After presenting a brief synopsis of the problem, including global to local impacts of climate change, they requested permission to move forward with a tree-planting campaign in public parks. Despite the politically conservative character of the region, participants were given approval for their request, recognition for their efforts, and a warm applause by the sixty-member audience of parents, neighbors, and BGC staff. They planted twelve trees (see Figure 11), including two large Cottonwoods in a newly-opened local park (see Figure 12). These efforts were later honored by town administrators with a plaque installed near the trees commemorating youths' environmental stewardship.

*Figure 10.* Town meeting presentation.

*Figure 11.* Tree-planting in the neighborhood.

*Figure 12.* Tree-planting in the park.

*4.2.2 Fort Collins: Photo Gallery and Website*

In Fort Collins, participants elected to raise awareness about climate change within and beyond their local community by designing a climate change education- and action-focused website (see Figure 13). In addition, they held a photo gallery event to display their photographs, communicate about climate change with family and community members, and to unveil the website (see Figure 14). The event was attended by more than one hundred visitors as part of a BGC-initiated, family-oriented event to showcase youths' accomplishments. During the event, participants discussed the content and meaning of their photographs with visitors, while directing them to the website for more information. The website was intended to inspire advocacy and action on climate change by describing SCA, the problem of climate change, and how to 'Get Involved' (see Figure 15).

*Figure 13.* Website designing.

*Figure 14.* Photo gallery event.


*Figure 15.* Website photo gallery page.

### *4.2.3 Loveland: BGC Community Garden*

In Loveland, participants chose to restore a disused garden and outdoor learning space on the property of their BGC unit. They weeded the overgrown lot, turned the soil, spread compost, and planted more than one hundred fruit and vegetable plants (see Figure 16). Farmland for more

than a century prior becoming part of the BGC, the fertile soil and large garden provided fresh produce to the youth, their families, and the BGC community (see Figure 17). To sustain the garden following the end of SCA, several participants joined the newly-established BGC garden club, open to all ages. During late summer, upon harvest, teenage members of the BGC used garden vegetables for healthy eating-focused educational activities with younger members.

*Figure 16.* Garden planting.

*Figure 17.* Garden harvest.

## 4.3 Survey Results

In this section, results of survey-based analyses are provided. Differences, before and after program participation, were examined in relation to participants' ($N$ = 55) climate change knowledge, attitudes, and behavior, sense of agency, and science engagement. Descriptive analyses of variables by sub-group (i.e., research site; level of participation; age; gender; ethnicity; socio-economic status) are provided at the end of this section (see Tables 18-23).

### *4.3.1 Climate Change Perceptions and Knowledge*

A total of 14 items were used to assess youths' general perceptions of, and knowledge about climate change. Three items examined youths' general perceptions about climate change before and after the program, including their self-estimated level of climate change knowledge and how often they thought about climate change, as well as whether they believed climate change to be happening now. Eleven items assessed youths' knowledge about the science and social dimensions of climate change. This portion of the survey included items assessing knowledge of Earth's climate system, the causes and consequences of climate change, and actions to reduce climate change. All 14 items were adapted from Leiserowitz and colleagues' (2011) study examining "American Teens' Knowledge of Climate Change." As these items were developed for U.S. teens (ages 13-17), selected items were modified for age appropriateness.

**General perceptions of climate change.** Before and after the program, participants were asked a series of three questions assessing their general perceptions about climate change. In the first, youth were asked, "How much [they] know about climate change," on a 5-point Likert scale ranging from 1 ("Nothing") to 5 ("A lot"). Before the program, the greatest proportion of youth (40%) selected the midpoint (3), indicating that they knew "A little" about climate change. After the program, the greatest proportion of youth (41.8%) reported that they knew "A lot" (see Figure 18). Of 55 participants completing this item, 31 (56.4%) felt like they knew more about

climate change after the program than before, 7 (12.7%) reported the opposite, and 17 (30.9%) did not differ over time.

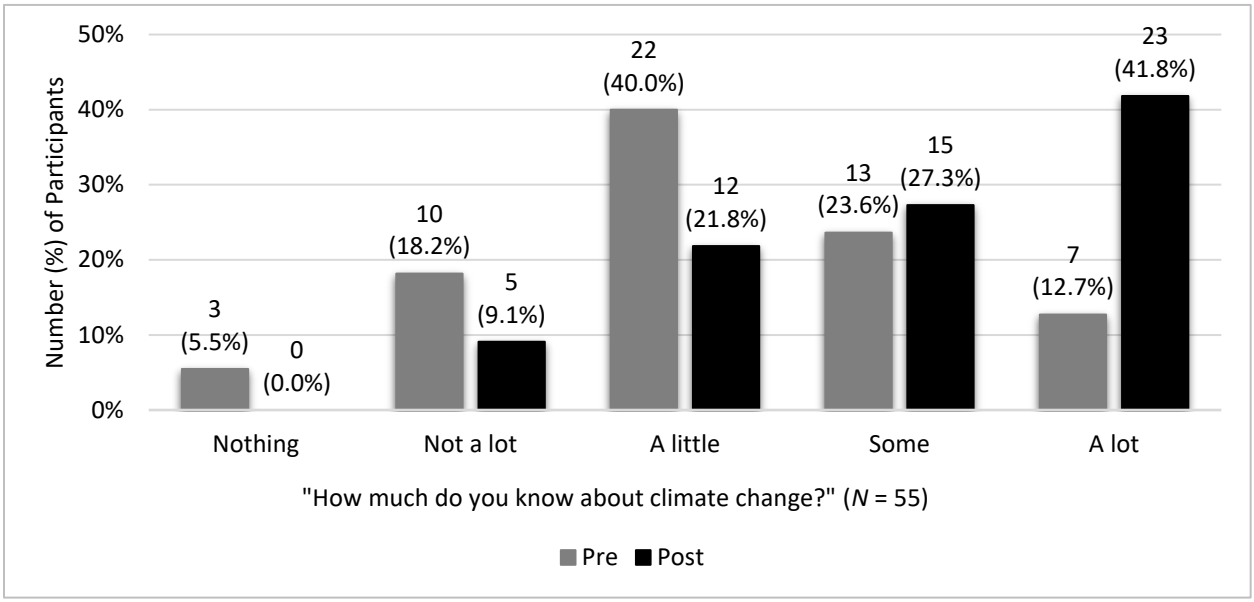


*Figure 18.* Self-estimated climate change knowledge.

A dependent samples *t*-test was performed to assess differences in youths' self-estimated climate change knowledge before and after SCA participation. There were no outliers in the data, as assessed by inspection of a boxplot, and all cases were retained in the analysis. The difference scores for this item were normally distributed, as assessed by visual inspection of a Normal Q-Q Plot. Difference scores were also determined to be normally distributed by examining skewness -0.04 (*SE* = 0.32) and kurtosis -0.23 (*SE* = 0.63). Results of the *t*-test revealed that self-estimated climate change knowledge was greater following program participation (*M* = 4.02, *SD* = 1.01), compared to before (*M* = 3.20, *SD* = 1.06). This mean increase of 0.82, 95% CI [0.44, 1.20], was statistically significant, $t(54) = 4.33$, $p < .001$, $d = .58$.

In exploring youths' general perceptions about climate change, a second question asked participants "How much [they had] thought about climate change before today." Likert scale responses ranged from 1 ("Not at all") to 5 ("A lot"). In the pre-survey, a combined 52.7% of youth reported that they had thought about climate change either "Not at all" or "Not a lot."

After the program, fewer than 1 in 5 youth (18.2%) thought about climate change “Not at all” or “Not a lot,” with more than 60% reporting that they thought about climate change either “Some” (27.3%) or “A lot” (34.5%, see Figure 19). Of the 55 participants to complete this item before and after the program, 31 participants (56.4%) reported thinking more about climate change after the program than before, 11 (20%) less, and 13 (23.6%) the same amount.

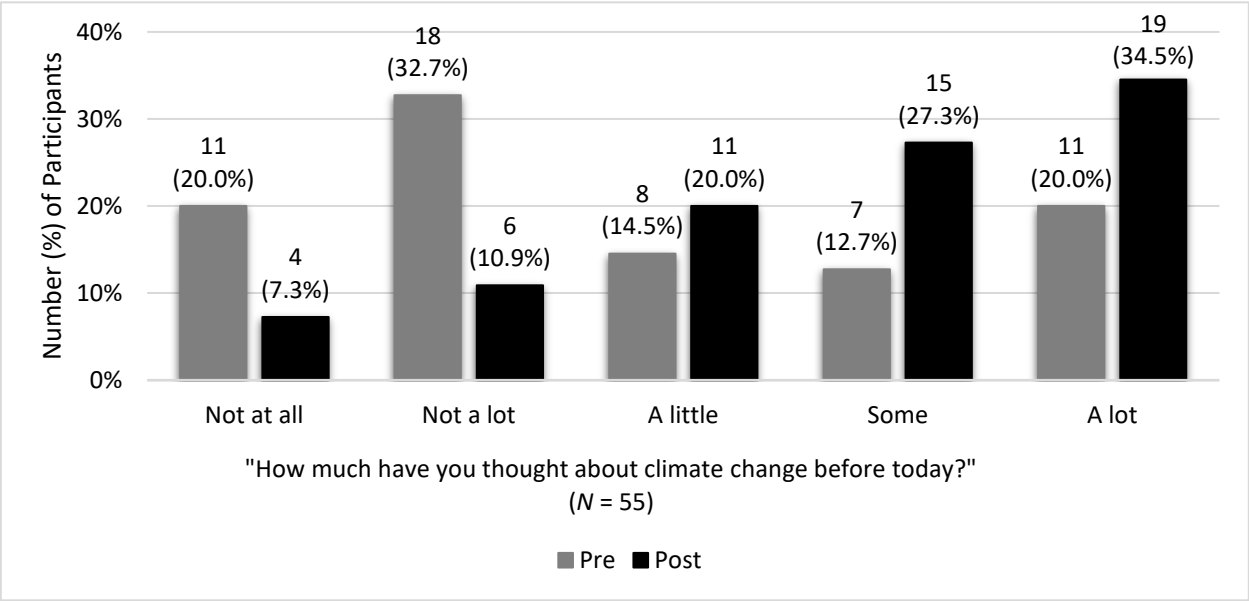


*Figure 19.* Time spent thinking about climate change.

A dependent samples *t*-test was performed to assess differences on this item before and after program participation. One outlier was detected that was more than 1.5 box-lengths from the edge of the box in a boxplot. Upon inspection, this value was not found to be extreme and was retained in the analysis. The difference scores for this item were normally distributed, as assessed by visual inspection of a Normal Q-Q Plot. Difference scores were also determined to be normally distributed by examining skewness -0.34 (*SE* = 0.32) and kurtosis -0.09 (*SE* = 0.63). Results of the *t*-test revealed that participants thought more about climate change after the program (*M* = 3.71, *SD* = 1.26), compared to before (*M* = 2.80, *SD* = 1.43). This mean increase of 0.91, 95% CI [0.43, 1.39], was statistically significant, $t(54) = 3.77$, $p < .001$, $d = .51$.

A final question exploring youths' general perceptions about climate change asked youth to respond, on a 4-point Likert scale ranging from 1 ("Definitely False") to 4 ("Definitely True"), whether "Earth's climate is changing now." Before the program, just two participants indicated that they thought this statement was "Probably False" and zero thought it was "Definitely False." Among those who believed this statement to be true, 21 (38.2%) said "Probably" and 31 (56.4%) said "Definitely." After the program, all youth felt this statement was true to some extent, with 12 (21.8%) indicating "Probably" and 42 (76.4%) indicating that Earth's climate is "Definitely" changing now. Of the 54 participants responding to this item at both pre and post, 16 participants (29.6%) became more certain that climate change is happening now, and 4 participants (7.4%) became less certain. However, most participants ($n$ = 34; 63%) did not change their response over time (see Figure 20).

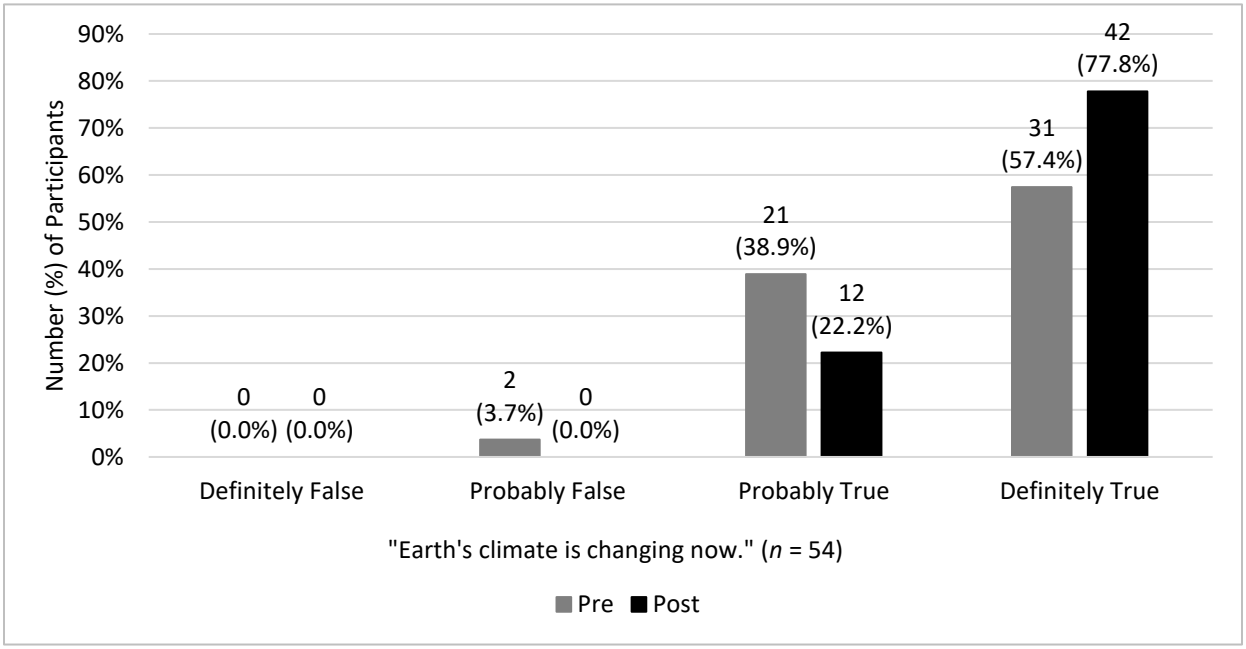


*Figure 20.* Climate change beliefs.

A dependent samples *t*-test was conducted to assess differences on this item before and after program participation. There were no outliers in the data, as assessed by inspection of a boxplot, and all cases were retained in the analysis. The difference scores for this item were

normally distributed, as assessed by visual inspection of a Normal Q-Q Plot. Difference scores were also determined to be normally distributed by examining skewness 0.33 (*SE* = 0.33) and kurtosis 0.45 (*SE* = 0.64). Results of the *t*-test revealed that certainty of climate change was greater after program participation (*M* = 3.78, *SD* = 0.42), compared to before (*M* = 3.54, *SD* = 0.57). This mean increase of 0.24, 95% CI [0.07, 0.41], was statistically significant, *t*(53) = 2.89, *p* = .006, *d* = .39.

**Climate change knowledge.** Eleven items were used to assess youths' knowledge of the science and social dimensions of climate change. Of these eleven items, five were true or false items (e.g., "Climate means average weather conditions in a region," *True*); four were multiple choice questions with a single correct answer (e.g., "Which country produces the most greenhouse gases per person?," *The United States*), and two were multiple choice questions with multiple correct and incorrect answers (e.g., "Which of the following are fossil fuels?," *Coil, Oil,* and *Natural Gas* [not Wood, Solar, or Nuclear]). Due to items with multiple correct and incorrect answers, the maximum possible score on the knowledge assessment was 23 points (see Table 3).

A paired-samples *t*-test was used to determine whether there was a statistically significant mean difference between climate change knowledge before and after program participation. Two outliers were detected through examination of a boxplot. Inspection of their values did not reveal them to be extreme and they were kept in the analysis. The differences between climate change knowledge before and after the program were normally distributed, as assessed by visual inspection of a Normal Q-Q Plot. Difference scores were also determined to be normally distributed by examining skewness -0.14 (*SE* = 0.32) and kurtosis 0.25 (*SE* = 0.63). The percentage of correct responses to the climate change knowledge assessment was higher (*M* = 68.70, *SD* = 14.84) after program participation, compared to before (*M* = 60.71, *SD* = 11.32), a statistically significant mean increase of 7.98 percentage points, 95% CI [4.47, 11.50],

$t(54) = 4.55$, $p < .001$, $d = .61$. A descriptive summary of individual knowledge items is provided in Table 3. A summary of *t*-tests for youths' climate change perceptions and knowledge is provided in Table 4.

Table 3

*Summary of Descriptive Statistics for Climate Change Knowledge*

| | Pre-Survey ($n$ = 59) | | Post-Survey ($n$ = 55) | | |
|---|---|---|---|---|---|
| Knowledge Items (Answer) | # Correct | % | # Correct | % | % Change |
| *True/False:* | | | | | |
| Climate means average weather conditions in a region. (T) | 48 | 81.36 | 53 | 96.36 | + 15.01 |
| Climate and weather mean pretty much the same thing. (F) | 25 | 42.37 | 24 | 43.64 | + 1.26 |
| The Earth's climate has been pretty much the same for millions of years. (F) | 37 | 62.71 | 34 | 61.82 | - 0.89 |
| Climate change will cause some places to get wetter, while others will get drier. (T) | 53 | 89.83 | 55 | 100.00 | + 10.17 |
| Climate change will make weather hotter by the same amount in all countries. (T) | 32 | 54.24 | 27 | 49.09 | - 5.15 |
| *Multiple Choice (Single Answer):* | | | | | |
| The "greenhouse effect" refers to: (Gases in the atmosphere that trap heat) | 34 | 57.63 | 41 | 74.55 | + 16.92 |
| Which one is a greenhouse gas? (Carbon dioxide) | 27 | 45.76 | 44 | 80.00 | + 34.24 |
| Which country produces the most greenhouse gases per person? (The United States) | 30 | 50.85 | 27 | 49.09 | - 1.76 |
| Which one of the following do you think contributes the most to climate change? (Burning fossil fuels for heat and electricity) | 10 | 16.95 | 19 | 34.55 | + 17.60 |
| *Multiple Choice (Multiple Answer):* | | | | | |
| Which of the following are "fossil fuels"? (*) | | 63.84 | | 73.03 | + 9.19 |
| Coal* | 39 | 66.10 | 43 | 78.18 | + 12.08 |
| Oil* | 41 | 69.49 | 40 | 72.73 | + 3.24 |
| Natural Gas* | 40 | 67.80 | 41 | 74.55 | + 6.75 |
| Solar | 36 | 61.02 | 41 | 74.55 | + 13.53 |
| Nuclear | 31 | 52.54 | 35 | 63.64 | + 11.09 |
| Wood | 39 | 66.10 | 41 | 74.55 | + 8.44 |
| Which of the following actions can people take to help reduce climate change? (*) | | 62.71 | | 69.55 | + 6.83 |
| Walk or bicycle instead of drive* | 53 | 89.83 | 47 | 85.45 | - 4.38 |
| Unplug TVs and computers when not in use* | 35 | 59.32 | 39 | 70.91 | + 11.59 |
| Turn off the lights when leaving a room* | 44 | 74.58 | 41 | 74.55 | - 0.03 |
| Turn off the tap while brushing teeth* | 44 | 74.58 | 43 | 78.18 | + 3.61 |
| Eat less meat* | 21 | 35.59 | 29 | 52.73 | + 17.13 |
| Take a bath instead of a shower | 37 | 62.71 | 34 | 61.82 | - 0.89 |
| Stop using aerosol spray cans | 20 | 33.90 | 31 | 56.36 | + 22.47 |
| Fly instead of drive | 42 | 71.19 | 42 | 76.36 | + 5.18 |
| **Total** | | **60.28** | | **68.70** | **+ 8.42** |

*Note.* Order of items and multiple-choice responses were altered between pre- and post-surveys. Total percentage correct was calculated by dividing the total number of correct responses by 23 (the maximum number of correct responses). Correct responses to each item are provided in parentheses above.

Table 4

*Summary of Paired-Samples t-Tests for Climate Change Perceptions and Knowledge*

| Variable | Pre *M (SD)* | Post *M (SD)* | *MD* | *t* | *df* | *p* | 95% CI *LL* | 95% CI *UL* | Cohen's *d* |
|---|---|---|---|---|---|---|---|---|---|
| Self-Estimated Knowledge about Climate Change[a] | 3.20 (1.06) | 4.02 (1.01) | +0.82 | 4.33 | 54 | < .001*** | 0.44 | 1.2 | 0.58 |
| Thoughts about Climate Change[a] | 2.80 (1.43) | 3.71 (1.26) | +0.91 | 3.77 | 54 | < .001*** | 0.43 | 1.39 | 0.51 |
| Certainty about Climate Change[a] | 4.54 (0.57) | 4.78 (0.42) | +0.24 | 2.89 | 53 | .006** | 0.39 | 0.07 | 0.41 |
| Climate Change Knowledge Assessment[b] | 60.71 (11.32) | 68.70 (14.84) | +7.98 | 4.55 | 54 | < .001*** | 0.04 | 0.12 | 0.61 |

*Note.* [a] Response range: 1 - 5; [b] Response range: 0-100% correct responses.

Finally, as a qualitative indicator of participants' climate change knowledge, they were asked in an open-ended survey item to describe how climate change will affect their lives. Responses ranged from naming the physical impacts of climate change (e.g., heat and drought) to describing the effects of climate change on social systems and livelihoods (e.g., travel and recreation; food). A thematic analysis summary of participants' responses is provided in Table 5.

### *4.3.2 Climate Change Attitudes*

**Connection with nature.** The "Connection with Nature" scale consisted of seven items assessing whether participants: "(a) [felt] comfortable in the outdoors; (b) [felt] that they are a part of nature, rather than separate from it; (c) actively engage[d] in observing their surroundings when in natural settings; and (d) show[ed] interest in outdoor activities" (Stern, Powell, & Ardoin, 2008, p. 34). Individual items are provided in Table 6. Responses ranged from 1 ("Strongly Disagree") to 5 ("Strongly Agree), with higher scores indicating a greater connection with nature. Before program participation ($M$ = 3.96, $SD$ = 0.62), as well as after

(*M* = 4.13, *SD* = 0.56), participants expressed a strong connection with nature. With the exception of two reverse-scored items, all individual items trended in the expected direction (see Table 6).

Table 5

*Thematic Analysis of Perceived Personal Impacts of Climate Change*

| Thematic Categories & Representative Quotations [a] | *n* [b] (%) |
|---|---|
| *Heat & Drought* | 15 (29.41) |
| "Where I live, it's going to get hotter." - Henry, 10 | |
| "It will affect my life because if it is too dry, we will have a drought." - Carlos, 10 | |
| *Animals* | 9 (17.65) |
| "I won't be able to see as many animals as I can now." - Owen, 12 | |
| "Nature is going to affect the animals." - Isabella, 12 | |
| *Sea Level Rise* | 6 (11.76) |
| "It will make it so house prices will be higher, since coastal land will sink, since glaciers will make more water." - Ali, 12 | |
| "Global warming will overflow our water amount." - Abigail, 13 | |
| *Disasters & Loss of Life* | 6 (11.76) |
| "It could cause bad accidents to happen." - Olivia, 12 | |
| ""It can make Colorado have a drought and people will die." - Riley, 10 | |
| *Lifestyle* | 5 (9.80) |
| "It will effect the weather and then I'll probly spend more time inside." - Scarlett, 12 | |
| "Climate could affect my life because we would need to adapt to the new climate." - Aubrey, 11 | |
| *Travel & Recreation* | 2 (3.92) |
| "It will make you not be able to go to certain places." - Gabe, 12 | |
| "The mountains will be dry and not fun during winter." - Bill, 13 | |
| *Food* | 2 (3.92) |
| "Farms won't be as able to produce that much food." - Peyton, 10 | |
| "If [climate change] kills animals and they have (don't have) food." - Luke, 11 | |
| *Better World* | 2 (3.92) |
| "It will make [it] better because the world will be made better." - Dominic, 10 | |
| "It will more better because I help make a difference." - Bryan, 10 | |

*Note.* *N* = 51.

[a] Categories appear in order of descending prevalence. Participant responses could be categorized into more than one response type. [b] *n* (%)= number of participant responses corresponding with each thematic category, followed by the percentage of full sample

Table 6

*Descriptive Statistics for Connection with Nature*

| Attitude Items | Pre-Survey *M (SD)* | Post-Survey *M (SD)* | *MD* |
|---|---|---|---|
| I feel comfortable in the outdoors. | 4.53 (0.75) | 4.73 (0.56) | +0.20 |
| Humans are a part of nature, not separate. | 4.36 (0.80) | 4.38 (0.87) | +0.03 |
| When I'm outside, I pay close attention to different plants and animals. | 3.81 (1.03) | 4.02 (0.95) | +0.20 |
| I'd rather play outside than inside. | 3.97 (1.17) | 4.22 (0.99) | +0.25 |
| I'd rather visit a national park than see a movie. | 3.80 (1.13) | 3.85 (1.05) | +0.06 |
| I'd rather play video games than explore the woods. (R)* | 3.51 (1.33) | 3.75 (1.32) | +0.24 |
| I'd rather go to a shopping mall than Rocky Mountain National Park. (R) | 3.78 (1.38) | 3.95 (1.31) | +0.17 |

*Note.* * R = reverse-scored item.

A dependent samples *t*-test was conducted to assess the statistical significance of participants' increased connection with nature. Two outliers were identified through the use of a boxplot, but were retained in the analysis as they did not unduly influence the results of the *t*-test. Difference scores across cases were normally distributed, as determined through visual inspection of a histogram, Normal Q-Q Plot, and Shapiro-Wilk's test ($p = .22$). Difference scores were also determined to be normally distributed by examining skewness 0.21 ($SE = 0.32$) and kurtosis 0.97 ($SE = 0.63$). The mean increase of 0.17 in youths' connection with nature, 95% CI [-0.001, 0.34], was not found to be statistically significant at the $p < .05$ level, $t(54) = 1.99$, $p = .052$.

**Ecological worldview.** The 10-item "New Ecological Paradigm Scale for Children" was used to assess youths' endorsement of an ecological worldview, on a continuum from anthropocentric (*Dominant Social Paradigm*; low scores) to ecocentric (*New Ecological Paradigm*; high scores). Individual items are provided in Table 7. Responses ranged from 1 ("Strongly Disagree") to 5 ("Strongly Agree), with higher scores indicating a stronger ecological worldview. Overall, participants' ecocentric views were higher ($M = 3.77$, $SD = 0.48$) after the program, compared to before ($M = 3.68$, $SD = 0.49$). All ten items trended towards a stronger ecological worldview, including all four reverse-scored items (see Table 7).

A dependent samples *t*-test was conducted to assess pre- and post-program differences. One outlier was identified through the use of a boxplot, but was determined not to be extreme and was retained in the analysis. Difference scores were normally distributed, as determined through visual inspection of a histogram, Normal Q-Q Plot, and Shapiro-Wilk's test ($p$ = .54). Difference scores were also determined to be normally distributed by examining skewness 0.37 ($SE$ = 0.32) and kurtosis 011 ($SE$ = 0.63). The small mean increase of 0.09 in youths' ecological worldview, 95% CI [-0.04, 0.22], was not statistically significant, $t(54) = 1.35$, $p$ = .183.

Table 7

*Descriptive Statistics for Ecological Worldview*

| | Pre-Survey | Post-Survey | |
|---|---|---|---|
| Attitude Items | *M (SD)* | *M (SD)* | *MD* |
| Plants and animals have as much right as people to live. | 4.41 (0.83) | 4.64 (0.59) | +0.23 |
| There are too many (or almost too many) people on earth. | 3.42 (1.10) | 3.73 (1.11) | +0.30 |
| People are clever enough to keep from ruining the earth. (R)* | 2.81 (1.31) | 2.27 (1.33) | -0.54 |
| People must still obey the laws of nature. | 4.20 (0.96) | 4.49 (0.88) | +0.29 |
| When people mess with nature it has bad results. | 4.34 (0.82) | 4.47 (0.77) | +0.13 |
| Nature is strong enough to handle the bad effects of our modern lifestyle. (R) | 3.12 (1.18) | 2.96 (1.37) | -0.16 |
| People are supposed to rule over the rest of nature. (R) | 4.10 (1.23) | 3.91 (1.25) | -0.19 |
| People are treating nature badly. | 3.86 (1.06) | 4.44 (0.74) | +0.57 |
| People will someday know enough about how nature works to be able to control it. (R) | 2.53 (1.07) | 2.38 (1.15) | -0.14 |
| If things don't change, we will have a big disaster in the environment soon. | 3.98 (1.11) | 4.42 (0.94) | +0.44 |

*Note.* * R = reverse-scored item.

**Environmental responsibility.** The six-item "Environmental Responsibility Scale" measured youths' feelings of motivation and self-efficacy towards protecting the environment (Powell, Stern, Krohn, & Ardoin, 2011). Responses ranged from 1 ("Strongly Disagree") to 5 ("Strongly Agree"), with higher scores indicating a stronger sense of environmental responsibility. To improve the internal reliability of this scale, one item was dropped from analysis (see Table 8). On the five-item measure, participants' environmentally responsible attitudes were strong before the program ($M$ = 4.33, $SD$ = 0.52) as well as after the program

(*M* = 4.55, *SD* = 0.49). All six items trended in the expected direction, towards a greater sense of environmental responsibility.

Differences between pre- and post-survey scores on the five-item scale were assessed using a paired-samples *t*-test. One case was dropped due to missing data. Prior to conducting the *t*-test, difference scores were inspected for outliers using a boxplot, which identified no extreme scores. Difference scores for the 54 cases were normally distributed, as determined through visual inspection of a histogram, Normal Q-Q Plot, and Shapiro-Wilk's test ($p = .24$). Difference scores were also determined to be normally distributed by examining skewness 0.04 (*SE* = 0.32) and kurtosis -0.02 (*SE* = 0.64). The mean increase of 0.22 in youths' sense of environmental responsibility, 95% CI [0.09, 0.35], was statistically significant, $t(53) = 3.42$, $p = .001$, $d = .47$. For individual item analyses, see Table 8.

Table 8

*Descriptive Statistics for Environmental Responsibility*

| | Pre-Survey | Post-Survey | |
|---|---|---|---|
| Attitude Statements | *M (SD)* | *M (SD)* | *MD* |
| My actions impact the health of the environment. | 4.04 (0.86) | 4.56 (0.66) | +0.52 |
| I have the power to help protect the environment. | 4.51 (0.86) | 4.53 (0.72) | +0.02 |
| I can make a change in my community. | 4.33 (0.79) | 4.56 (0.69) | +0.23 |
| I am interested in learning about how to protect the environment. | 4.29 (0.81) | 4.58 (0.66) | +0.29 |
| I am interested in working to make my community a better place. | 4.36 (0.80) | 4.55 (0.66) | +0.19 |
| I work as a volunteer in my community often.* | 3.00 (1.22) | 3.02 (1.22) | +0.02 |

*Note.* *Item dropped from scale in paired-samples *t* -test.

**Attitudes towards the urgency of climate change**. To measure youths' feelings of concern and belief in the importance of action on climate change, participants completed the six-item "Attitudes towards the Urgency of Climate Change" scale (Dijkstra & Goedhart, 2012). Individual items are provided in Table 9. Responses ranged from 1 ("Strongly Disagree") to 5 ("Strongly Agree), with higher scores indicating a greater sense of urgency. Overall, participants felt greater urgency after the program (*M* = 4.07, *SD* = 0.62), compared to before

($M$ = 3.81, $SD$ = 0.65). With the exception of two reverse-scored items, all individual items trended in the expected direction (see Table 9).

A dependent samples *t*-test was performed to assess the statistical significance of participants' increased sense of urgency towards climate change. Prior to conducting the *t*-test, difference scores were inspected for outliers using a boxplot, which identified no extreme scores. Difference scores were normally distributed, as determined through visual inspection of a histogram, Normal Q-Q Plot, and Shapiro-Wilk's test ($p$ = .13). Difference scores were also determined to be normally distributed by examining skewness -0.45 ($SE$ = 0.32) and kurtosis -0.01 ($SE$ = 0.63). The mean increase of 0.26 in youths' attitudes towards the urgency of climate change, 95% CI [0.06, 0.45], was statistically significant, $t(54) = 2.64$, $p$ = .011, $d$ = .36. A summary of *t*-tests for youths' climate change attitudes is provided in Table 10.

Table 9

*Descriptive Statistics for Attitudes Towards the Urgency of Climate Change*

| | Pre-Survey | Post-Survey | |
|---|---|---|---|
| Attitude Items | *M (SD)* | *M (SD)* | *MD* |
| People should care more about climate change. | 4.56 (0.62) | 4.76 (0.47) | +0.20 |
| Climate change should be given top priority. | 4.03 (0.96) | 4.20 (1.11) | +0.17 |
| It is annoying to see people do nothing for the climate change problems. | 4.15 (0.98) | 4.62 (0.65) | +0.47 |
| People worry too much about climate change. (R)* | 3.49 (1.15) | 3.64 (1.35) | +0.14 |
| The seriousness of climate change has been exaggerated. (R) | 2.93 (1.23) | 3.05 (1.39) | +0.12 |
| Climate change is a threat to the world. | 3.71 (1.22) | 4.16 (1.29) | +0.45 |

*Note.* * R = reverse-scored item.

### *4.3.3 Climate Change Behaviors*

**Pro-environmental behaviors and environmental stewardship.** A total of ten items were used to assess youths' behavior with respect to the environment. Of these, four items were unique to the 8-item "Pro-environmental Behaviour" scale (Dijkstra & Goedhart, 2012), two items were unique to the 7-item "Environmental Stewardship Scale" (Stern, Powell, & Ardoin, 2008, p. 34), and four items were shared between these two scales. The combined 10-item "Pro-environmental Behavior and Environmental Stewardship" (PEBES) scale measured attitudes

toward environmental conservation as well as youths' behavioral intentions and specific actions regarding the environment. Individual items are provided in Table 11. Responses ranged from 1 ("Strongly Disagree") to 5 ("Strongly Agree), with higher scores indicating greater pro-environmental intentions and behaviors. Overall, PEBES scores were high before the program ($M$ = 4.14, $SD$ = 0.58) as well as after ($M$ = 4.35, $SD$ = 0.53). All individual items trended in the expected direction (see Table 11).

Table 10

*Summary of Paired-Samples t-Tests for Climate Change Attitudes*

| | Pre | Post | | | | | 95% CI | | Cohen's |
|---|---|---|---|---|---|---|---|---|---|
| Variable | *M (SD)* | *M (SD)* | *MD* | *t* | *df* | *p* | *LL* | *UL* | *d* |
| Connection with Nature | 3.96 (0.62) | 4.13 (0.56) | +0.17 | 1.99 | 54 | .052 | -0.001 | 0.34 | 0.43 |
| Ecological Worldview | 3.68 (0.49) | 3.77 (0.49) | +0.09 | 1.35 | 54 | .183 | -0.04 | 0.22 | 0.18 |
| Environmental Responsibility | 4.33 (0.52) | 4.55 (0.49) | +0.22 | 3.42 | 53 | .001** | 0.09 | 0.35 | 0.47 |
| Attitudes Towards the Urgency of Climate Change | 3.81 (0.65) | 4.07 (0.62) | +0.26 | 2.64 | 54 | .011* | 0.06 | 0.45 | 0.36 |

A paired-samples *t*-test was conducted to assess pre-post program differences in participants' pro-environmental behaviors and environmental stewardship. Inspection of a boxplot revealed no outliers. PEBES differences before and after the program were normally distributed, as assessed by Shapiro-Wilk's test ($p$ = .35) and visual inspection of a histogram and a Normal Q-Q Plot. Difference scores were also determined to be normally distributed by examining skewness 0.01 ($SE$ = 0.33) and kurtosis -0.58 ($SE$ = 0.64). Results of the *t*-test revealed that the mean increase of 0.21 in participants' pro-environmental behaviors and environmental stewardship, 95% CI [0.07, 0.35], was statistically significant, $t(53) = 3.06$, $p$ = .003, $d$ = .42.

Table 11

*Descriptive Statistics for Pro-Environmental Behaviors and Environmental Stewardship*

| Attitude Statements | Pre-Survey *M (SD)* | Post-Survey *M (SD)* | *MD* |
|---|---|---|---|
| I am careful not to waste water.[a] | 4.11 (0.88) | 4.45 (0.69) | +0.35 |
| I am careful not to waste food.[a] | 4.09 (0.95) | 4.36 (0.78) | +0.27 |
| I separate most of my waste for recycling.[b] | 4.16 (0.94) | 4.25 (0.97) | +0.09 |
| I prefer to use public transport or bicycle over car.[b] | 3.67 (1.17) | 4.05 (1.06) | +0.38 |
| I always switch off the lights when I leave a room.[a] | 4.02 (1.11) | 4.33 (0.88) | +0.31 |
| I always turn off the computer when I do not use it.[b] | 4.36 (0.93) | 4.22 (1.12) | -0.15 |
| I try to save energy.[b] | 4.45 (0.81) | 4.53 (0.69) | +0.08 |
| I talk to my friends and family about the environment.[c] | 3.25 (1.17) | 3.67 (1.33) | +0.42 |
| I feel it's important to take good care of the environment.[a] | 4.69 (0.60) | 4.76 (0.54) | +0.07 |
| It's important to protect as wide a variety of animals and plants as we possibly can.[c] | 4.64 (0.65) | 4.64 (0.73) | 0.00 |

*Note.* [a] Item from Pro-environmental Behaviors scale only; [b] Item from both Pro-environmental Behaviors scale and Environmental Stewardship scale; [c] Item from Environmental Stewardship scale only.

**Carbon footprint.** A paired-samples *t*-test was conducted to examine differences in youths' carbon footprints at the beginning of the action phase and again five weeks later. This 20-item assessment included frequency of engagement in specific energy- and waste-related behaviors that have a measurable impact on the environment (see Table 12). Inspection of a boxplot revealed no outliers. The pre-post differences in youths' carbon footprint scores were normally distributed, as assessed by Shapiro-Wilk's test ($p$ = .12) and visual inspection of a histogram and a Normal Q-Q Plot. Difference scores were also determined to be normally distributed by examining skewness -0.38 ($SE$ = 0.35) and kurtosis -0.78 ($SE$ = 0.69). Carbon footprint scores were converted into the metric of pounds (lbs.) of carbon dioxide equivalent ($CO_2e$) emitted over the course of a year corresponding with participants' self-reported behaviors. The minimum possible $CO_2e$ score was 805 lbs./year and the maximum was 10,475 lbs./year.

Since participation in this phase of the program required attendance on specific program weeks, not every participant was able to complete the carbon footprint surveys at pre and post. In total, 46 participants completed both surveys. Results of the *t*-test revealed that participants' carbon footprints were lower ($M$ = 4,514.03, $SD$ = 1,525.29) in the post-survey, compared to the pre-survey ($M$ = 5,162.25, $SD$ = 1,374.23), showing a reduction in youths' environmental impact. This was a statistically significant mean decrease of 648.22 lbs. of $CO_2e$, 95% CI [-972.64, -323.80], $t(45) = -4.02$, $p < .001$, $d = .59$. A summary of *t*-tests for youths' climate change behaviors is provided in Table 13.

### *4.3.4 Sense of Agency*

In post-program surveys, participants were asked to respond, yes or no, to the question: "Did *Science, Camera, Action!* help you to feel like you can make a difference in the world around you?" Fifty-four of 55 participants provided a response. Of these, all but one participant ($n$ = 53; 98.2%) responded affirmatively. In an open-ended survey item, participants were asked to explain why. Results of a thematic analysis are provided in Table 14.

Youths' sense of self-efficacy—or belief in their agentic capabilities—to make a difference in the world was strengthened by *feeling informed* about, (1) Specific actions they could take to reduce their environmental impact; (2) How to help the environment more generally; (3) What is happening in the world; and (4) How they could improve their communities and the world. Participants' self-efficacy to make a difference was also supported by *greater confidence* that they, and children in general, could have a positive impact. In sum, SCA supported youths' sense of agency by strengthening their knowledge and building their confidence.

Table 12

*Descriptive Statistics for Carbon Footprint*

| Questionnaire Item (Response Range) | Pre-Survey ($n$ = 49) Item Response *M (SD)* | Post-Survey ($n$ =46) Item Response *M (SD)* | *MD* | Pre-Survey ($n$ = 49) Avg. $CO_2$e/year *M (SD)* | Post-Survey ($n$ =46) Avg. $CO_2$e/year *M (SD)* | *MD* |
|---|---|---|---|---|---|---|
| *How many days per week do you:* (0 - 5 days) | | | | | | |
| Walk or ride your bike to school? | 1.20 (1.74) | 1.13 (1.61) | - 0.07 | 0.00 (0.00) | 0.00 (0.00) | 0.00 |
| Ride the bus to school? | 1.71 (2.25) | 1.37 (2.10) | - 0.34 | 32.72 (46.78) | 27.37 (42.86) | - 5.35 |
| Share a ride (carpool) to school? | 0.59 (1.46) | 1.04 (1.76) | + 0.45 | 29.61 (70.51) | 72.46 (130.33) | + 42.85 |
| Get a ride to school? | 2.98 (2.19) | 2.52 (2.16) | - 0.46 | 562.10 (459.54) | 512.29 (473.13) | - 49.81 |
| *How often do you:* (1 - 5)[a] | | | | | | |
| Turn off lights when you leave a room? | 4.16 (1.01) | 4.59 (0.88) | + 0.42 | 161.24 (33.99) | 146.94 (29.83) | - 14.30 |
| Unplug chargers when you're not using them? | 3.12 (1.44) | 3.93 (1.36) | + 0.81 | 13.22 (3.24) | 11.40 (3.05) | - 1.83 |
| Hang clothes to dry instead of using the dryer? | 1.69 (1.12) | 1.98 (1.44) | + 0.28 | 619.90 (210.34) | 566.58 (269.52) | - 53.32 |
| Turn off the water when brushing your teeth? | 4.59 (0.91) | 4.78 (0.76) | + 0.19 | 54.33 (49.24) | 44.83 (40.66) | - 9.50 |
| Turn off the TV when you're not watching it? | 4.10 (1.33) | 4.50 (1.19) | + 0.40 | 64.55 (29.10) | 51.53 (19.43) | - 13.02 |
| Turn off your video game system when you're not using it? | 4.27 (1.58) | 4.02 (1.79) | - 0.24 | 29.46 (13.75) | 30.19 (17.67) | + 0.73 |
| Put the computer in "sleep" mode when you're not using it? | 3.41 (1.85) | 3.63 (1.98) | + 0.22 | 126.81 (62.97) | 117.85 (61.96) | - 8.96 |
| *How often do you recycle:* (1 - 5)[a] | | | | | | |
| Magazines? | 2.84 (1.77) | 3.61 (1.53) | + 0.77 | 8.11 (6.64) | 5.22 (5.73) | - 2.89 |
| Newspaper? | 2.96 (1.79) | 3.76 (1.51) | + 0.80 | 45.92 (40.29) | 27.88 (33.94) | - 18.04 |
| Glass? | 3.08 (1.78) | 3.87 (1.50) | + 0.79 | 3.36 (3.11) | 1.98 (2.62) | - 1.38 |
| Plastic? | 3.80 (1.59) | 4.26 (1.12) | + 0.46 | 5.72 (7.57) | 3.51 (5.34) | - 2.21 |
| Aluminum and steel cans? | 3.69 (1.64) | 4.15 (1.19) | + 0.46 | 28.08 (35.17) | 18.23 (25.63) | - 9.85 |
| *How many days per week do you:* (0 - 7 days) | | | | | | |
| Eat meat? | 4.92 (1.88) | 3.89 (2.40) | - 1.03 | 1,692.62 (647.03) | 1,310.67 (838.81) | - 381.95 |
| Drink from a reusable water bottle? | 5.00 (2.59) | 4.83 (2.77) | - 0.17 | 40.30 (52.19) | 45.87 (56.95) | + 5.57 |
| *For dinner, how often do you:* (1 - 5)[b] | | | | | | |
| Eat out (Fast Food, Delivery, Restaurant)? | 2.02 (0.88) | 1.83 (0.74) | - 0.19 | 1,153.23 (907.52) | 998.51 (930.87) | - 154.72 |
| Eat home cooked food? | 4.06 (0.85) | 4.11 (1.02) | + 0.05 | 480.58 (116.38) | 498.64 (121.53) | + 18.06 |
| Total | | | | 5,156.04 (1,352.63) | 4,514.03 (1,525.29) | - 648.22 |

*Note.* [a] Response range: 1 = "Never"; 2 = "Hardly Ever"; 3 = "Half the Time"; 4 = "Most of the Time"; 5 = "Always." [b] Response range: 1 = "0 (Never)"; 2 = "1-2 days per week"; 3 = "3-4 days per week (Half the Time)"; 4 = "5-6 days per week"; 5 = "7 (Every day)."

Table 13

*Summary of Paired-Samples t-Tests for Climate Change Behavior*

| | Pre | Post | | | | | 95% CI | | Cohen's |
|---|---|---|---|---|---|---|---|---|---|
| Variable | *M (SD)* | *M (SD)* | *MD* | *t* | *df* | *p* | *LL* | *UL* | *d* |
| Pro-Environmental Behaviors and Environmental Stewardship[a] | 4.14 (0.58) | 4.35 (0.53) | +0.21 | 3.06 | 53 | .003** | 0.07 | 0.35 | 0.42 |
| Carbon Footprint[b] | 5,162.25 (1,372.40) | 4,514.03 (1,525.29) | -648.22 | -4.02 | 45 | < .001*** | -972.64 | -323.80 | 0.59 |

*Note.* [a] Response range: 1-5, with higher scores indicating more pro-environmental behavior; [b] Response range: 805 - 10,475 lbs. of $CO_2$e/year (carbon dioxide emissions equivalent), with lower scores indicating more pro-environmental behavior.

### *4.3.5 Science Engagement*

A portion of the questionnaire was employed to measure participants' attitudes towards science. A combined 15 items asked youth, before and after program participation, about their views of school science, science careers, and the societal implications of science. Participants were also asked to report their most recent letter grade in science class before the program (i.e., from the fall term) and after the program (i.e., from the spring term). Following the program, youth were asked about their career aspirations as well as whether and how the program helped them to like science more.

**Attitudes towards school science.** The "Attitudes towards School Science" scale consists of seven items (Dijkstra & Goedhart, 2012) completed by participants before and after SCA. Individual items are provided in Table 15. Responses ranged from 1 ("Strongly Disagree") to 5 ("Strongly Agree), with higher scores indicating more positive attitudes towards school science (ATSS). Participants' ATSS were very positive overall, though they were more positive following program participation

($M$ = 4.41, $SD$ = 0.54), compared to before ($M$ = 4.25, $SD$ = 0.70). Three of seven items trended in a direction opposite of expectation, including both reverse-scored items. However, most items trended towards greater positivity towards school science (see Table 15).

Table 14

*Thematic Analysis of SCA's Impact on Sense of Agency*

| Thematic Categories & Representative Quotations [a] | *n* [b] (%) |
|---|---|
| **The program helped me to feel like I can make a difference in the world because..** | **53 (98.15)** |
| ***SCA helped me to feel informed about…*** | |
| *Specific actions I can take.* | 13 (24.07) |
| "Because I know what small things I can do." - Ali, 12 | |
| "Because it gives me ideas to take action." - Arie, 10 | |
| *How to help the environment.* | 10 (18.52) |
| "We learned how to recycle and save our ecosystem." - Henry, 10 | |
| "Because it showed me that I can find ways to help the environment. - Abigail, 13 | |
| *What is happening in the world.* | 5 (9.26) |
| "It helped me know what the world is like and how to protect it." - Noah, 10 | |
| "Because I know what is happening so I can help." - Cecelia, 10 | |
| *How I can improve my community and the world.* | 4 (7.41) |
| "It can help me make a change to the community." - Tim, 11 | |
| ***SCA strengthened my confidence that…*** | |
| *I can make a difference.* | 5 (9.26) |
| "Because I think that I can do it, too." - Miguel, 12 | |
| "Because now I know I can make a difference in the world/my community." - Sydney, 12 | |
| *Kids can make a difference.* | 4 (7.41) |
| "Because at first I thought that kids don't really get a bigger opportunity to help change the world." - Aubrey, 11 | |
| "Because all the kids have some power." - Athena, 10 | |
| **The program did not help me to feel like I could make a difference in the world bec** | **1 (1.85)** |
| ***I already felt that way.*** | 1 (1.85) |
| "I already did think that I could." - Eli, 12 | |

*Note.* $N$ = 54.

[a] Categories appear in order of descending prevalence. Participant responses could be categorized into more than one response type. [b] *n* (%) = number of participant responses corresponding with each thematic category, followed by the percentage of full sample coverage.

Table 15

*Summary of Descriptive Statistics for Science Attitudes*

| Attitude Statements | Pre-Survey *M (SD)* | Post-Survey *M (SD)* | *MD* |
|---|---|---|---|
| *Attitudes Towards School Science* | | | |
| I learn interesting things in science lessons. | 4.22 (0.99) | 4.58 (0.57) | +0.36 |
| I would like to do less science at school. (R)* | 4.00 (1.19) | 4.16 (1.07) | +0.16 |
| I look forward to science lessons. | 4.44 (0.71) | 4.40 (0.85) | -0.04 |
| What I learn in science lessons is useful for me. | 4.05 (1.03) | 4.38 (0.78) | +0.33 |
| Science lessons are fun. | 4.38 (1.01) | 4.44 (0.76) | +0.05 |
| Science is one of the interesting school subjects. | 4.15 (0.95) | 4.29 (0.98) | +0.15 |
| Science lessons bore me. (R) | 4.35 (0.99) | 4.36 (1.08) | +0.02 |
| Composite | 4.23 (0.75) | 4.37 (0.62) | +0.15 |
| *Attitudes Towards Careers in Science* | | | |
| Working in a laboratory would be interesting. | 3.15 (1.24) | 3.67 (1.23) | +0.53 |
| When I leave school, I would like to work with people who make discoveries in science. | 3.47 (1.00) | 3.76 (0.96) | +0.29 |
| I would like being a scientist after I leave school. | 4.04 (0.84) | 4.25 (0.97) | +0.22 |
| A job as scientist would be interesting. | 4.07 (0.96) | 4.20 (0.91) | +0.13 |
| A career in science would be dull and boring. (R) | 3.89 (1.21) | 3.95 (1.19) | +0.05 |
| Composite | 3.72 (0.78) | 3.97 (0.80) | +0.24 |
| *Attitudes Towards Societal Implications of Science* | | | |
| Science helps to make life better. | 4.04 (1.05) | 4.53 (0.66) | +0.49 |
| Government decisions should be more based on what scientists say. | 3.80 (0.91) | 3.95 (0.93) | +0.15 |
| Science can help to make the world a better place in the future. | 4.45 (0.66) | 4.55 (0.63) | +0.09 |
| Composite | 4.10 (0.72) | 4.34 (0.56) | +0.24 |

*Note.* * R = reverse-scored item.

A paired-samples *t*-test was conducted to assess changes in ATSS following program participation. Two cases were dropped from analysis due to missing data. Inspection of a boxplot revealed no outliers. Across the 53 cases included in the analysis, ATSS differences were normally distributed, as assessed by visual inspection of a histogram, a Normal Q-Q Plot, and Shapiro-Wilk's test ($p$ = .42). Difference scores were also determined to be normally distributed by examining skewness 0.28 ($SE$ = 0.33) and kurtosis -0.35 ($SE$ = 0.64). Results of the *t*-test

revealed that the mean increase of 0.16 in youths' ATSS, 95% CI [0.02, 0.30], was statistically significant, $t(52) = 2.22$, $p = .031$, $d = .30$.

After the program, participants were asked, "Did *Science, Camera, Action!* help you to like science more?" Of the 52 participants responding to this question, the majority responded affirmatively (see Figure 21). Participants were then asked, in an open-ended survey item, to explain "Why or why not?" Thematic analyses were conducted separately for "Yes" ($n = 46$) and "No" ($n = 6$) responses. For those reporting that SCA helped them to like science more, most said it was because: (1) SCA was fun and they learned science could be fun; (2) they learned new things in SCA; and (3) they gained a better understanding of the applicability of science to real-world problems. For those who did not feel SCA helped them to like science more, most said it was because they already loved science. A summary of thematic analyses of participants' explanations is provided in Table 16.

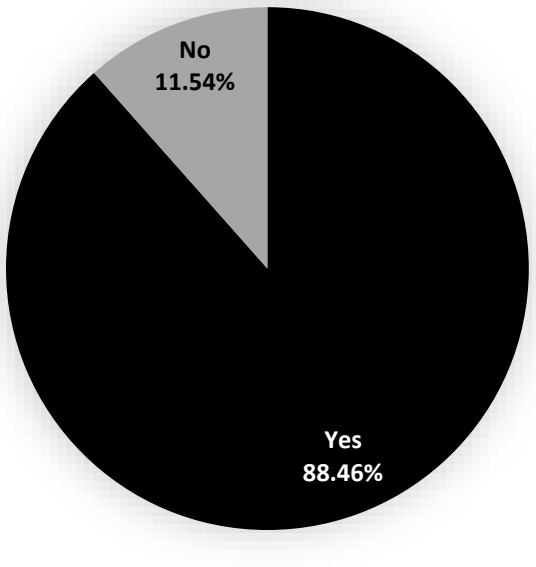


*Figure 21.* Did SCA help you to like science more?

Table 16

*Thematic Analysis of SCA's Impact on Participants' Attitudes Towards Science*

| Thematic Categories & Representative Quotations [a] | *n* [b] (%) |
|---|---|
| **The program helped me to like science more because…** | **46 (88.46)** |
| *SCA was fun and I learned that science can be fun.* | 11 (21.15) |
| "Because I now know science can be FUN!" - Ali, 12 | |
| "Because we did fun activities." - Riley, 10 | |
| *I learned new things in SCA.* | 10 (19.23) |
| "I learned things I never knew!" - George, 11 | |
| "Because I had learned more about my subjects in school." - Lexi, 11 | |
| *SCA helped me understand the applicability of science.* | 9 (17.31) |
| "Yes, because science can help the world." - Gabe, 12 | |
| "Yes, because I like helping other people, and science helps people." - Maria, 10 | |
| *It gave me ideas for action-taking to benefit the environment.* | 6 (11.54) |
| "[SCA] helped me learn what I could do to help." - Tim, 11 | |
| "Because we can save our ecosystem." - Henry, 10 | |
| *SCA made science more interesting.* | 4 (7.69) |
| "Because I slept through class in school. Now I don't." - Nora, 12 | |
| "[SCA] helped me like science more because I know there is a point to it." - Noah, 10 | |
| *It built on my existing enjoyment of science.* | 4 (7.69) |
| "It allowed me to do a lot of science." - Owen, 12 | |
| "Because it made me enjoy the science even more than I did." - Bill, 13 | |
| *It helped me to understand science as a career.* | 2 (3.85) |
| "Because it taught about science. Now I kind of want to be a scientist." Carlos, 10 | |
| "Because it helps to know what to do if you become a scientist." - Olivia, 12 | |
| **The program did not help me to like science more because…** | **6 (11.54)** |
| *I already liked science.* | 4 (7.69) |
| "I liked science already too much to add to." - Abigail, 12 | |
| "SCA is great, but my love for science is too strong already." - Scarlett, 12 | |
| *The program could be improved.* | 1 (1.92) |
| "It didn't really have interesting activities." - Ben, 10 | |
| *I just don't like science.* | 1 (1.92) |
| "Not really. I still hate science!!" - Kelly, 12 | |

*Note.* $N = 52$.

[a] Categories appear in order of descending prevalence. Participant responses could be categorized into more than one response type. [b] *n* (%)= number of participant responses corresponding with each thematic category, followed by the percentage of full sample coverage.

**Attitudes towards science careers.** Five items assessed youths' "Attitudes towards Careers in Science" (Dijkstra & Goedhart, 2012). Individual items are provided in Table 15, above. Responses ranged from 1 ("Strongly Disagree") to 5 ("Strongly Agree), with higher scores indicating more positive attitudes towards careers in science (ATCS). Participants' ATCS were more favorable after the program ($M$ = 4.02, $SD$ = 0.71), compared to before ($M$ = 3.73, $SD$ = 0.78). Four of five individual items trended in the expected direction, towards greater positivity towards science careers (see Table 15).

A paired-samples $t$-test was conducted to assess differences in participants' attitudes towards science careers prior to, and following their participation in the program. Three cases were dropped from analysis due to missing data. A boxplot revealed one outlier in the data, which upon inspection was not determined to be extreme and was retained in the analysis. Across the 52 cases entered into analysis, pre-post differences were normally distributed, as assessed by visual inspection of a histogram, a Normal Q-Q Plot, and Shapiro-Wilk's test ($p$ = .46). Difference scores were also determined to be normally distributed by examining skewness, -0.31 ($SE$ = 0.33) and kurtosis -0.04 ($SE$ = 0.65). The mean increase of 0.29 in youths' ATCS, 95% CI [0.09, 0.49], was statistically significant, $t(51) = 2.96$, $p = .005$, $d = .41$.

**Career choice.** In the post-survey, one open-ended item asked participants about their career aspirations. The 55 responses were categorized into major career fields. More than half (52.73%) aspired to a STEM career (see Figure 22). These included careers in physical science (e.g., physicist), earth science (e.g., geologist), space science (e.g., astronomer), and life science (e.g., biologist) careers, as well as applied science careers in engineering, computer science, and medicine.

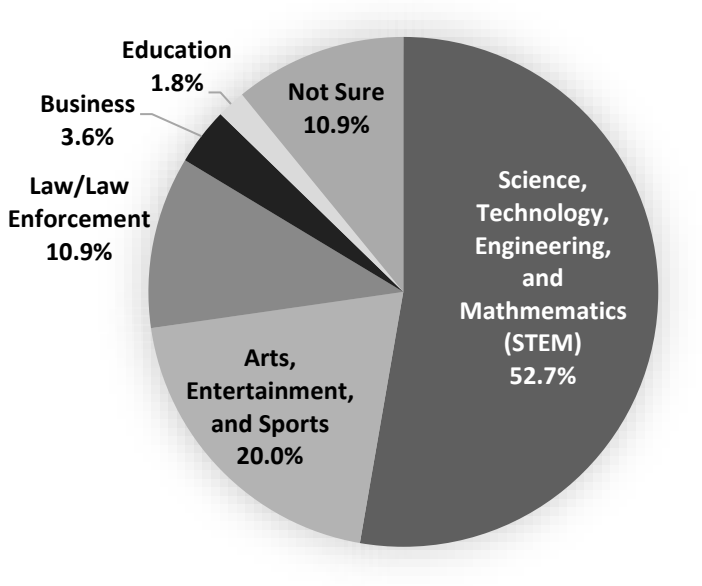


*Figure 22.* Participants' career aspirations by major career category.

**Attitudes towards societal implications of science.** Three items assessed youths' "Attitudes towards Societal Implications of Science" (Dijkstra & Goedhart, 2012). Individual items are provided in Table 15, above. Responses ranged from 1 ("Strongly Disagree") to 5 ("Strongly Agree), with higher scores indicating more positive attitudes towards the societal implications of science (ATSIS). Participants' ATSIS were very positive overall, though they were more positive following program participation ($M$ = 4.33, $SD$ = 0.56), compared to before ($M$ = 4.12, $SD$ = 0.70). All three individual items trended in the expected direction, towards greater positivity towards the role of science in society (see Table 15).

A paired-samples $t$-test was conducted to assess pre- and post-program differences in participants' ATSIS. Prior to analysis, an extreme value was identified through the use of a boxplot and dropped from analysis. Among the 54 cases retained for analysis, the differences in scores before and after program participation were approximately normally distributed, as assessed by Shapiro-Wilk's test ($p$ = .07) as well as visual inspection of a Normal Q-Q Plot and a histogram. Difference scores were also determined to be normally distributed by examining

skewness 0.39 (*SE* = 0.33) and kurtosis 0.18 (*SE* = 0.64). The mean increase of 0.20 in youths' ATSIS, 95% CI [0.01, 0.40], was statistically significant, $t(53) = 2.13$, $p = .038$, $d = .29$.

**Science grades.** As a behavioral measure of youths' science engagement, participants' grades in science class were assessed prior to program participation and afterward. Since the program began in late January and ended during or after students' final week of school in May, participants were asked to report their "most recent grade in science class" for the Fall term in the pre-survey, and for Spring term at post. In the pre-survey, 40.7% (*n* = 22) of participants reported receiving a B in science class the previous Fall, while 44.4% (*n* = 24) received an A. In the post-survey, 22.2% (*n* = 12) of participants reported receiving a B grade in science class in the Spring term, while 70.4% (*n* = 38) reported receiving an A. Of the 54 participants who completed these items, 20 (37.0%) received improved science grades after the program compared to before, seven (13.0%) received a lower grade, and 27 (50.0%) received the same grade (see Figure 23).

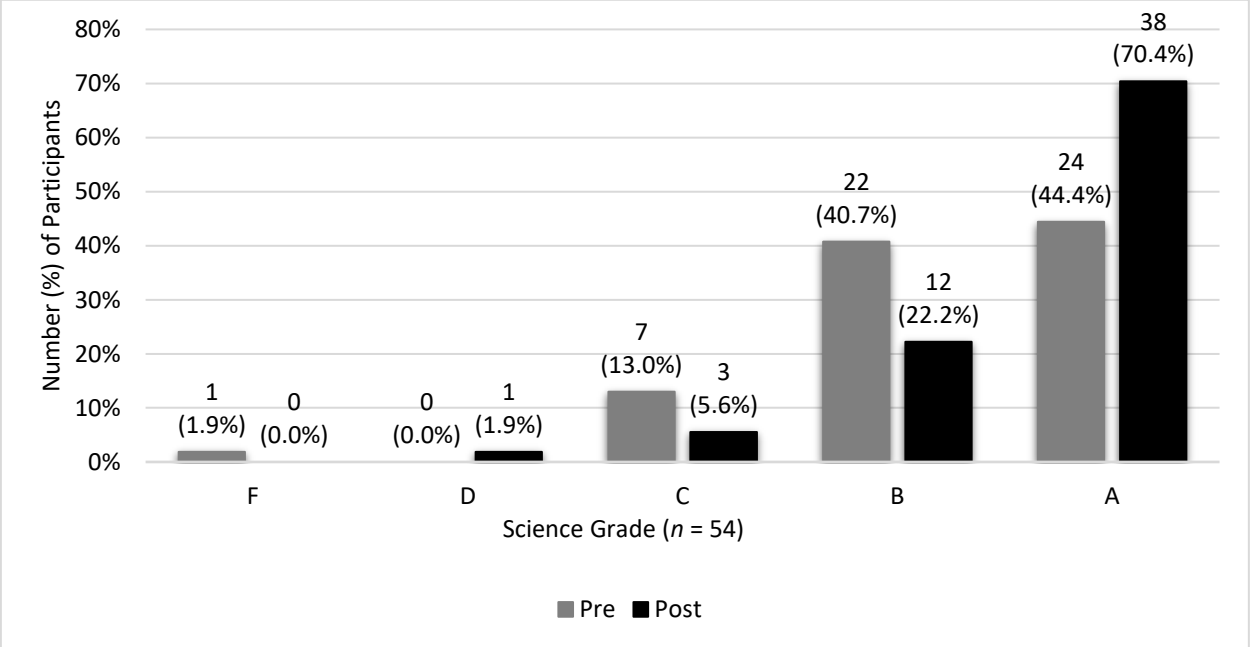


*Figure 23.* Participants' science grades.

Scores ranging from 0 (F) to 10 (A+) were subjected to a dependent samples *t*-test to determine pre- and post-program differences. Prior to analysis, one outlier was identified through inspection of a boxplot, but was determined not to be extreme and was retained in the analysis. One case was removed due to missing data. Across the 54 cases entered into analysis, the differences between self-reported science grades before and after the program were normally distributed, as assessed by Shapiro-Wilk's test ($p$ = .224) and visual inspection of a Normal Q-Q Plot and a histogram. Difference scores were also determined to be normally distributed by examining skewness 0.23 ($SE$ = 0.33) and kurtosis -0.11 ($SE$ = 0.66). Results of the *t*-test revealed that participants' science grades improved from the Fall term ($M$ = 7.20, $SD$ = 2.48) to the Spring term ($M$ = 8.02, $SD$ = 2.10), a statistically significant mean increase of 0.82, 95% CI [0.07, 1.56], $t(53) = 2.19$, $p$ = .033, $d$ = .30. A summary of *t*-tests for youths' science engagement is provided in Table 17.

Table 17

*Summary of Paired-Samples t-Tests for Science Attitudes and Grades*

| | Pre | Post | | | | | 95% CI | | Cohen's |
|---|---|---|---|---|---|---|---|---|---|
| Variable | *M (SD)* | *M (SD)* | *MD* | *t* | *df* | *p* | *LL* | *UL* | *d* |
| Attitudes Towards School Science | 4.25 (0.70) | 4.41 (0.54) | +0.16 | 2.22 | 52 | .031* | 0.01 | 0.30 | 0.30 |
| Attitudes Towards Careers in Science | 3.73 (0.78) | 4.02 (0.71) | +0.29 | 2.96 | 51 | .005** | 0.09 | 0.49 | 0.41 |
| Attitudes Towards Societal Implications of Science | 4.12 (0.70) | 4.33 (0.56) | +0.20 | 2.13 | 53 | .038* | 0.01 | 0.40 | 0.29 |
| Science Grades | 7.20 (2.48) | 8.02 (2.10) | +0.81 | 2.19 | 53 | .033* | 0.07 | 1.56 | 0.30 |

See Tables 18 to 23 for descriptive analyses of survey variables by sub-group (i.e., research site; level of participation; age; gender; ethnicity; socio-economic status).

Table 18

*Descriptive Statistics for Survey Variables by Research Site*

| Variable (Number of Items) | Wellington ($n$ = 9) Pre-Survey *M (SD)* | Wellington ($n$ = 9) Post-Survey *M (SD)* | Wellington *MD* | Fort Collins ($n$ = 19) Pre-Survey *M (SD)* | Fort Collins ($n$ = 19) Post-Survey *M (SD)* | Fort Collins *MD* | Loveland ($n$ = 27) Pre-Survey *M (SD)* | Loveland ($n$ = 27) Post-Survey *M (SD)* | Loveland *MD* |
|---|---|---|---|---|---|---|---|---|---|
| *Climate Change Perceptions and Knowledge* (14 items) | | | | | | | | | |
| How much do you know about climate change? (1)[a] | 3.11 (0.60) | 4.22 (0.83) | + 1.11 | 2.74 (1.05) | 3.89 (1.15) | + 1.16 | 3.56 (1.09) | 4.04 (0.98) | + 0.48 |
| How much have you thought about climate change before today? (1)[a] | 2.67 (1.22) | 3.67 (1.00) | + 1.00 | 2.21 (1.23) | 3.95 (1.03) | + 1.74 | 3.26 (1.51) | 3.56 (1.48) | + 0.30 |
| Earth's climate is changing now. (1)[a] | 4.44 (0.53) | 4.89 (0.33) | + 0.44 | 4.53 (0.61) | 4.74 (0.45) | + 0.21 | 4.58 (0.58) | 4.77 (0.43) | + 0.19 |
| Climate Change Knowledge Assessment (11)[b] | 56.04 (7.03) | 73.43 (10.07) | + 17.39 | 61.10 (10.40) | 66.59 (16.01) | + 5.49 | 62.00 (12.91) | 68.60 (15.41) | + 6.60 |
| *Climate Change Attitudes* (27 items) | | | | | | | | | |
| Connection with Nature (7)[a] | 4.21 (0.58) | 4.16 (0.54) | - 0.05 | 3.86 (0.74) | 4.20 (0.64) | + 0.34 | 3.94 (0.55) | 4.06 (0.53) | + 0.12 |
| Ecological Worldview (10)[a] | 3.66 (0.31) | 3.71 (0.34) | + 0.06 | 3.78 (0.55) | 3.70 (0.42) | - 0.08 | 3.62 (0.51) | 3.84 (0.57) | + 0.22 |
| Environmental Responsibility (5)[a] | 4.60 (0.22) | 4.60 (0.36) | + 0.00 | 4.29 (0.62) | 4.58 (0.55) | + 0.28 | 4.21 (0.53) | 4.53 (0.49) | + 0.31 |
| Attitudes Towards the Urgency of Climate Change (5)[a] | 3.80 (0.49) | 4.10 (0.65) | + 0.30 | 3.89 (0.78) | 3.91 (0.59) | + 0.03 | 3.77 (0.62) | 4.17 (0.63) | + 0.40 |
| *Climate Change Behaviors* (30 items) | | | | | | | | | |
| Pro-environmental Behaviors and Environmental Stewardship (10)[a] | 4.00 (0.96) | 4.26 (0.68) | + 0.26 | 4.21 (0.39) | 4.56 (0.45) | + 0.35 | 4.15 (0.54) | 4.19 (0.57) | + 0.04 |
| Carbon Footprint (20)[c] | 4598.91 (1533.82) | 3347.22 (1623.56) | - 1251.68 | 5065.11 (1334.00) | 4463.30 (1582.16) | - 601.81 | 5370.39 (1299.57) | 4919.15 (1290.29) | - 451.24 |
| *Science Engagement* (17 items) | | | | | | | | | |
| Attitudes Towards School Science (7)[a] | 4.08 (0.76) | 4.40 (0.40) | + 0.32 | 4.21 (0.72) | 4.29 (0.80) | + 0.08 | 4.29 (0.79) | 4.43 (0.53) | + 0.14 |
| Attitudes Towards the Societal Implications of Science (3)[a] | 4.33 (0.76) | 4.30 (0.72) | - 0.04 | 4.11 (0.75) | 4.37 (0.59) | + 0.26 | 4.01 (0.69) | 4.33 (0.51) | + 0.32 |
| Attitudes Towards Careers in Science (5)[a] | 3.87 (0.85) | 4.00 (0.81) | + 0.13 | 3.47 (0.86) | 3.74 (0.71) | + 0.26 | 3.85 (0.68) | 4.12 (0.84) | + 0.27 |
| Science Grade (1)[d] | 3.56 (0.53) | 3.78 (0.44) | + 0.22 | 2.89 (1.24) | 3.50 (0.71) | + 0.61 | 3.30 (0.72) | 3.63 (0.74) | + 0.33 |
| Science Career Aspirations (1, post-only)[e] | | 66.67 ($n$ = 6) | | | 42.11 ($n$ = 8) | | | 55.56 ($n$ = 15) | |

*Note.* [a] Response range: 1 - 5, where higher scores indicate greater knowledge or certainty, stronger and/or more positive attitudes, and more pro-environmental behavior; [b] Response range: 0-100% correct responses; [c] Responses are in the metric of carbon emissions (lbs. of $CO_2$e/year), with lower scores indicating more pro-environmental behavior (lowest possible score = 805; highest possible score =10,475); [d] Response range = 0 - 4, where scores are coded as grade point averages (0 = F; 4 = A). [e] Response range: 0-100% of participants within each group aspiring to a science career.

Table 19

*Descriptive Statistics for Survey Variables by Level of Participation*

| Variable (Number of Items) | 5 to 7 weeks ($n$ = 10) Pre-Survey *M (SD)* | 5 to 7 weeks ($n$ = 10) Post-Survey *M (SD)* | *MD* | 8 to 11 weeks ($n$ = 16) Pre-Survey *M (SD)* | 8 to 11 weeks ($n$ = 16) Post-Survey *M (SD)* | *MD* | 12 to 15 weeks ($n$ = 29) Pre-Survey *M (SD)* | 12 to 15 weeks ($n$ = 29) Post-Survey *M (SD)* | *MD* |
|---|---|---|---|---|---|---|---|---|---|
| *Climate Change Perceptions and Knowledge* (14 | | | | | | | | | |
| How much do you know about climate change? (1)[a] | 3.20 (1.14) | 4.10 (0.99) | + 0.90 | 3.50 (0.97) | 3.81 (1.05) | + 0.31 | 3.03 (1.09) | 4.10 (1.01) | + 1.07 |
| How much have you thought about climate change before today? (1)[a] | 3.40 (1.58) | 3.30 (1.42) | - 0.10 | 2.94 (1.53) | 3.63 (1.09) | + 0.69 | 2.52 (1.30) | 3.90 (1.29) | + 1.38 |
| Earth's climate is changing now. (1)[a] | 4.60 (0.52) | 4.70 (0.48) | + 0.10 | 4.63 (0.62) | 4.88 (0.34) | + 0.25 | 4.46 (0.58) | 4.75 (0.44) | + 0.29 |
| Climate Change Knowledge Assessment (11)[b] | 62.61 (10.69) | 63.48 (16.55) | + 0.87 | 61.96 (12.65) | 71.47 (16.42) | + 9.51 | 59.37 (10.98) | 68.97 (13.34) | + 9.60 |
| *Climate Change Attitudes* (27 items) | | | | | | | | | |
| Connection with Nature (7)[a] | 3.93 (0.33) | 3.87 (0.53) | - 0.06 | 3.99 (0.75) | 4.12 (0.64) | + 0.13 | 3.95 (0.64) | 4.22 (0.52) | + 0.27 |
| Ecological Worldview (10)[a] | 3.53 (0.39) | 3.60 (0.49) | + 0.07 | 3.74 (0.55) | 3.76 (0.38) | - 0.02 | 3.70 (0.50) | 3.84 (0.53) | + 0.13 |
| Environmental Responsibility (5)[a] | 4.16 (0.61) | 4.40 (0.67) | + 0.24 | 4.28 (0.46) | 4.46 (0.49) | + 0.19 | 4.37 (0.56) | 4.66 (0.39) | + 0.29 |
| Attitudes Towards the Urgency of Climate Change (5)[a] | 3.62 (0.58) | 3.83 (0.56) | + 0.22 | 4.05 (0.55) | 3.95 (0.62) | - 0.10 | 3.75 (0.71) | 4.21 (0.62) | + 0.47 |
| *Climate Change Behaviors* (30 items) | | | | | | | | | |
| Pro-environmental Behaviors and Environmental Stewardship (10)[a] | 3.97 (0.49) | 4.14 (0.55) | + 0.17 | 4.17 (0.44) | 4.21 (0.57) | + 0.04 | 4.19 (0.66) | 4.46 (0.55) | + 0.27 |
| Carbon Footprint (20)[c] | 5670.99 (625.99) | 5815.12 (471.80) | + 144.13 | 5273.93 (1687.85) | 5024.32 (1795.37) | - 249.61 | 5000.73 (1203.31) | 4144.75 (1313.51) | - 855.98 |
| *Science Engagement* (17 items) | | | | | | | | | |
| Attitudes Towards School Science (7)[a] | 4.06 (0.66) | 4.06 (0.64) | + 0.00 | 4.43 (0.77) | 4.36 (0.75) | - 0.07 | 4.17 (0.77) | 4.49 (0.50) | + 0.32 |
| Attitudes Towards the Societal Implications of Science (3)[a] | 4.07 (0.54) | 4.13 (0.55) | + 0.07 | 4.06 (0.74) | 4.29 (0.59) | + 0.23 | 4.13 (0.78) | 4.44 (0.54) | + 0.31 |
| Attitudes Towards Careers in Science (5)[a] | 3.76 (1.01) | 3.98 (0.76) | + 0.22 | 3.55 (0.62) | 3.74 (0.85) | + 0.19 | 3.81 (0.79) | 4.09 (0.78) | + 0.28 |
| Science Grade (1)[d] | 3.30 (0.67) | 3.80 (0.42) | + 0.50 | 3.13 (1.20) | 3.44 (0.89) | + 0.31 | 3.21 (0.86) | 3.64 (0.62) | + 0.44 |
| Science Career Aspirations (1, post-only)[e] | | 80.00 ($n$ = 8) | | | 31.25 ($n$ = 5) | | | 55.17 ($n$ = 16) | |

*Note.* [a] Response range: 1 - 5, where higher scores indicate greater knowledge or certainty, stronger and/or more positive attitudes, and more pro-environmental behavior; [b] Response range: 0-100% correct responses; [c] Responses are in the metric of carbon emissions (lbs. of $CO_2$e/year), with lower scores indicating more pro-environmental behavior (lowest possible score = 805; highest possible score =10,475); [d] Response range = 0 - 4, where scores are coded as grade point averages (0 = F; 4 = A). [e] Response range: 0-100% of participants within each group aspiring to a science career.

Table 20

*Descriptive Statistics for Survey Variables by Age*

| Variable (Number of Items) | Age 10* (*n* = 27) Pre-Survey *M (SD)* | Age 10* (*n* = 27) Post-Survey *M (SD)* | Age 10* (*n* = 27) *MD* | Age 11 (*n* = 16) Pre-Survey *M (SD)* | Age 11 (*n* = 16) Post-Survey *M (SD)* | Age 11 (*n* = 16) *MD* | Age 12 (*n* = 12) Pre-Survey *M (SD)* | Age 12 (*n* = 12) Post-Survey *M (SD)* | Age 12 (*n* = 12) *MD* |
|---|---|---|---|---|---|---|---|---|---|
| *Climate Change Perceptions and Knowledge* (14 items) | | | | | | | | | |
| How much do you know about climate change? (1)[a] | 3.30 (1.10) | 3.85 (1.10) | + 0.56 | 2.94 (0.93) | 4.13 (0.96) | + 1.19 | 3.33 (1.15) | 4.25 (0.87) | + 0.92 |
| How much have you thought about climate change before today? (1)[a] | 3.41 (1.39) | 3.74 (1.35) | + 0.33 | 2.00 (1.15) | 3.13 (1.15) | + 1.13 | 2.50 (1.31) | 4.42 (0.79) | + 1.92 |
| Earth's climate is changing now. (1)[a] | 4.50 (0.65) | 4.73 (0.45) | + 0.23 | 4.56 (0.51) | 4.81 (0.40) | + 0.25 | 4.58 (0.51) | 4.83 (0.39) | + 0.25 |
| Climate Change Knowledge Assessment (11)[b] | 58.13 (11.32) | 64.41 (12.18) | + 6.28 | 61.96 (9.19) | 67.93 (17.31) | + 5.98 | 64.86 (13.17) | 79.35 (12.31) | + 14.49 |
| *Climate Change Attitudes* (27 items) | | | | | | | | | |
| Connection with Nature (7)[a] | 4.10 (0.53) | 4.18 (0.55) | + 0.08 | 3.84 (0.59) | 4.00 (0.58) | + 0.16 | 3.81 (0.82) | 4.18 (0.59) | + 0.37 |
| Ecological Worldview (10)[a] | 3.58 (0.60) | 3.77 (0.54) | + 0.19 | 3.80 (0.34) | 3.71 (0.44) | - 0.09 | 3.76 (0.35) | 3.87 (0.44) | + 0.11 |
| Environmental Responsibility (5)[a] | 4.36 (0.56) | 4.56 (0.48) | + 0.21 | 4.40 (0.47) | 4.55 (0.55) | + 0.15 | 4.07 (0.53) | 4.55 (0.44) | + 0.48 |
| Attitudes Towards the Urgency of Climate Change (5)[a] | 3.70 (0.63) | 3.92 (0.52) | + 0.22 | 3.76 (0.67) | 4.17 (0.69) | + 0.41 | 4.14 (0.64) | 4.26 (0.69) | + 0.13 |
| *Climate Change Behaviors* (30 items) | | | | | | | | | |
| Pro-environmental Behaviors and Environmental Stewardship (10)[a] | 4.25 (0.52) | 4.30 (0.55) | + 0.05 | 3.87 (0.69) | 4.24 (0.68) | + 0.37 | 4.28 (0.43) | 4.51 (0.41) | + 0.23 |
| Carbon Footprint (20)[c] | 5015.43 (1242.92) | 4656.56 (1355.85) | - 358.87 | 5640.68 (1306.08) | 5017.99 (1477.93) | - 622.69 | 4792.54 (1574.60) | 3729.86 (1707.83) | - 1062.68 |
| *Science Engagement* (17 items) | | | | | | | | | |
| Attitudes Towards School Science (7)[a] | 4.17 (0.81) | 4.44 (0.55) | + 0.28 | 4.34 (0.67) | 4.28 (0.77) | - 0.06 | 4.20 (0.79) | 4.35 (0.55) | + 0.14 |
| Attitudes Towards the Societal Implications of Science (3)[a] | 4.05 (0.75) | 4.35 (0.52) | + 0.30 | 4.17 (0.67) | 4.40 (0.64) | + 0.23 | 4.11 (0.77) | 4.25 (0.59) | + 0.14 |
| Attitudes Towards Careers in Science (5)[a] | 3.81 (0.72) | 3.96 (0.92) | + 0.16 | 3.53 (0.66) | 3.86 (0.69) | + 0.34 | 3.80 (1.05) | 4.12 (0.64) | + 0.32 |
| Science Grade (1)[d] | 3.41 (0.97) | 3.85 (0.46) | + 0.44 | 2.88 (1.02) | 3.50 (0.89) | + 0.63 | 3.17 (0.58) | 3.25 (0.62) | + 0.08 |
| Science Career Aspirations (1, post-only)[e] | | 48.15 (*n* = | | | 56.25 (*n* = 9) | | | 58.33 (*n* = 7) | |

*Note.* * Age at pre-survey; [a] Response range: 1 - 5, where higher scores indicate greater knowledge or certainty, stronger and/or more positive attitudes, and more pro-environmental behavior; [b] Response range: 0-100% correct responses; [c] Responses are in the metric of carbon emissions (lbs. of $CO_2$e/year), with lower scores indicating more pro-environmental behavior (lowest possible score = 805; highest possible score =10,475); [d] Response range = 0 - 4, where scores are coded as grade point averages (0 = F; 4 = A). [e] Response range: 0-100% of participants within each group aspiring to a science career.

Table 21

*Descriptive Statistics for Survey Variables by Gender*

| Variable (Number of Items) | Girls ($n$ = 29) Pre-Survey *M (SD)* | Girls ($n$ = 29) Post-Survey *M (SD)* | Girls *MD* | Boys ($n$ = 26) Pre-Survey *M (SD)* | Boys ($n$ = 26) Post-Survey *M (SD)* | Boys *MD* |
|---|---|---|---|---|---|---|
| *Climate Change Perceptions and Knowledge* (14 items) | | | | | | |
| How much do you know about climate change? (1)[a] | 3.00 (1.04) | 4.21 (0.94) | + 1.21 | 3.42 (1.06) | 3.81 (1.06) | + 0.38 |
| How much have you thought about climate change before today? (1)[a] | 2.62 (1.35) | 3.83 (1.10) | + 1.21 | 3.00 (2.06) | 3.58 (1.42) | + 0.58 |
| Earth's climate is changing now. (1)[a] | 4.48 (0.57) | 4.72 (0.45) | + 0.24 | 4.60 (3.06) | 4.84 (0.37) | + 0.24 |
| Climate Change Knowledge Assessment (11)[b] | 60.42 (12.26) | 69.42 (13.62) | + 9.00 | 61.04 (10.40) | 67.89 (16.32) | + 6.86 |
| *Climate Change Attitudes* (27 items) | | | | | | |
| Connection with Nature (7)[a] | 4.14 (0.62) | 4.20 (0.55) | + 0.06 | 3.75 (0.57) | 4.04 (0.58) | + 0.29 |
| Ecological Worldview (10)[a] | 3.78 (0.52) | 3.75 (0.47) | - 0.03 | 3.58 (0.44) | 3.80 (0.51) | + 0.22 |
| Environmental Responsibility (5)[a] | 4.44 (0.53) | 4.58 (0.44) | + 0.14 | 4.15 (0.52) | 4.53 (0.54) | + 0.38 |
| Attitudes Towards the Urgency of Climate Change (5)[a] | 3.87 (0.74) | 4.13 (0.60) | + 0.26 | 3.75 (0.55) | 4.00 (0.65) | + 0.25 |
| *Climate Change Behaviors* (30 items) | | | | | | |
| Pro-environmental Behaviors and Environmental Stewardship (10)[a] | 4.18 (0.65) | 4.35 (0.49) | + 0.17 | 4.11 (0.49) | 4.31 (0.64) | + 0.20 |
| Carbon Footprint (20)[c] | 5101.65 (1389.51) | 4360.72 (1528.06) | - 740.93 | 5174.88 (1332.11) | 4712.65 (1514.62) | - 462.23 |
| *Science Engagement* (17 items) | | | | | | |
| Attitudes Towards School Science (7)[a] | 4.20 (0.74) | 4.41 (0.64) | + 0.22 | 4.26 (0.79) | 4.33 (0.60) | + 0.07 |
| Attitudes Towards the Societal Implications of Science (3)[a] | 4.11 (0.75) | 4.33 (0.61) | + 0.22 | 4.08 (0.70) | 4.35 (0.51) | + 0.27 |
| Attitudes Towards Careers in Science (5)[a] | 3.60 (0.85) | 3.81 (0.82) | + 0.21 | 3.86 (0.69) | 4.14 (0.74) | + 0.28 |
| Science Grade (1)[d] | 3.21 (0.90) | 3.62 (0.62) | + 0.41 | 3.19 (0.98) | 3.60 (0.76) | + 0.41 |
| Science Career Aspirations (1, post-only)[e] | | 68.97 ($n$ = 20) | | | 34.62 ($n$ = 9) | |

*Note.* [a] Response range: 1 - 5, where higher scores indicate greater knowledge or certainty, stronger and/or more positive attitudes, and more pro-environmental behavior; [b] Response range: 0-100% correct responses; [c] Responses are in the metric of carbon emissions (lbs. of $CO_2e$/year), with lower scores indicating more pro-environmental behavior (lowest possible score = 805; highest possible score =10,475); [d] Response range = 0 - 4, where scores are coded as grade point averages (0 = F; 4 = A). [e] Response range: 0-100% of participants within each group aspiring to a science career.

Table 22

*Descriptive Statistics for Survey Variables by Race/Ethnicity*

| Variable (Number of Items) | Hispanic/Latino ($n$ = 14) Pre-Survey *M (SD)* | Hispanic/Latino ($n$ = 14) Post-Survey *M (SD)* | *MD* | White/European American ($n$ = 32) Pre-Survey *M (SD)* | White/European American ($n$ = 32) Post-Survey *M (SD)* | *MD* | Other* ($n$ = 9) Pre-Survey *M (SD)* | Other* ($n$ = 9) Post-Survey *M (SD)* | *MD* |
|---|---|---|---|---|---|---|---|---|---|
| *Climate Change Perceptions and Knowledge* (14 items) | | | | | | | | | |
| How much do you know about climate change? (1)[a] | 2.86 (1.03) | 3.21 (1.05) | + 0.36 | 3.47 (1.02) | 4.34 (0.87) | + 0.87 | 2.78 (1.09) | 4.11 (0.78) | + 1.33 |
| How much have you thought about climate change before today? (1)[a] | 2.93 (1.44) | 4.14 (0.95) | + 1.21 | 2.88 (1.43) | 3.72 (1.33) | + 0.84 | 2.33 (1.50) | 3.00 (1.22) | + 0.67 |
| Earth's climate is changing now. (1)[a] | 4.07 (0.62) | 4.79 (0.43) | + 0.71 | 4.69 (0.47) | 4.81 (0.40) | + 0.13 | 4.75 (0.46) | 4.63 (0.52) | - 0.13 |
| Climate Change Knowledge Assessment (11)[b] | 52.17 (10.51) | 63.66 (8.96) | + 11.49 | 64.81 (10.56) | 71.60 (16.38) | + 6.79 | 59.42 (7.53) | 66.18 (15.18) | + 6.76 |
| *Climate Change Attitudes* (27 items) | | | | | | | | | |
| Connection with Nature (7)[a] | 3.90 (0.53) | 4.36 (0.44) | + 0.46 | 4.02 (0.59) | 4.04 (0.61) | + 0.02 | 3.84 (0.88) | 4.08 (0.50) | + 0.24 |
| Ecological Worldview (10)[a] | 3.42 (0.39) | 3.66 (0.46) | + 0.24 | 3.86 (0.50) | 3.90 (0.50) | + 0.04 | 3.46 (0.37) | 3.49 (0.29) | + 0.03 |
| Environmental Responsibility (5)[a] | 4.26 (0.62) | 4.69 (0.30) | + 0.43 | 4.31 (0.51) | 4.53 (0.53) | + 0.23 | 4.38 (0.56) | 4.44 (0.56) | + 0.07 |
| Attitudes Towards the Urgency of Climate Change (5)[a] | 3.49 (0.41) | 3.83 (0.49) | + 0.35 | 4.07 (0.65) | 4.25 (0.59) | + 0.18 | 3.39 (0.58) | 3.79 (0.74) | + 0.40 |
| *Climate Change Behaviors* (30 items) | | | | | | | | | |
| Pro-environmental Behaviors and Environmental Stewardship (10)[a] | 4.23 (0.47) | 4.61 (0.36) | + 0.39 | 4.20 (0.50) | 4.26 (0.57) | + 0.06 | 3.82 (0.86) | 4.13 (0.67) | + 0.31 |
| Carbon Footprint (20)[c] | 4736.72 (1189.48) | 3670.51 (1129.02) | - 1066.21 | 5259.13 (1484.77) | 4892.17 (1484.66) | - 366.96 | 5355.37 (1107.74) | 4745.35 (1768.23) | - 610.02 |
| *Science Engagement* (17 items) | | | | | | | | | |
| Attitudes Towards School Science (7)[a] | 3.90 (0.96) | 4.40 (0.59) | + 0.50 | 4.46 (0.63) | 4.40 (0.67) | - 0.05 | 3.92 (0.54) | 4.24 (0.49) | + 0.32 |
| Attitudes Towards the Societal Implications of Science (3)[a] | 3.90 (0.82) | 4.50 (0.41) | + 0.60 | 4.24 (0.66) | 4.34 (0.56) | + 0.10 | 3.89 (0.73) | 4.07 (0.70) | + 0.19 |
| Attitudes Towards Careers in Science (5)[a] | 3.94 (0.67) | 4.01 (0.90) | + 0.07 | 3.78 (0.74) | 4.07 (0.72) | + 0.29 | 3.18 (0.94) | 3.53 (0.84) | + 0.36 |
| Science Grade (1)[d] | 2.64 (1.01) | 3.77 (0.44) | + 1.13 | 3.34 (0.90) | 3.53 (0.76) | + 0.19 | 3.56 (0.53) | 3.67 (0.71) | + 0.11 |
| Science Career Aspirations (1, post-only)[e] | | 42.86 ($n$ = 6) | | | 50.00 ($n$ = 16) | | | 77.78 ($n$ = 7) | |

*Note*. * Participants of multiple ethnicities ($n$ = 7) and Asian American participants ($n$ = 2); [a] Response range: 1 - 5, where higher scores indicate greater knowledge or certainty, stronger and/or more positive attitudes, and more pro-environmental behavior; [b] Response range: 0-100% correct responses; [c] Responses are in the metric of carbon emissions (lbs. of $CO_2$e/year), with lower scores indicating more pro-environmental behavior (lowest possible score = 805; highest possible score =10,475); [d] Response range = 0 - 4, where scores are coded as grade point averages (0 = F; 4 = A). [e] Response range: 0-100% of participants within each group aspiring to a science career.

Table 23

*Descriptive Statistics for Survey Variables by Socio-economic Status*

| Variable (Number of Items) | Below Poverty Line ($n$ = 24) Pre-Survey *M (SD)* | Below Poverty Line ($n$ = 24) Post-Survey *M (SD)* | *MD* | Above Poverty Line ($n$ = 31) Pre-Survey *M (SD)* | Above Poverty Line ($n$ = 31) Post-Survey *M (SD)* | *MD* |
|---|---|---|---|---|---|---|
| *Climate Change Perceptions and Knowledge* (14 items) | | | | | | |
| How much do you know about climate change? (1)[a] | 3.08 (0.93) | 3.83 (1.09) | + 0.75 | 3.29 (1.16) | 4.16 (0.93) | + 0.87 |
| How much have you thought about climate change before today? (1)[a] | 2.79 (1.32) | 3.67 (1.31) | + 0.87 | 2.81 (1.54) | 3.74 (1.24) | + 0.94 |
| Earth's climate is changing now. (1)[a] | 4.33 (0.56) | 4.75 (0.44) | + 0.42 | 4.70 (0.53) | 4.80 (0.41) | + 0.10 |
| Climate Change Knowledge Assessment (11)[b] | 58.15 (9.05) | 65.58 (17.05) | + 7.43 | 62.69 (12.59) | 71.11 (12.63) | + 8.42 |
| *Climate Change Attitudes* (27 items) | | | | | | |
| Connection with Nature (7)[a] | 3.79 (0.58) | 4.14 (0.53) | + 0.35 | 4.09 (0.64) | 4.12 (0.60) | + 0.03 |
| Ecological Worldview (10)[a] | 3.63 (0.45) | 3.78 (0.43) | + 0.15 | 3.73 (0.53) | 3.76 (0.53) | + 0.04 |
| Environmental Responsibility (5)[a] | 4.27 (0.53) | 4.60 (0.42) | + 0.33 | 4.34 (0.55) | 4.52 (0.53) | + 0.19 |
| Attitudes Towards the Urgency of Climate Change (5)[a] | 3.87 (0.58) | 4.00 (0.56) | + 0.13 | 3.77 (0.71) | 4.12 (0.66) | + 0.35 |
| *Climate Change Behaviors* (30 items) | | | | | | |
| Pro-environmental Behaviors and Environmental Stewardship (10)[a] | 4.30 (0.34) | 4.48 (0.53) | + 0.18 | 4.02 (0.68) | 4.21 (0.57) | + 0.19 |
| Carbon Footprint (20)[c] | 4807.11 (1379.07) | 3946.16 (1486.48) | - 860.95 | 5366.96 (1304.71) | 4926.17 (1425.72) | - 440.79 |
| *Science Engagement* (17 items) | | | | | | |
| Attitudes Towards School Science (7)[a] | 4.14 (0.85) | 4.28 (0.74) | + 0.14 | 4.29 (0.68) | 4.45 (0.51) | + 0.16 |
| Attitudes Towards the Societal Implications of Science (3)[a] | 4.21 (0.69) | 4.37 (0.51) | + 0.17 | 4.01 (0.74) | 4.31 (0.60) | + 0.30 |
| Attitudes Towards Careers in Science (5)[a] | 3.67 (0.83) | 3.91 (0.73) | + 0.24 | 3.77 (0.75) | 4.01 (0.85) | + 0.25 |
| Science Grade (1)[d] | 2.88 (1.12) | 3.48 (0.85) | + 0.60 | 3.45 (0.68) | 3.71 (0.53) | + 0.26 |
| Science Career Aspirations (1, post-only)[e] | | 45.83 ($n$ = 11) | | | 58.06 ($n$ = 18) | |

*Note.* [a] Response range: 1 - 5, where higher scores indicate greater knowledge or certainty, stronger and/or more positive attitudes, and more pro-environmental behavior; [b] Response range: 0-100% correct responses; [c] Responses are in the metric of carbon emissions (lbs. of $CO_2$e/year), with lower scores indicating more pro-environmental behavior (lowest possible score = 805; highest possible score =10,475); [d] Response range = 0 - 4, where scores are coded as grade point averages (0 = F; 4 = A). [e] Response range: 0-100% of participants within each group aspiring to a science career.

### 4.4 Focus Group Results

Findings from focus groups are organized in the order of this study's research questions. Selected quotations from youth participants are provided to illustrate key themes. All quotations are attributed to participants through the use of youth-chosen pseudonyms and the age of participants at the time focus groups were conducted. See Table 24 for an overview of participant identifiers by research site.

Table 24

*Participants' Pseudonyms and Ages by Research Site*

| Wellington ($n$ = 9) | | Fort Collins ($n$ = 19) | | | |
|---|---|---|---|---|---|
| Cecelia | 10 | Melanie | 10 | Nora | 12 |
| Athena | 10 | Dori | 10 | Katherine | 12 |
| Lexi | 10 | Bri | 10 | Olivia | 12 |
| *Jimmy* | 10 | *Henry* | 10 | Isabella | 12 |
| Cristy | 11 | *Carlos* | 10 | *Miguel* | 12 |
| Sammy | 12 | *Theo* | 10 | *Evan* | 12 |
| Sydney | 12 | Grace | 11 | Annie | 13 |
| Ali | 12 | *Luke* | 11 | Abigail | 13 |
| *Matthew* | 13 | *Tim* | 11 | Rose | 13 |
| | | Kelly | 12 | | |
| **Loveland ($n$ = 27)** | | | | | |
| Lucy | 10 | *Daniel* | 10 | Scarlett | 12 |
| Maria | 10 | *George* | 10 | Claire | 12 |
| Peyton | 10 | *Noah* | 10 | *Owen* | 12 |
| Alexis | 10 | Charlotte | 11 | *Gabe* | 12 |
| Riley | 10 | Aubrey | 11 | *Wayne* | 12 |
| Arie | 10 | *Frank* | 11 | *Eli* | 12 |
| *Dominic* | 10 | *Jack* | 11 | *Bill* | 13 |
| *Connor* | 10 | *Andrew* | 11 | | |
| *Bryan* | 10 | *James* | 11 | | |
| *Ben* | 10 | *Michael* | 11 | | |

*Note* . For clarification of gender, boys' names are italicized while girls' are not.

### *4.4.1 Climate Change Perceptions and Knowledge*

During focus groups, participants were asked to reflect on their climate change perceptions and knowledge before and after their participation in SCA. Before the program, youth reported varying degrees of familiarity with climate change. Following SCA, numerous participants demonstrated their knowledge of fundamental principles about the scientific and social dimensions of climate change, including its causes, consequences, and solutions. They reported that learning about climate change during the program was fun. Further, participants understood climate change as a major problem to be solved, and they were eager to be part of the solution. With their enhanced knowledge, many expressed that they felt motivated to learn more and do more about climate change.

**General perceptions about climate change.** A portion of the focus group guide was dedicated to exploring youths' perspectives on, and sources of information about climate change prior to their participation in the program. When asked whether they had "heard of global warming or climate change before the program," participant responses varied widely. Several, mostly younger, participants reported having had no knowledge of climate change, such as Lucy, age 10, who said, "I didn't know about climate change before the program. At all." Others reported having heard of climate change, but not knowing very much, if anything, about it:

> Before the program I just-, I didn't really know much at all about climate change. I just knew that there was something *called* climate change. – Arie (10)

> I didn't really know what climate change was. I just heard it a few times and I had no idea. – Ben (10)

> When we started talking about climate change, I never really knew what it was. So when we started getting into it, I kind of started to learn what it was, and what it does to Earth and what the effects on it was. – Charlotte (10)

When asked to "think back to before the program started" and describe what came to mind when they thought about climate change, participants reported a range of associations. Aubrey, age 11, said she "thought it was the same as elevation pretty much." Other examples included:

Annie (13): Electricity.
Theo (10): Melting ice cream. I'm joking, no, polar bears.
Melanie (10): The ocean.
Kelly (12): The sun.
Miguel (12): Solid that turns into a liquid.

Most prevalent, however, were responses similar to that given by Rose, age 13, who said, "I just thought about weather. How weather changes and stuff." This perception was common across age groups and research sites.

> I had heard of [climate change], but before [SCA], I thought it was just snow, rain, and summer. I just thought of it as weather. Now I think of it like that's where I live and grow. – Alexis (10)

> I thought it was something like the weather and how the weather could change in a short period of time. – Tim (11)

> I didn't really know the exact definition. I thought that climate change was where the Earth changes its weather every once in a while. Not that it was from us doing stuff to it. – Olivia (12)

> I thought that weather and climate change were almost the exact same thing. – Nora (12)

Some participants said they had some awareness of climate change before the program, though the extent to which they thought about the issue varied, as did their level of knowledge. Andrew, age 11, said that he had "known what it was," but the he "didn't really think about it that much." Twelve-year-old Wayne "always knew it was bad and it's going to kill the Earth someday."

When asked to "think back to before the program started" and describe what came to mind when they thought about climate change, a number of participants provided mostly accurate information about climate change impacts:

> I thought that [climate change] was like global warming and how it can melt everything. – Grace (11)

> I thought [climate change] was how the sun was melting glaciers and stuff in Antarctica. Yeah. How the sun was melting the glaciers, and ... the sea level would rise. – Katherine (12)

> I thought about global warming and how it's hurting a whole bunch of different animals and how if we don't stop, it's going to end up killing our whole ecosystem. – Abigail (13)

**Sources of climate change information.** Youth from each research site discussed having learned about climate change to some extent in school, though their exposure varied by school and by grade level. Older participants more often than younger participants reported learning about climate change in school, such as Abigail, age 13, who "heard about it in science and geography" class. As Wayne, age 12, described:

> Everybody's talking about it and my teacher told me about it and she said that it's a big deal. And I actually believed that it was a big deal, and that it will affect the Earth someday if we don't fix it. – Wayne (12)

However, as the following two exchanges illustrate—first in Fort Collins between Nora and Tim, and later in Loveland between Jack and Maria—not everyone reported learning about climate change in school.

Nora (12): [Learning about climate change in school] depends on what grade they're in. It also depends on what the school teaches. Because in [Western state], when I was there until fifth grade, I didn't learn anything about climate change. They didn't tell me anything about it.

Tim (11): Yeah, they don't teach us here either.

Nora (12): When I got here in fifth grade, too, they kind of told me a little bit more about climate change … I never knew what greenhouse gases were until I came to this program.

Tim (11): I didn't even know there was such thing as greenhouse gases.

Jack (11): I didn't know that much about $CO_2$.
Maria (10): Yeah. Me and Jack's teacher didn't really talk about it.

Beyond school, participants reported having heard about climate change on television, in the news, from books, and through field trips and visits to museums and zoos. The following statements represent sources of climate change information or awareness by youth from each of the three research sites:

> It's just everywhere I go. I always see posters … about climate change. – Nora (12)

> I learned it through books. I knew that migration patterns were changing, and plants were blooming earlier. – Ali (12)

> I have known about climate change because ... my mom likes watching the news in the morning. My grandma likes watching the news in the morning. I've heard a lot about it in my life, but I never knew how serious it could be. Ever. – Bill (13)

For some, especially younger, participants, hearing about climate change made them curious to know more. Ten-year-old Noah, who "didn't think about [climate change] that much," nevertheless had a feeling that "it was important to know about." As Daniel, age 10, put it, "[Before the program], I didn't really know what to do with [climate change] … Now that I know what climate change is, I can probably answer more [questions]." As others described:

> I had a lot of questions about it, but I heard about it a lot on the news, because that was like the big thing on the news whenever it came on. – Cecelia (10)

> I saw it on the news and I kind of paid attention to it, then I stopped paying attention to it. I heard about it and I started researching it and then I stopped. – Jimmy (10)

**SCA's impact on youths' climate change knowledge.** Several participants said that what they learned in SCA built on what they had previously learned in school because it included more or different information. As Andrew, age 11, explained, "Since [we're] not in middle school, [SCA] actually teaches you more about [climate change]." Compared to school, SCA was perceived to cover the causes and consequences of climate change in greater depth.

> [SCA] makes me think about [climate change] more because now I know that climate change has done more than what I just learned in class. – Daniel (10)

> You learn way more [in SCA] than your school because sometimes the school doesn't really talk about these [fossil fuel] resources that we're using. And that they should stop using old resources. – James (11)

> I don't know how to put this, but I knew from class … that [climate change] was really bad and it wasn't a good thing. But I didn't exactly know why until this program and that just let me see why it's bad and what it does. – Scarlett (12)

Like Scarlett, others explained that SCA expanded their knowledge about the extent of the problem, particularly regarding the intensity of climate change impacts. Irrespective of their prior knowledge, many participants explained that SCA deepened their understanding of "how bad" climate change could be.

> I knew that [climate change] could hurt the environment very badly …[but] I didn't know that it could be very bad like what I learned here. – Cristy (11)

> I learned just how bad global warming was. I knew that it was bad, but I didn't know just how *bad*… Like, for one of the glaciers, there was a glacier and now there's just a lake! – Ali (12)

> [Before the program], I didn't really think about [climate change] actually. I just didn't care for it, but after the program, I realized how it can affect the world just by glaciers melting and sea levels rising. Homes will be lost. – Sydney (12)

> I didn't think it was that bad and I thought maybe it was just happening in one country or something like that, but I actually learned that it's happening almost everywhere. – Peyton (10)

> Before the program, I thought that people were going to need to fix it or something bad is going to happen. I didn't know what was *going* to happen, or what *could* happen until we did this, and I learned what could happen. – Gabe (12)

***Causes of climate change.*** Following the program, youth reported increased knowledge of the scientific and social dimensions of climate change. During focus groups, many participants demonstrated this knowledge by explaining various aspects of climate change while reflecting on the program. For example, several participants displayed knowledge of the primary

cause of Earth's rapidly changing climate, which is the emission of greenhouses gases into the atmosphere through the burning of fossil fuels (e.g., coal, oil, natural gas).

> Greenhouse gases [are] the main cause of climate change. – Bill (13)

> [Now that the program is over], I still think about how global warming impacts the world, but I also think about how the greenhouse gases are hurting our atmosphere. – Abigail (13)

Though not true of all SCA participants, a basic understanding of climate change was demonstrated by participants at each research site and by every age group. Youths' grasp of the causes and consequences of climate change could be quite substantive, as the following exchange exemplifies. This conversation begins with Andrew voicing concerns about non-renewable energy sources being depleted one day.

Andrew (11): Okay, so fossil fuels are killing animals and everything, but in the next fifty years they're all going to be gone … Also, if we keep using fossil fuels, it'll make our earth almost unlivable.

James (11): …A lot of fossil fuels can kill a lot of things, but it could kill like a whole ecosystem ... because if we don't stop using fossil fuels–

Noah (10): I think they should definitely fix that.

Daniel (10): I think we should … now that the whole world knows that we are using fossil fuels that are harmful for our environment and we're killing animals that really probably should survive.

James (11): I think that people should stop using a bunch of resources because they're not going to be around anymore … Like all the ores because, basically they're not coming back.

Understanding climate change as human-caused, several participants expressed concerns about manufactured products and the actions of people in relation to fossil fuel consumption.

> People should not get trucks as much because they're a bigger problem than cars or motorcycles are. – Rose (13)

> Plastic sucks. It's made out of oil. – Theo (10)

> People should stop [using] coal … [and producing] gases that can cause climate change or global warming. – Jimmy (10)

> People should start using unlimited [renewable] sources instead of sources from the ground and all those, like coal, that release all the gases. You can just only use solar panels to generate more energy, even wind power. – Andrew (11)

At the same time, a few participants said that they did not know very much, if anything at all, about climate change following the program.

> I still don't know what [climate change] is. – Miguel (12)

> I actually didn't learn that much about climate change. – Tim (11)

> I don't really know a lot about climate change. – Lucy (10)

These participants varied in age, gender, and research site, but two shared the same school. At Tim and Miguel's elementary school, there is no science class. For Miguel, this left him uncertain about the content of the program. For Tim, this was a primary motivation for joining.

> All the projects that we've been doing, has it been science, or what? – Miguel (12)

> I was interested in [the program] because I didn't know that much about anything of science … When I came here I learned a lot of new stuff. – Tim (11)

According to Lucy, a limited comprehension of program content did not detract from seeing the bigger picture.

> Sometimes I was not the best with understanding what was going on [in the program], but I knew that I had to help the environment somehow. It motivated me to help the environment more than I already was. – Lucy (10)

***Consequences of climate change.*** In explaining the consequences of climate change, some younger participants appeared to conflate the meaning of climate change with the function of the greenhouse effect. The greenhouse effect traps the sun's warmth inside Earth's atmosphere, insulating the globe and allowing plants, animals, and people to thrive on what would otherwise be a frozen planet. Climate change, however, is related to the human expansion of the greenhouse effect. The burning of fossil fuels and subsequent release of greenhouse gases contribute to further warming. In the following statements, participants seem to have confused

these concepts, describing the necessity of the greenhouse effect as a reason to evaluate climate change positively.

> I thought [climate change] was really bad at first, but then I [learned] that it also keeps our earth warm and it lets us [live]. It's like livable here. – Riley (10)

> [Climate change] helps the animals grow. – Alexis (10)

In the following exchange, the same mix-up could be inferred from Ben's statement.

> Noah (10): [Climate change] is bad for the earth, and it's...
> Ben (10): Well it's not *always* bad.
> Noah (10): It's mainly bad.

Conversely, Ben and Noah may be displaying a detailed understanding of the varied (positive and negative) effects of climate change. During SCA, the vast diversity of climate change impacts was a key topic. For example, some places will become wetter and others drier, and some places will gain arable land, suitable for growing crops, where it was previously nonexistent. As Michael points out below, the consequences of climate change are not uniform.

> Ben (10): It's important to make sure that we have a steady climate to thrive.
> Alexis (10): [It's important to] know what's coming up ahead of you, like for the weather forecast.
> Michael (11): Now when I think about it, it's more dangerous. Climate change can help ways of life and it *cannot* help ways of life.

The majority of participants clearly demonstrated their knowledge of the impacts of climate change on the Earth and its inhabitants. Nora explained that the program helped her to understand the difference between weather and climate. As she and several others noted, climate change is more than day-to-day weather conditions.

> Climate change is *a lot* different than weather. Now in my mind ... [I think], "Oh, if we keep polluting and everything, the Arctic is going to have no more ice and polar bears and stuff like that will die." – Nora (12)

> [Climate change] can cause… If it's really rainy, it can cause a flood. If it's too hot, it can cause stuff to set on fire. – Carlos (10)

> Now I know that [climate change] is not like weather and it can be a danger to the world. – Grace (11)

A chief concern, expressed by numerous participants, was the impact of climate change on animals. When asked what they thought about climate change after completing the program, one group responded:

> Andrew (11): It's killing penguins.
> Arie (10): It's killing a lot of animals.
> Daniel (10): It's just killing a lot more animals than it was earlier when Earth had *humans* on it, but it wasn't really affected by [us] that much … Now we use a lot more electronics and that just starts creating more chaos.
> Arie (10): Now I think of climate change as just something that will hurt the Earth.

Other participants discussed the high stakes of inaction on climate change—not only for the environment and animals, but for people as well.

> I think about [climate change] different because now I know that it has an impact on the Earth and all the animals that could die if we don't fix climate change and what a difference it could make to our lives, too. – Olivia (12)

> [SCA] changed me, but it didn't just change me looking at the world different. It changed me looking at *humans* different, because humans pollute a lot and when they pollute, the world has greenhouse gases. Then animals start to die, then humans will start to die because they won't have food. When the world doesn't have food … it just leads back to the humans because we pollute the most. – Nora (12)

An appreciation for the interconnectedness of natural systems was expressed by several participants. As Nora (above) and Luke (below) describe, plants and animals are connected to one another and to people in the context of ecosystems. In our interdependent environment, a threat to one component may endanger the delicate balance of the food web upon which humans and animals rely for survival:

> If we got rid of plants [by] polluting, then the animals wouldn't have food that ate the plants. Then the ones that ate those animals would die off and then so on. Then we wouldn't have any food to eat. – Luke (11)

Food systems are not the only survival-related human necessity threatened by a changing climate. As Ali and Sydney explained, the homes and livelihoods of people living along coasts are also placed at increased risk due to sea-level rise.

> [Climate change] can also hurt the economy because countries can lose a lot of coastal land. If the glaciers are melting, there's more water. People would move inland and there'd be limited space. – Ali (12)

> I realized how global warming is affecting us. It made me think [about] how we could help. It's just horrible what would happen if the glaciers melted. Homes would be lost. Lots of land would be lost. – Sydney (12)

Most participants described the effects of climate change in a distant manner, as occurring along coasts or affecting wildlife in the Artic or Antarctic. However, some participants made personal connections to the likely consequences of climate change. For siblings Grace and Katherine, a rising sea-level meant their place of birth may one day be underwater.

> Katherine (12): Adding on to the glaciers melting and the sea-levels rising, if the sea-levels rise then we can lose most of … the beaches.
> Grace (11): We could also lose most of Florida.
> Katherine (12): We were born there.

As with a more thorough understanding of its causes, youths' grasp of the consequences of climate change lent urgency to the need for human actions to address the problem:

> With climate change ... we need to control it because it could get out of hand and destroy crops, plants. – Aubrey (11)

> I would think that people should be helping the planet because it's kind of getting extinct. I think that's what I would do because people are killing a lot of animals and plants. People are killing a lot of things in the world! – James (11)

***Solutions to climate change.*** During focus groups, participants' perspectives on reasons or ways to address climate change were not always articulated in relation to their knowledge of particular causes and effects of climate change. Rather, expressed holistically, addressing climate change meant taking action to avoid bigger problems in the future. As Gabe, age 12, put it,

"People need to fix it, or something bad's going to happen." When asked how they thought about the world differently after SCA, Olivia and Aubrey described an expanded view of the problem and the importance of preventative action.

> [SCA] changed how I look at the world because before I just thought that we can't really do anything to help it be better besides just planting stuff, like planting seeds and all that stuff and to just not litter. Now I know that more stuff can happen [from climate change] and that we really need to … keep everything safe. We have to just help the environment a little bit more than we normally do. – Olivia (12)

> [Before the program], I thought [that] weather happens whenever it wants to happen, stuff like that. Now, I think … if there's problems in the skies or whatever we need to stop it because it could get out of hand. – Aubrey (11)

Turned inward, a heightened awareness of the importance of human action to address climate change was understood by many participants to reflect on their own behaviors. Ten-year-old Noah said that, after SCA, he thinks "more about how the world is affected by what we do." For Ali and Athena, learning about the environmental impact of their daily habits was among the most influential aspects of the program. When asked to describe how participating in SCA affected them, they said:

> [I learned] that I have a big carbon footprint. – Athena (10)

> I found out just how big my carbon footprint was. – Ali (12)

For several participants, learning about climate change through SCA was beneficial because knowledge about environmental problems was paired with solutions.

> I learned a lot from *Science, Camera, Action!* because now I know a little bit more about the earth and how to help it from being polluted. – Olivia (12)

> [SCA] helped me learn more about climate change and how to help the environment. – Grace (11)

**Knowledge as motivating.** Participants often described their participation in SCA as motivating, due in large part to the knowledge they gained. As ten-year-old Ben explained,

"Since I know more about climate change, now I realize how it's kind of important to act." Feeling informed led to a greater sense of competence and enthusiasm. Youth across research sites, age groups, genders, and ethnicities said that SCA boosted their knowledge and built their confidence that they could make a difference. Cecelia said, "I felt more confident since I knew more." As she and others put it:

> I think more about [climate change] now, more than I used to. I know what's going on in our world and how the world's changing by every minute. And I know I can make a difference by helping. – Cecelia (10)

> This program helped me make a difference in the world because it was teaching me to affect the outside world and it [taught] me more about what to do if something goes wrong with the climate. – Michael (11)

> [I feel like we can make a difference] because we know a little bit more now, and since we made a website, it might help a lot, depending on who looks at it. – Rose (13)

Despite the gravity of the issue, many reported that learning about climate change was fun. For some, the activities were enjoyable. For others, it was a matter of discovering new things about their world, from up in the sky down to the neighborhoods where they lived.

> It was fun learning about climate change. – Isabella (12)

> All the activities were fun and you could learn a lot. From what we were talking about, you could learn a lot about what you didn't know. – Grace (11)

> I enjoyed learning about … climate change and different things that we can do to help the environment. – Katherine (12)

> I liked learning about our community. – Cecelia (10)

> I enjoyed learning stuff and I liked learning about climate change. I like learning about what greenhouse gases are and how what carbon footprints are. Stuff like that. – Tim (11)

As Tim went on to explain, and further echoed by Grace, learning about the risks and hazards posed by climate change was compelling. SCA was engaging because it prompted concern and offered an outlet for action.

> [The program] changed my point of view because at first I didn't really care or didn't want to do anything about [climate change], but then I came here and started to learn about it. It could be dangerous, and then I started to see it different and I started to do more stuff about it. – Tim (11)

> I liked all of the activities that we did, but I also liked learning about the dangers and how I can make a difference. – Grace (11)

*4.4.2 Climate Change Attitudes*

During focus groups, few participants elaborated on their climate change attitudes prior to program participation. Notably, throughout the duration of the program as well as in focus groups, none of the youth expressed explicit doubts or uncertainties about the veracity of climate change. It is possible, however, that Alexis had some distrust prior to participating in the program. As she put it:

> I feel different about the climate change because now I know a little bit more about it than what I used to know. And now I trust it some more. – Alexis (10)

An alternative interpretation is that, after SCA, Alexis felt more confident in her own knowledge. More common were statements like Sydney's, who said that she had "heard of" climate change, but that she "just didn't really care for it."

After the program, participants articulated a range of environmental attitudes. In some cases, it was unclear whether SCA had shifted youths' perspectives, or if pre-existing pro-environmental attitudes were a key driver of their SCA participation. For example, participants across age groups and research sites expressed views indicating a deep respect for the natural environment and the role of humans as its stewards.

> Earth is a very special planet. I mean we have so many people living on the planet. It's just something that we can't just throw away. We need to respect it and in every possible way. – Sydney (12)

> I don't really like people treating the earth like it's just a big dumpster. That's what really bugs me. – Maria (10)

> It kind of hurts me to think that because of what humans are doing they're hurting animals. – Abigail (13)

The importance of caring for the earth was a view shared by boys and girls, though boys more often spoke about death as a consequence of climate change. When asked how they thought about the world after participating in SCA, Wayne offered a metaphorical description of the earth as an injured body in need of healing, while Jimmy's response was quite literal.

> I think of the earth as like a body getting hurt. You can fix a scar, you can get cut and it will heal but you gotta take care of it. You cut your arm and you don't take care of it, it will get infected. It will die pretty much. – Wayne (12)

> I think of [the world] as a place that we should care about and not [pollute] .... Now I think that we only probably have a few more centuries before it's going to get too hot and everyone's gonna die. – Jimmy (10)

**SCA's impact on youths' climate change attitudes.** Participants attributed to their SCA participation a mixture of positive and negative feelings about climate change, an increased sense of respect for nature, and feelings of intensified urgency about addressing the issue.

***Mixed emotions about climate change.*** Participants described a range of emotions about climate change. On its own, climate change was perceived as scary, depressing, and anxiety-provoking. However, taking action to benefit the environment offered comfort and led to positive feelings. For Abigail, initial feelings of sadness gave way to happiness. Nora's fears about climate change seemed to coexist alongside a sense of appreciation for knowledge gained, and the motivation to raise others' awareness. When asked to describe how climate change made them feel, they responded this way:

> Abigail (13): Depressed…
> Nora (12): I was a little bit afraid because people could just throw something ... put out a greenhouse gas and we won't know about it until [it's too late] …
> Abigail (13): I feel happy that I was able to contribute to [helping] it a little bit ... [through our action project].

Nora (12): I feel like it was good that I learned about [climate change] because now I can go and inspire other kids to learn about it.

A similar exchange took place between Katherine and Grace. Knowing ways to address climate change provided a sense of relief, even joy, though their ambivalence was clear. Climate change is worrisome.

Grace (11): It makes me happy because now I understand how to help the environment.

Katherine (12): It also makes me happy, but also worried because if we don't do anything about it … the sea-levels will rise and we could lose some of our beaches. It also makes me happy because I know things that I can do to help stop that.

Grace (11): It makes me worried, too, because if the water rises, Florida might be gone.

Ten-year-old Carlos expressed similar feelings when he said that he, "would worry that the sea-level was going to rise too much… and flood states." After the program, he reported feeling more confident. As he put it, "Now I feel like I can like do stuff to protect the environment." Others felt the same way.

> I feel like I can actually do something…about the environment and what's going on. – Rose (13)

> I know what's happening in our world and I know that I can make a difference by helping. – Cecelia (10)

> I know that we have the power to stop it. – Ali (12)

***Respect for nature.*** A number of participants reported that SCA gave them a deeper appreciation for the environment, which they often described in the language of being in the outdoors, or "outside." Compared to "most people" (and themselves prior to SCA), they reported greater awareness of the wonder and significance of nature.

> [I learned] that outside matters ... [more than] most people think it does. – Luke (11)

> It opened up my mind to see that the outside [environment] matters more than what most people see. – Nora (12)

> [This program] made me feel confident about how I could be interested in the outside things more often. It encouraged me-, it made me confident that I could learn more things about the outside world and that the outside world is really amazing and what you can learn about it can be really cool. – Michael (11)

During a focus group that took place outside under a pavilion, ten-year-old Noah articulated an enhanced respect for nature by excitedly pointing out a group of running horses on a farm not far from our picnic table. Upon asking how SCA impacted them, a welcomed interruption ensued.

> Noah (10): Look at the ponies! They're all trotting in line. With me, [SCA] made me care about those horses over there more. One's black, one's white with brown dots—
> Lucy (10): Shhh, if you be quiet, you can hear them hooves.

As Noah went on to explain, fully appreciating nature goes beyond being awed by its aesthetic beauty. SCA helped him to perceive nature's crucial and life-sustaining functions.

> This [program] just gave me responsibility and it made me appreciate nature more, appreciate nature for what it is. Not that it's just nature and it *looks* cool, [but] that it actually has a purpose and it *does* something. – Noah (10)

For some participants, learning to appreciate nature translated into feeling and behaving more amicably towards the environment. As twelve-year-old Gabe put it, "[SCA] influenced me to care more about the environment, and want to help it out more than kill it." In Ben's case, having a higher regard for animals meant treating them with greater respect. For Alexis, understanding the important role of insects in the food web made her feel less bothered by them.

> I learned to respect nature and animals because when I was littler and before this program, I would throw rocks at squirrels and stuff, but after doing this program, I learned that I need to respect them just as well as I respect [other things]. – Ben (10)

> This [program] helped me because I used to be afraid of the bugs, and I would swat them like that. Now that I know what eats them and they'll go away, they'll die, just like us. I feel a little more confident about it. – Alexis (10)

Others explained that, after participating in SCA, they had a better grasp of the interconnectedness of the natural world. For Nora, this meant feeling a part of nature, rather than separate from it. For Lucy, it meant newly understanding the environment as a shared resource.

> It helped me notice stuff like I'm part of the environment, too. – Nora (12)

> It's hard to explain, but this is how I thought about the world now. I think that people need to stop putting things in the ocean, and stop just hurting the environment. Because everybody shares the environment around us. It's not like one person's going to hurt the environment, and everybody's going to be like, "Okay, just one person did that." Everybody's going to want to get up on that person and try to stop them. – Lucy (10)

Like Lucy, a number of participants expressed that respecting nature meant keeping the environment clean and free of litter. Pollution, in the atmosphere and on land, was unacceptable.

> When I see people littering and stuff, it makes me sad to see that because then I think about ... this one video, [where] people litter and then it ends up getting into the ocean, and then it gets wrapped around fish. It helps them die sooner and then we don't have food sooner. – Luke (11)

> When you're walking, like hiking or something, you always have some sort of trash on your way up and I think we should at least, to clean up, have signs saying, "please don't do this" and have trash cans every other mile or so. It'll stop the littering. – Charlotte (10)

***Urgency of climate action.*** Drawing on knowledge gained through SCA activities, some participants discussed the need to stabilize Earth's temperature to allow safe and predictable conditions. For this reason, they felt it was important to take action to address the issue.

> I think about climate change like it's a serious thing, I want to be actively involved in changing it to go down to be kind of a bit more normal. – Bill (13)

Particularly impactful for Ben was a "Young Voices for the Planet" video shown during SCA. In this five-minute video, a teenage boy in California raised awareness about climate change in his community by erecting tall wooden poles on a beach, and marking sea-level rise predictions over the coming decades.

> I learned it was important to act on climate change. To cool down the world … because that one video where it showed … poles and where the water would be [after sea-level rise]. – Ben (10)

Believing in the fundamental importance of taking action, some participants reflected on the environmental impact of their daily habits, and called into question their own and others' environmentally-significant behaviors, particularly those involving energy consumption. Ten-year-old Jimmy said, "We shouldn't waste coal and we shouldn't waste natural stuff." As Lexi, age 10, put it, "[SCA] made me care more about what I do." Sydney and Abigail expressed their views on longer time scales, pointing out that fossil fuels are non-renewable sources of energy that, in aggregate, are the key driver of climate change. Seeing the bigger picture, they drew connections between the problem of climate change and the day-to-day actions of individuals.

> [SCA] definitely helped me learn how saving energy is really important, and how we might not have that certain energy one day. – Sydney (12)

> [I learned] that keeping the lights off [is important] because a few people in my family aren't very good at remembering to turn off the lights after they are in the bathroom or something. Sometimes, it makes me wonder how many people leave their lights on all the time and produce so much towards the world. – Abigail (13)

Also taking the long view, Daniel and Gabe offered grave predictions of the future if present conditions prevail. Daniel expressed concern about the integrity of natural systems and the risks to human survival if they continue unprotected and under siege by climate change.

> I think this program taught me how to realize what climate change is doing to all of our animals that we might need to rely on in the future. Because if we don't take care of the planet now, we probably won't have anything left in the next fifty years …We're just probably going to die out and not live anymore. – Daniel (10)

Gabe's pre-existing attitudes about climate change were unchanged by SCA. He maintained that technology was the real culprit. If humans had been prevented from developing the means to destroy the environment, the planet and its inhabitants would all be better off.

Gabe (12): I think the same way as when I first learned about climate change. I thought that the world probably should have stayed in the Stone Age, because now that we're not in the Stone Age, there's nasty stuff going into the air which is probably going to kill us all. [Technology] helped us, but then it betrayed us.

Lucy (10): Hurt us at the same time.

Feelings of increased urgency about the need for action on climate change were fueled by a perception that existing responses to climate change were insufficient or nonexistent. Such views were expressed across age groups and research sites. Ali, age 12, said, "Nobody is literally doing anything [about climate change]." Jimmy and Wayne pointed to examples of hypocrisy, emphasizing that not everyone 'walks the talk' when it comes to climate change, but they should.

> Everyone, they act like they care … The president acts like he cares sometimes at meetings … [but] he's flying planes and stuff even though that can cause climate change too. – Jimmy (10)

> I'm so happy that people finally stepped up to it [during our action project]. Just *saying* that you're going to help isn't helping. You've got to *help*-help. You got to actually do stuff. I hate people who say you got to do *this* to help and you got to do *this* to help when they're not even helping. – Wayne (12)

Though the topic was not a focus of SCA, a belief in the inadequacy of others' actions was pervasive, and was explained as a cause for concern. In the following exchange, Rose and Abigail had once shared a view that people were rising to the challenge of climate change, but agreed that they were mistaken. In fact, people were making it worse.

Rose (13): I didn't think that it was such a big deal, but now I think it's more of a bigger deal. Some people need to work on changing it, because, or else our world is just going to fall apart.

Tim (11): Our world's already falling apart.

Abigail (13): I didn't think that it was bad until I heard that people aren't doing very much to help it, that they're just letting it happen, and that they're contributing to it.

Rose (13): Yeah, I felt like a lot more people were definitely doing something about it.

Abigail (13): I thought people were actually trying to help instead of contributing to the mess.

*4.4.3 Climate Change Behaviors*

Youths' increased knowledge about climate change, combined with their enhanced pro-environmental attitudes through SCA, fueled participants' enthusiastic engagement in pro-environmental behaviors. Modifying their daily habits to become more environmentally-friendly was a result of participants' increased consideration for the ways that their own behaviors affected the environment. A desire to help the environment was behind youths' informed actions.

> [SCA] made me think about … what I was doing to help or hurt the environment. It made me think about what I could do to help the environment, so I made sure that I [had] good habits so I didn't hurt it. – Scarlett (12)

> Before *Science, Camera, Action!*, I didn't on a constant basis help the environment, but now I'll do it four times a week—a school week. Then over the weekend, too. – Gabe (12)

**SCA's impact on youths' pro-environmental behaviors.** After SCA, many participants reported regularly engaging in behaviors that save energy and reduce waste. Energy-saving behaviors in particular led several participants to become more physically active by turning off the television and leaving behind videogames to ride bikes and play outdoors. Behavior change was described by participants as a direct result of specific program activities that heightened their awareness and rewarded their efforts, particularly the Carbon Footprint Contest.

***Carbon Footprint Contest*.** Prior to SCA, few participants thought about the environmental impact of their behaviors, and no one had heard of a "carbon footprint." However, the idea of tackling climate change through individual behavior change was met with interest and excitement. Participants were motivated to make a difference. As ten-year-old Athena put it, "I never cared about my carbon footprint until I went through this club." Throughout the process, participants reported having fun, while feeling challenged. What Gabe, age 12, enjoyed "about

the Carbon Footprint Contest … was that we saw how we were living originally, and then we tried to go home and change it." As he added later, changing routine behaviors was not always a walk in the park. Ten-year-old Lucy agreed.

> Gabe (12): The difficult part for me about the Carbon Footprint Contest was trying to change how you were [at home].
> Lucy (10): [It was hard] to stop your original things that you originally do, like keeping your phone plugged in. You always have to unplug your phone. Getting used to new things was really hard.
> Gabe (12): And killing old habits.
> Lucy (10): Yep. Like chewing your nails.

Despite its challenges, the process was illuminating for many participants and left them feeling encouraged. Some were surprised by their own success.

> I started with a big carbon footprint that went down lower and [I] found out that I can actually lower my footprint. – Lexi (10)

> [I learned] that I have a really kind of on-and-off carbon footprint. I did good stuff and then I did stuff that wasn't so good to the environment, like left the water on, didn't turn off the lights as much. – Jimmy (10)

> I thought I was doing badly [with my carbon footprint] and that I needed some help with stuff, like to recycle more and that I don't recycle enough. And that I eat too much meat or I waste too much water or stuff. [The contest] helped me find out that I can make a difference. – Luke (11)

A number of participants had pre-existing low-impact lifestyles, particularly those from low-income households. As Nora put it, "[Having a low] carbon footprint was easy for me because I didn't really have to change much … I just had to change what I eat which was really easy." At the end of the contest, participants were rewarded with certificates on a number of dimensions, including having a low carbon footprint to begin with. As a winner, Nora reflected on how the contest made her feel, saying, "I liked the Carbon Footprint Contest ... [My small footprint] made me open my eyes and see that, 'Oh, I'm doing really great' instead of doing really poorly in my life." Receiving rewards was viewed positively by a number of participants.

For Peyton, it was about being recognized. Lucy enjoyed the constructive atmosphere. Despite being a competition, people were friendly and supportive of one another.

> I liked that people actually got noticed when they did something [in SCA], like in the Carbon Footprint Contest, they actually got rewards. – Peyton (10)

> [I liked] the Carbon Footprint Contest [and] that some people won, and some people didn't, but nobody got too upset. – Lucy (10)

It could be that participants' positive attitudes about the contest were rooted in some level of awareness that what they were doing had meaning beyond the contest itself. As Sydney explained, the contest was not her only motivation to change her behaviors.

> We did the Carbon Footprint Contest. Maybe instead of having a contest, it should be a daily routine now. People need to know that we need to save energy because … power plants … pollute the air and it really does us no good. – Sydney (12)

***Minimizing waste.*** During focus groups, many participants reported that their daily routines had changed. A common theme in youths' updated habits was the goal to minimize waste through recycling and reusing things, as well as reducing their contributions to the quantity of single-use items that end up in the landfill. For example, several participants described beginning to recycle, or recycling more often than they did before. They understood that reusing things is beneficial for the environment. Katherine, age 12, explained, "If we recycle more, then they can reuse it, and it wouldn't cause as much pollution." Others reported:

> [I] recycle more stuff, so they could be reused. – Miguel (12)

> I used to not recycle a lot and now I've gotten a lot better about recycling cans and plastic. – Grace (11)

> It changed my daily routine because I usually ... my parents would always leave the newspaper in the driveway, and every morning, I would start to go outside and pick it up and start recycling it. – Arie (10)

Beyond recycling, some participants discussed the value of trying to minimize waste by not throwing things away in the first place. According to them, single-use items—especially those that do not biodegrade, such as Stryofoam and plastic—should be replaced by durable products.

Nora (12): I think it's good to use reusable bottles because you're not just getting a Styrofoam cup and just throwing it out.
Abigail (13): I think that if people do use Styrofoam cups and stuff that they should use them like they would their actual dishes and just reuse them until it breaks.
Rose (13): Honestly, I think that people should just get durable things so they could just keep washing it and then use it over and over until it breaks.
Abigail (13): Or use paper bags and not plastic bags…
Tim (11): There's a bunch of pollution in the ocean.

***Saving energy.*** Another goal in participants' newly-adopted behaviors was to reduce the amount of energy consumption associated with their daily habits. As Lucy, age 10, explained, "[SCA] introduced me [to the goal] to not waste energy." To save energy, participants reported using less electricity (e.g., by turning off lights) and unplugging 'vampire' appliances that use energy even when not in use (e.g., cell phone chargers). Under the energy-saving umbrella, decreasing water consumption was seen as important, given its relationship to the energy needed to supply, treat, and use (e.g., heat) water for daily necessities, such as for hydration and hygiene. The selected examples below are from participants across age groups and research sites:

> Now I use less water. - Jimmy (10)

> I would try to use less water at home and everywhere. We should bring a water bottle because water fountains, when you drink out of them, most of the water falls out. – Luke (11)

> [SCA] changed my daily routine because now every morning, I unplug my charger and I make sure that not several devices at once are charging. And I try to space it out between days, so that way it's not every single night. – Scarlett (12)

> I have done a lot more stuff, like I've been unplugging my chargers when I'm not using them and one reason ... when I leave my charger in, it makes a buzzing noise like electricity is going to fly out of it. – Bill (13)

In the following exchange, pairs of family members (Isabella and Carlos; Grace and Katherine) discuss improvements to their energy savings, while seeming to hold one another to account.

Isabella (12): I would never turn off the lights that much when I don't use them, so now I do.
Grace (11): I've gotten better at [turning off the lights].
Carlos (10): I use less video games.
Isabella (12): Oh yeah, and water.
Carlos (10): Because [Isabella] knows me. I always just play games.
Katherine (12): Grace never turned off the lights either.
Grace (11): I've gotten better at that.
Katherine (12): Yeah, she's gotten better at it.

***Becoming more active.*** As a result of minimizing their energy use, some participants described becoming more physically active in their free time. These participants reported walking, biking, and playing outside more often, rather than watching television or playing videogames. Ten-year-old Carlos, who in the previous exchange mentioned playing fewer videogames, said, "Now I like to stop pollution, like ride a bike or walk more." As Bill put it, "[SCA] changed my daily life by having me ride my bike a lot again." Beyond riding his bike for fun, he explained that he uses it to get places, replacing vehicle transport.

> I have been riding my bike more often to school. I'm going to be hopefully riding my bike to the Boys and Girls Club if I'm bored at home, don't want to play videogames, stuff like that, because I'm bored and lonely. I come over here because I can ride my bike here and it doesn't pollute anything and I'm safe. – Bill (13)

Other participants described leaving behind the electronics to play outside more often. Riley said she "decided instead of watching TV all the time," that she "can just go outside and play with [her] neighbor." She and others explained being similarly influenced by SCA.

> Before we started actually talking about "you can change the world" in this program, at first me and my neighbor just were going inside playing the videogame at my mom's house. Now we're walking around hiking by this house that's still being built and going up dirt hills and going anywhere pretty much. – Riley (10)

> I learn[ed] to be outside more. Take more advantage of the outside world, such as planting. – Michael (11)

> First when I like got here, I was watching cartoons at the house and then watching TV and then now it changed me. We can play outside and, instead of TV, I can play with my bike and plant plants. – Dominic (10)

As Bill summed up, "running around outside a lot more" has led to "[being] more active." He added, "I've just been relaxed."

***Other pro-environmental behaviors.*** Concerned about pollution, several participants explained that they engaged in behaviors aiming to protect the environment and maintain Earth's beauty. Though these behaviors are less directly relevant to climate change in that they do not reduce carbon emissions, they were nevertheless rooted in a desire to help the planet. Grace and Lucy described regularly cleaning up trash that others had left behind, while Alexis—inspired by her understanding of ecosystems—reported growing flowers to help honeybees and animals.

> Around the school, people just drop wrappers and stuff on the ground and whenever I see it, I pick it up and throw it away. – Grace (11)

> I [help the environment] every day. It was hard to start, getting it on, starting helping the environment instead of polluting it. Whenever I walked around my school with my class, I was always telling my class to pick up trash, "Don't pollute the world." My school ended up with no trash around it from my whole entire class help[ing] doing that. Whenever I saw trash when I was walking ... Like today, I was walking down from the bus stop to here, and I found three pieces of trash, and I got them, and I threw them away at the nearest trash can. – Lucy (10)

> [I learned that] I love to plant. I even have my own flowers at home to help the animals… [SCA] made me feel like I could make a difference because I could plant random seeds around me or I could start making flowers for the bees to make honey and all that stuff. – Alexis (10)

**Action builds confidence.** Several participants said that taking individual environmental action helped build their confidence that they could make a difference to benefit the environment. Aubrey, age 11, said, "At the beginning, I wasn't very confident in helping the environment. Until we went through the little things that [we could change], I started becoming

more confident." In describing overcoming self-doubt, Olivia and Gabe seemed to realize that what is challenging can also sometimes be rewarding.

> When I want to do something that is really hard for me to do, this [program] made me feel like I can be more confident in myself, and have a better chance at actually being able to succeed. – Gabe (12)

> I also liked it when we did the ... Carbon Footprint [Contest] because it helps us to [understand] better … that we can actually save energy. People that thought that they would do really poorly like [Luke] … and they succeeded, they knew that they could do more than what they thought they could. – Olivia (12)

A couple of participants felt good that, in taking steps to reduce their environmental impact, they were also doing more with less. For Charlotte, saving energy was helpful to her family. Lucy said that cutting back on energy consumption made her feel more satisfied with what she has in her life.

> I became more confident about helping my family start recycling and saving the power and stuff. It's helped my family go longer with whatever. It helps. – Charlotte (10)

> [The program] made me confident that I could do something that I [thought] I couldn't. *Science, Camera, Action!* motivated me to be stronger, and to just be more pleased with what I got, not what I need…[or] what I want. – Lucy (10)

Referring to her confidence level, Lucy added later, "[I learned that] I could really change the environment, and that I'm not just one person. I am more than something."

*4.4.4 Sense of Agency*

As participants reflected on the impact of SCA as a whole, it was clear that the program strengthened their self-confidence in their abilities and sense of self-efficacy to influence others and the world around them. Many left the program feeling informed, capable, and inspired to continue making a difference to improve the environment and the lives of others. Participants commonly described undergoing a perspective-shift that allowed them to view themselves, and young people in general, as competent and effective change agents in their families and

communities. Further, they described numerous instances where their knowledge, motivation, and confidence had a positive impact beyond the program, especially through their engagement with others in family, school, and community settings. They were active agents of sustainable change through and beyond SCA action projects.

**Self-confidence.** Participants reported that SCA built their self-confidence that they could make a difference on climate change, as well as on issues beyond the environment that are important to them. Ten-year-old Theo said, "We can help stop global warming or pollution." As ten-year-old Riley put it, "[SCA] made me confident that I could change the world." For Scarlett and Arie, SCA made addressing climate change seem possible. For Tim, the program made him feel empowered to stand up and take action.

> Before the program, I didn't know I could really help it. I thought [climate change] was something that was there that would keep growing and hurting the environment, but now I know that I can help out. – Scarlett (12)

> I felt different about my abilities because I didn't really know how to take action to save my planet but from *Science, Camera, Action!*, I found ways to do it. – Arie (10)

> [The program] helped me be more confident of what I can do. How I can do it and where … It made me more confident because … it can make me do stuff instead of just holding back and just standing there, not doing anything. – Tim (11)

Other participants reflected on specific abilities they honed in SCA. In particular, they took pride in their capacities to gain knowledge, communicate, work together, and persevere. When asked what she learned about herself in SCA, ten-year-old Arie said, "How smart I can get. That's what I learned." Ali, age 12, who took a leadership role in preparing the town meeting presentation exclaimed, "[I learned] I can write a pretty dang good speech!" Later, she added, "I felt more confident about myself and more confident about being in a team." Ben was encouraged by his group's action project, noting that what he learned about dedication and persistence could be applied to other life aspirations, like being in a rock band.

> The way I thought that I made a difference is… Often, I talked with my friends about doing something, like making plans for a rock band … and have this awesome drum set and stuff like that when we were older. But that didn't actually come out to be real. We all knew that. But when we were planning for [the garden] and planting carrots and stuff and we're actually putting our mind to it, that taught me that if we actually put our mind to it, it can happen. – Ben (10)

A few participants, all adolescent girls, described the positive impact of SCA on their courage to communicate, to express their views despite reservations. Nora and Olivia felt emboldened to speak up on issues, including climate change.

> [The program] helped me change how confident I am ... because it told me I can go speak out to the world even though they might not listen to me. I can go speak out to them and they might listen and it might change their bad habits. The way that I saw myself at the beginning was like, "Oh, nobody likes me. Nobody wants to listen to me." And [being here] helped me open up my eyes. – Nora (12)

> It changed how confident I felt because getting to know all this stuff, I wasn't sure if I would be able to do all the stuff that we did. But then I was able to do it. And also, it helped me see how clearly things can seem—how *bad* things can seem. But in the end, when you finally know that you can do it, it helps you so you can feel more confident about yourself and how to talk to people. Before I would think, "No one would ever listen to me." And now-, and then I figured out that it's easier to talk than to be worried about what to say. – Olivia (12)

For her group's action project, Sydney faced her fears and spoke publicly at the town meeting, which boosted her self-confidence.

> I learned that I can do a lot more than just talk in front of people. I learned so much more that I thought I couldn't learn … I don't really like talking in front of people but I do because it's not that big of a deal, but sometimes I make a big deal out of it. After this program, after we talked to the town hall at the meeting, I felt so much better about talking in front of people. I was way more confident. – Sydney (12)

Finally, some participants described an enhanced sense of self-confidence in their abilities to handle large responsibilities. When asked whether SCA made him feel more confident in his abilities, Noah, age 10, said, "I have a garden at home, but this made me think … that gardening a bigger garden is more responsibility, and you always need responsibility. You

always need something to be responsible for." For ten-year-old George, caring for his own digital camera was impactful. As he put it, "Honestly, getting my camera and using my camera made me feel more confident [about] being responsible and having large responsibilities."

**Views of youth capabilities.** During focus groups, some participants expressed having had little confidence in the ability of children and young people to have a meaningful impact on the world. After SCA, these participants expressed greater estimations of youth potential. Taking action on climate change, especially through collaborative action projects, gave them a new perspective on youth capabilities, particularly their own. Referring to his group's action project, ten-year-old Bryan said, "The way [SCA] changed me…was that I didn't really think that we could do as much as the adults." Like Bryan, Peyton and Scarlett were surprised and encouraged that, as young people, their actions mattered and they were making a real difference.

> Before *Science, Camera, Action!*, I [didn't] realize how easy it is to make a big change in your world. Because I always thought, "I'm just twelve, I'm just small and insignificant," but I can make a big impact on the earth. – Scarlett (12)

> So how [SCA] changed my mind is because I thought "Well, I'm just a kid. I cannot do that much," but I actually found out that we can do a lot. I didn't even think … going out there and working [in the garden] …was helping that much. But that should be *everybody*. It actually *really is* helping. – Peyton (10)

As ten-year-old Riley put it, "I think that you can change the world. You can save the world, even if you're a kid … a four-year-old kid." In the following exchange, she and Bill agree that any type of person can change the world if they decide to.

Bill (13): I feel confident that I can change the world because, as a person in general, you can change stuff. You don't need to be some big official person like the president. You need to be ...
Riley (10): Anybody.
Bill (13): Anybody. Any random person can walk around with a sign saying, "Blah, blah, whatever."
Riley (10): "Save the world!"
Bill (13): "Save the polar bears!"

> Riley (10): "Save the polar bears!" … What I feel like is that, I have the power to change the world. I can decide, *everybody* can decide, *anybody* can decide, even just this random guy walking on the street, like, "Hey, how yeah doin'?" And then next thing you know, "Save the world!"

Bill added later, "To save the world, you don't need a superpower. You don't need anything like that. All you need is yourself and others to support you. That's all you need."

**Youth as change agents.** Beyond engaging in personal pro-environmental behaviors, the youth participants in this study provided abundant examples of sharing knowledge and inspiring action by others. As agents of change, they spread information and awareness to those around them, especially family members and friends. Their audience included adults as well as children. Through their collaborative action projects, they also engaged members of their communities. For some participants, SCA led to opportunities for their increased influence in school and community settings.

***Sharing knowledge.*** Upon learning about the causes and consequences of climate change, as well as its solutions through individual and collaborative action, youth participants reported feeling motivated to share their knowledge. Having had limited knowledge of climate change prior to SCA, they recognized that other people, like themselves in the recent past, may not be informed. Participants felt it was important for others to know about climate change. As Katherine, age 12, explained, "It could really make a difference because if [people] didn't know a lot … you could teach other people." Peyton reported that she had already taught others things learned in SCA, while Olivia saw the potential for having a wide impact because, by telling others, information can spread.

> So some people have even [learned] what I learned from here. I've taught some other people stuff that you guys taught me. – Peyton (10)

> To change the environment, we can just tell people what we know and they could tell other people. – Olivia (12)

Informing other people about climate change, for several participants, was viewed as a prosocial act. Telling people meant helping them, and SCA strengthened their confidence to do so. When asked what he learned about himself in SCA, twelve-year-old Gabe said, "I have the power to help people, and not just help myself." Scarlett and Nora felt similarly inspired and empowered, which gave them motivation to share their knowledge.

> I really feel like this program helped me make a difference because before, as I said, I felt insignificant but now I feel empowered. And I know that even by sharing the information that I've learned from this program, I can help others. – Scarlett (12)

> [SCA] inspired me to help out others and inspire them to look at the environment differently. – Nora (12)

Beyond the goal of helping others, the motivation to share information learned in SCA was explained as a strategy for change. Telling people meant spurring shifts in others' perspectives and actions. When asked whether she felt like she could make a difference in her community, Annie, age 13, responded affirmatively because, "Now you know the bad stuff that's going on in nature and the good stuff. And you could help … by telling people." For Arie, urging change meant engaging with the opposition.

> [We could influence] people who would rather … keep the greenhouse gases than get rid of them. If you got together a few people, that would make a real impact and maybe even get them to change. – Arie (10)

Olivia said that even though climate change can be an overwhelming problem, spreading hope and inspiring others could be a matter of simply telling them about youths' accomplishments in SCA.

> We could influence people to help save the environment … to try to make people … see that things can seem rough, but then at the end it ends up okay. Because you can influence people by saying, "You can do stuff" when they think that they can't do it or they can't make it through something. You can influence people to help save the environment by telling them what we did in the program. – Olivia (12)

*Sharing knowledge with family.* Participants provided numerous examples of engaging their family members on SCA content. Ten-year-old Theo, referring to a game about ecosystems, said, "I told my little sister about the thing that we were doing with the yarn." More often, participants told others about climate change, including Melanie and Kelly, who taught their younger family members.

> I taught my little cousin about global warming. She is seven. – Melanie (10)
>
> I taught my [younger] brother …[about] global warming. – Kelly (12)

Abigail and Nora discussed the program with additional family members, including parents. Nora's conversations reached through her parents to their co-workers and her grandparents. In one instance, she found herself teaching an adult about climate change.

> I had talked to [my niece] about [the program] … I told my parents and my little sister and everyone. – Abigail (13)
>
> I talked to my parents and they talked to their parents and their workers and everything. I actually had one of [the] workers come up to me and talk to me about what the program was like. "Hey, what have they taught you about global warming and everything?" I talked to him and he kept talking to me. – Nora (12)

*Sharing knowledge with friends.* Participants also told of teaching their friends and schoolmates about program content. Examples ranged from telling friends about program activities and explaining specific concepts to inspiring their motivation and concern about climate change. In referring to an SCA game about energy-saving behaviors, Miguel, age 12, said, "I taught one of my friends a lot about the [energy] bingo." Later, he added, "[I taught] the greenhouse [effect] to one of my small friends, [who's in] the same grade." Eleven-year-old Jack said, "My friend … didn't know what carbon dioxide was and I helped him recognize what it was." Daniel viewed SCA as "basically an extra class," which made him feel capable of sharing his knowledge about climate change with his friends.

> I definitely think I can influence my friends. Most of my friends at school don't really know about this stuff yet. Since I'm doing this [program] … I'm learning … and they're learning from me. I'm teaching other people. – Daniel (10)

Other participants discussed the potential to inspire or bond with friends over climate change. For Dominic, this meant energizing others to act as change agents. For Rose, friendships could be strengthened through shared concerns about climate change.

> Everyone can shape the world. We can talk with our friends and we can talk about how to change the world. – Dominic (10)

> If you tell people that you're actually worrying about [climate change], then they might agree and then you might be better friends when you get to talk about it. – Rose (13)

***Inspiring action.*** In addition to sharing knowledge gained in SCA, participants were committed to encouraging environmental action by others around them. Most commonly, they spread information about pro-environmental behaviors that could be undertaken by individuals, rather than collaborative climate change action requiring coordination by groups. For example, participants advocated behaviors that save energy, minimize waste, or otherwise protect the environment. They said SCA helped them to better understand their own environmental impact and how to make choices to benefit the environment, which was information they wanted to share. As eleven-year-old Grace put it, "[SCA] taught me how to change the environment … [and] how to help other people to [do so]." Arie, age 10, said, "I started looking around for people who kept doing things that would hurt the world and I would go and talk to them and try to get them influenced to help to save the world." For Olivia, even though adopting energy-saving behaviors is simple, advocating climate change action requires courage.

> I think that maybe we could [make a difference]. If we actually have the courage to stick up and tell people that it's better to turn off the lights or ... or unplug stuff when you're not using it, or just leave stuff alone when it doesn't need to be used. Like when you can see just fine not to turn on the light if you don't really need it. Just open the blinds or something. To just do stuff like that. – Olivia (12)

*Inspiring family action.* Participants across age groups and research sites gave examples of influencing family members to engage in pro-environmental action. Some described raising others' awareness, like ten-year-old Melanie, who said, "I taught my little cousin and my entire family, 'You need to cut down on the energy and stuff, man!'." Others gave evidence that family members had begun to adopt energy-saving behaviors. For example, Cecelia, age 10, said, "I got my big sister and my big brother to turn off the lights more." Twelve-year-old Gabe said, "I feel like I influenced some of my cousins, because they have started using less, being on the TV less, and playing outside more." Tim engaged multiple family members during the Carbon Footprint Contest. According to him, their help was important to reaching his carbon-savings goals.

> When I talked to people, my cousins … they helped me with stuff I needed to do [for the Carbon Footprint Contest] and how I could do it and stuff. It helped me make a real difference because … I had like five other people who helped me …. I planted my tree already. They helped with gardening. – Tim (11)

Encouraging pro-environmental behaviors by family members could spread to additional people as well. As Sydney explained, once her mom was onboard, so was her mom's boyfriend.

> I told my mom about it and she knows how important it is to me. She got her boyfriend to start saving energy by turning off the lights after he leaves, and unplugging the charger cords whenever they're not in use. Anything like that. – Sydney (12)

*Inspiring action with friends.* Some participants talked about engaging friends in climate change action, though less often than with family. Engaging other young people was seen by many as an effective strategy for spreading climate change awareness and promoting action. In the following exchange, participants explain that involving youth is important because, that way, information can spread across generations and allow more people to help the environment.

> Katherine (12): You could teach [other kids] all you learned from this [program] and then they could teach other people and then those people could teach other people and it could just be ongoing.
> Carlos (10): Generation to generation.

Isabella (12): I was going to say some kids don't know what climate change is…
Facilitator: Do you think it's important for them to know about that?
Group: Yes.
Carlos (10): Yes, because I think they can make a change in the world, too.
Grace (11): I was going to say "yes" because if we can go around teaching them, then they can go around teaching others and it can start spreading and soon lots of people would be able to help out.

Grace offered an example of influencing a friend's behavior, saying, "I talked to my friend and told her about climate change … and she's starting to help the environment." Later, she told of conversations with friends about how to save energy and minimize waste.

> I talked to my friend about how we're making a website and how she can go on to help change her behaviors ... And another one of my friends didn't really know how to recycle, and so I gave her one of the recycling papers [from the program] and now she understands. – Grace (11)

***Collaborative community action projects.*** In addition to engaging family and friends, participants discussed their ability to make a difference in the wider community through their collaborative action projects. Reflecting on their participation in SCA, many viewed the action project as the program's most influential component. Ten-year-old Maria said, "I liked how I actually got to work on something." Peyton, age 10, had a similar view, saying, "I like [that] … the kids actually get to go help instead of the kids just being inside and doing things." Later, she said of the action project, "You guys actually let us be like grown-ups in a way." Arie said, "I would say the most important part was the action part." As she and others explained, the action projects were enjoyable and inspirational.

> I liked all of them, all of the activities. In the program, the action part was very exciting. It helped me realize that I could take action to help save the world. – Arie (10)

> My favorite was the action project, because we got to say our own opinion about what we wanted to do and then vote on what do we want to do. Then after we got done with that process, we got to actually do it and have fun with it. – Charlotte (10)

> The program … it's amazing. I don't know, there's something about it …Towards the end, [the action project is] so much fun, getting together, creating projects, knowing each other, working together. – Sydney (12)

At the same time, action projects were not without challenges. As ten-year-old Cecelia from Wellington recalled, it was difficult "getting all of the stuff we did done to get to the town so we could present it." The Fort Collins photo gallery, for Nora, age 12, was difficult because, as she put it, "…talking to parents, I'm not really good at. I was a little shaky at first." Ten-year-old Noah said, of planning for the Loveland garden, "The measurements for me got a little confusing. To add them up and put them together, get the right measurement. It was sort of hard the first day." Despite challenges and frustrations, participants across research sites viewed the collaborative action projects as a positive experience. They had fun while having an impact on their communities.

*Wellington: Town meeting and tree-planting.* When asked about their favorite moment in SCA, Ali responded, "I liked presenting to the town ... It was fun." Lexi agreed, saying, "My favorite moment was presenting in front of the town." As Jimmy, age 10, put it, "The presentation [at the town hall]. I think that was smart and cool because I wouldn't have been able to do that in any other group." For twelve-year-old Sydney, speaking in public initially provoked anxiety, but afterward she said, "I love speaking. I love having the thought of speaking in front of people and being confident." Responding to whether or not SCA helped them to feel like they could make a difference in their communities, Ali and Lexi said that it did.

> Ali (12): The fact that we can do something to help protect our environment and the town. So yes it did.
> Lexi (10): Yeah basically, [the program] makes you feel like you can actually do something instead of ignoring the stuff around us.
> Ali (12): I think it's a lot better for making a difference than Fort Collins because there's so many people in Fort Collins and Denver and Loveland, but because we're such a small group.

As agents of change in their small town, this group engaged fifty-plus family and community members as well as town leaders and administrators during their presentation. After receiving approval to proceed with their tree-planting campaign, they successfully planted twelve trees.

*Fort Collins: Photo gallery and website.* For Fort Collins participants, making a difference in their community meant raising awareness about climate change and inspiring action by community members. At the gallery event, Nora reported engaging both adults and children. As she recalled, adults were quite interested.

> I also liked the photo gallery because I helped set it up and I got to see how parents interacted with it and when kids walked by, they interacted differently. It showed me different views … The kids would just walk by and just be like, "Eh." They would not even pay attention … but parents would stop and read them and talk to you…about it and wonder what we were doing in [SCA] and what the [program] is all about. We would explain it to them and they would keep looking and ask more questions. – Nora (12)

Twelve-year-old Katherine thought that "the website's also helping [to inspire change] because people just can get on it, can read about stuff we've done and try and make a difference." Ten-year-old Carlos said he "enjoyed making the [website]." To make sure it had an impact, he said, "I started to talk about it to my friends, my teacher, and kids at my school." To Tim and Nora, influencing the community most effectively required ensuring the website's visibility.

> Another way we can help is by spreading it around, like the website. We could tell people, like if you like to help your community, go to this website. – Tim (11)

> Going around just even over the Internet [promoting] the website ... [or] going around telling your friends about it could inspire them to tell more friends. – Nora (12)

*Loveland: BGC community garden.* Participants in Loveland reported having enjoyed the garden project. Thirteen-year-old Bill said, "[I learned] that I love to hang out with people and pull weeds and stuff." Ten-year-olds Peyton and Ben said that working together in the garden was hard work, but it didn't feel like an imposition.

> Some people took turns [in the garden] and we all got certain job that we had to finish ... It didn't feel like a chore but it felt like something you had to do to help. – Peyton (10)

> I really like the weeding part. Usually at home I just, I really just don't like to weed, but for some reason I was really excited … to do it. – Ben (10)

Several participants reported also gardening at home, which to them was an extension of their action project. In explaining how he regularly engages in pro-environmental behaviors, twelve-year-old Gabe said, "I have a garden in my front yard, and I check it every day." Bill said, "[SCA] impacted me [because] me and my dad, we've been planting a garden." Others made clear that they started new gardens at home, inspired by SCA.

> We started our garden [at home after] I talked to my family about it. We went on a shopping spree for garden stuff and we got a box so we can plant flowers, watermelon, cantaloupe… – Bryan (10)

> I've been telling my mom about the garden and she likes the idea so we're going to start [one] ... We even pulled out all the weeds from the sides and we're going to start a garden because the inspiration of our garden. – Peyton (10)

To influence others in the community, these participants were enthusiastic about informing others about gardening. Bryan said, "I feel like I could make a difference by telling others that they should start growing a garden." Peyton considered volunteering with the garden at her neighborhood church. She said, "How I felt like I could make a difference is by the garden. Also, I live right next to a church and they're growing a garden, and maybe in my free time, I could go to the church and help them with the garden from stuff I learned. Maybe I could give them tips."

*Community engagement beyond SCA.* Through their participation in SCA, a number of participants took advantage of additional opportunities be influential in school and community settings. Scarlett's ideas were taken up by teachers for Earth Day celebrations, Andrew discussed climate change with his teacher, and Daniel successfully persuaded his teacher to cover the carbon cycle with his science class.

> On Earth Day at school, we were talking about stuff like this and since I have this background information, I put that into my schoolwork and the teachers were really impressed and took some of my ideas and now we're trying to help. – Scarlett (12)

> When I started coming here, I mostly told my teacher what was happening. Like people using bad stuff like gases and they can ruin the planet and kill a lot of things in the ecosystem. – Andrew (11)

> At school, we're now doing plants right now and how the sun beats down and all the $CO_2$ and this goes in the air and helps it grow. We're now learning about it because I gave my teacher the idea to see if we could do that. – Daniel (10)

In addition, four participants—Abigail, Rose, Nora, and Tim—reported having joined a youth advisory committee to weigh in on the development of a park in their community. According to Abigail, she may not have considered joining if not for her participation in SCA.

> Abigail (13): Me, Nora, and Rose, we got into this committee thing. And it's so that we can work on what goes back there in that field. I think that me personally being in this program made me want to actually participate in that more than I would have before …We're the committee who is going to decide what's going to go in there. This is just a big field.
> Rose (13): …They want kids to have a say in it because kids are probably going to more use it.

*4.4.5 Science Engagement*

A portion of focus group discussions explored youths' views of science before and after their participation in SCA. For some, a main reason for joining a program called *Science, Camera, Action!* was a love of science. Others described gaining a greater appreciation for science through SCA, especially those who initially did not feel very interested in the subject. This came about through their enjoyment of SCA activities, gaining a more expansive view of what science entails, and viewing science as more accessible, interesting, or valuable. Several participants said SCA enhanced their performance in science class through their increased science knowledge, interest, or confidence.

**Perceptions of science.** Before SCA, participants' knowledge about, and perceptions of science ranged widely. While some felt it was important, others were less familiar with science. Theo and Miguel reported not knowing a lot about science, while Gabe viewed it as extremely important to society.

> I don't do science at school. – Miguel (12)
>
> I don't know much about science. – Theo (10)
>
> Overall, I think science is a big help to the human race, and without it, we'd not be where we are now. – Gabe (12)

A few participants explained that SCA expanded their perspectives on science, particularly which types of problems are dealt with in science and how scientists do their work. Some began with simplified impressions of science. To Theo, science was about "making rockets fly." Without having a class in school dedicated explicitly to science, Miguel perceived science to be "all about experiments." Olivia and Nora had similar impressions, sharing that before participating in SCA, they understood science to take place "indoors," such as in laboratories, and focus on "inside" things rather than the environment.

> I thought that science was just like an indoors thing … Like science experiments and stuff? I didn't know it had anything to do with the outdoors or anything … We don't need to mix stuff together to make science. – Olivia (12)
>
> I thought it was like ... I didn't know that science was like outside things. I thought that was social studies. Social studies and science are two different things. It confused me at the beginning of the program, but I kind of get it now. – Nora (12)

By including nature in their concept of science, both Olivia and Nora adopted much wider views of science. Olivia remarked that, "Science is actually all around the world." Nora said, "Science opened my mind … Science is a bigger topic than [I thought]." In the following exchange, three additional participants, all girls, agree that anyone can do science, and that science is much more than "chemicals and labs."

Riley (10): At first, I just thought *scientists* could do science and you had to be a scientist or grow up to be one. But now I know that you don't have to be a scientist, you can be anyone [and do science].

…

Aubrey (11): Like Riley said, it doesn't matter if someone is a scientist or not because, at the beginning, I thought, like Riley, "You have to be a scientist to know what you're doing." But I learned that if you have enough experience, you don't have to be a scientist … You can do all this stuff.

Charlotte (10): When I hear the word "science," I think of like chemicals and like labs, but then we're going through this program and it's not just chemicals and labs. It's the Earth and it can be—

Riley (10): Anything!

Charlotte (10): —It could be plants, the sky. It could be… *That* can be science.

Riley (10): Climate change … Inventions. It's so magical.

For some participants, science was interesting because scientific innovation was understood to have a significant impact on people's lives, including the need for science in addressing climate change.

> I think science makes Earth cool because, with science, people can change a lot of things, like how we do this or how we do that. – James (11)

> [SCA] changed how I felt because now I know that science is all around us and we can do science stuff to help the environment and to help the Earth be healthy and for us to be able to live without any of this bad stuff. Also, that sometimes science can do bad things to the Earth, but if you do more science then it will help fix it, too. – Olivia (12)

Eleven-year-old Grace explained that SCA enhanced her views of the importance of science. As she put it, "I used to think that science wasn't that important and now I know it's really important and that we can help." Not everyone's views of science changed. For example, ten-year-old Ben said he "[didn't] really think of science differently" because, as he put it, "scientific studies … can be about anything really."

**Attitudes towards science.** During focus groups, several participants said they viewed science favorably before the program. When asked whether SCA helped them to like science

more than they did before, ten-year-old Noah said he "always liked" science, while thirteen-year-old Matthew said he "already liked science." More commonly, participants reported that SCA enhanced their interest in, and enjoyment of science. As ten-year-old Lexi put it, "I kind of did not like science before. I do like it now." Girls and boys across ethnicities, age groups, and research sites explained that SCA either deepened their appreciation or changed their views in favor of science.

> I didn't really like science until I actually started to learn more about [it in] the program. – Bryan (10)

> What I feel about science now is I like it more than I did before. – Michael (11)

> I enjoy science a lot now. It's one of my favorite subjects now actually. – Sydney (12)

> I mean, I liked science but I didn't like science *too* much. I didn't think it was very interesting. I can tell you this much, I like my Geo classes a lot more! – Ali (12)

Some participants suggested that SCA captured their interest and held their attention more than school science sometimes did.

> At my school, if there's a topic that we're talking about that doesn't interest me ... science is not actually fun for me. But [this program] made me care a lot about global warming. – Athena (10)

> I've been learning about [climate change] in class, but I wasn't paying attention much ... So now I really know what it means and ... how it is. – Luke (11)

When asked to explain whether his views on science had changed overall, Luke continued, "Well, I thought that science was kind of boring and you didn't really have to do it. But when I came here and I knew that it was about climate change and how the world is, I thought of it differently." Climate change made science relevant. Grace expressed a similar view, saying, "I didn't really like [science] before, and I wasn't interested in it. But now I know that you really need to know about it and you can't just ignore the changes happening in the world." For Arie, science went from "not really that interesting" to absolutely essential. As she explained, "Before

[SCA], I had thought of [science] as just something to do and something that's not really that interesting. But now science is interesting a lot, and I'd rather do science now than pretty much anything else."

**Science performance.** Several participants reported that their participation in SCA had a positive impact on their performance in school science. For some, doing better in school was attributed to their enjoyment of SCA. Ten-year-old Lexi said, "I liked … learning all this stuff and plus I'm ahead in my class." Others attributed their improved school science performance to an enhanced interest in science, which they gained through SCA.

> [After SCA], I enjoy science *so* much more. Before, I thought science was just one of those things we had to learn and so I wasn't really interested. I did what I had to do to get a good grade. Before I started *Science, Camera, Action!*, I started falling behind in science, but after I started the program it helped me catch up [in school]. – Sydney (12)

A number of participants reported that SCA content mapped onto current school science topics. As Scarlett, age 12, explained, "[SCA] helped me out in class because we're kind of learning about the same things at the same times and so I could put more input into my science class because I knew more from here." Participants across age groups identified connections between SCA and school science, which they said made them feel knowledgeable and better able to absorb information.

> It helped me learn what we're actually doing in school. – Daniel (10)

> In science, sometimes I don't know the answers, and now I know a lot more answers about carbon dioxide and that stuff. – Jack (11)

> With all that … I've learned here, I feel like it's kind of helped me with my learning … Because the time that I'm here … I had time to really understand what I need to in science or social studies. – Wayne (12)

Several participants described feeling more confident in science, which made them more likely to actively participate in science class. As Wayne continued, "I feel like it was easier for

me to open up [and say] what I learned at my school and stuff." When asked whether SCA influenced her self-confidence, ten-year-old Peyton said, "When we read books [in science class], they would ask us questions on the side of the books. And I was usually the one that would be most confident to raise my hand and tell them what I know about." After participating in SCA, Scarlett and Arie also felt more confident communicating about science.

> Every year … we do the school science fair. *Science, Camera, Action!* gave me more ideas for the science fair and gave me more confidence in myself so I could present it to everyone. – Arie (10)

> I learned how to better communicate what I meant … because, when we were learning about [climate change] in school, I didn't know to say certain terms. Or how to [choose] my words so that it made sense or got my point clear. I felt like this program really helped me realize how to tell better on what I learned and what I know. How to put that into real life. – Scarlett (12)

A couple of participants explained that their increased interest and confidence in science, gained through SCA, helped them to feel better on school science tests and standardized tests (e.g., the Transitional Colorado Assessment Program [TCAP]).

> Well, I wasn't really into science [before the program]. But after I got more into science, it actually made me feel better on my tests when I had to take tests. – Bryan (10)

> I thought [the program] did help because … we had TCAP, and doing this program actually helped me feel more confident on one of the tests. Some people were like, "I don't want to take the test because I don't know a lot about science." But I was pretty excited because I know about it. – Peyton (10)

Others reported getting better grades in science. For Cristy, it was a matter of paying more attention in science class. Jimmy thought joining SCA may help boost his science grades. After the program, he said his science performance had improved a full letter grade.

> Cristy (11): I pay attention to class now. I'm getting an A.
> Ali (12): I'm getting a B.
> Jimmy (10): I'm getting one C, because this is why I did the program … Before the program, I would usually get C-pluses or C-minuses and now I'm getting either B-pluses or A-minuses.

# CHAPTER 5: DISCUSSION

## 5.1 Summary of Findings

This dissertation sought to gain insight into youth climate change engagement by evaluating the impact of SCA on youth participants': (1) climate change knowledge, attitudes, and behaviors; (2) sense of agency; and (3) science engagement. Analyses of survey and focus group data showed significant improvements to youths' knowledge about climate change causes, consequences, and solutions, including both scientific and social dimensions of climate change. Participants reported a range of positive (e.g., hope) and negative (e.g., sadness) feelings about climate change, but felt inspired and motivated by their knowledge and action. Overall, participants left SCA with a deeper sense of respect for nature, a heightened sense environmental responsibility, and a stronger sense of urgency about the need for climate change action. Through their participation in SCA, participants reported increased engagement in pro-environmental (i.e., energy-saving; waste-reducing) behaviors, felt a greater sense of self-confidence to make a difference on climate change, and provided numerous examples of acting as agents of change in family and community contexts. Finally, SCA had a positive impact on youths' science engagement. Following the program, participants displayed improved attitudes towards science (e.g., in school, careers, and society), and reported enhanced interest, participation, confidence, and performance in school science.

## 5.2 Strengthening Youths' Knowledge about Climate Change

Survey analyses showed significant improvements to participants' climate change knowledge, based on a set of pre-determined items about Earth's climate system, the effects of climate change, and sustainable behaviors. Items selected for use in this study were adapted from Leiserowitz and colleagues' (2011) report examining "American Teens' Knowledge of Climate

Change," which compared the climate change knowledge of nationally-representative samples of U.S. teens and adults. Due to modifications made for age-appropriate wording in this study, not all items were directly comparable. However, the majority of individual knowledge items—fifteen of twenty-three (see Table 5)—allowed for the comparison of climate change knowledge between SCA youth and U.S. teens and adults. Following SCA, thirteen of fifteen items (86.7%) were answered correctly by a greater proportion of youth than U.S. teens. Comparing SCA youth to U.S. adults, following the program, eleven of fifteen items (73.3%) were answered correctly by a greater proportion of youth than U.S. adults (Leiserowitz et al., 2011).

Quantitative and qualitative analyses together suggested that, before participating in SCA, youth had some awareness of climate change. In the pre-survey, participants expressed a range of self-estimated knowledge and prior thinking about climate change, while nearly all endorsed the view that "Earth's climate is changing now." Focus groups lent some clarification to these findings, with some (mostly younger) participants claiming no prior knowledge about climate change, but having had some familiarity with the phrase, and most declaring some level of exposure to the topic, primarily through school (e.g., class, field trips) and media (e.g., news, books). A key theme in participants' views of the impact of SCA on their climate change knowledge was that SCA provided more or different information compared to their previous exposure. In many cases, participants said that SCA illuminated "how bad" the effects of climate change could be.

Throughout the program, as well as in focus groups, youth demonstrated an elaborated knowledge of climate change topics beyond those covered in SCA. For example, SCA content and activities were compiled to paint climate change with a broad brush, focusing more on ecosystem impacts (e.g., on forests, animals) than on societal impacts. However, participants commonly and easily connected the dots between key scientific elements of climate change (e.g.,

global warming melts glaciers) and related social implications (e.g., loss of homes due to sea-level rise). Moreover, participants across research sites expressed concerns about human and policy inaction on climate change, which was not a focus of the program. SCA aimed only to emphasize the importance of our own individual and collective actions.

Importantly, youths' extrapolations about the effects of climate change on human systems—despite their often apocalyptic predictions—were not perceived as personally-threatening, and their concerns about human inaction were not a reason for despair. Rather, discussions of participants' social concerns seemed to strengthen their connection to climate change as a human issue, and further inspired their motivation for action. In describing environmental risks, children are known to use severe language (Brown, Henderson, & Armstrong, 1987). At the same time, children often express optimism and perceive a low risk to self (Whalen et al. 1994; Howe, Kahn, & Friedman, 1996). A theme of perpetual optimism and positivity in youths' perspectives was observed throughout SCA, as documented in focus groups. An overall positive outlook was maintained, despite youths' apparent grasp of climate change risks. Youths' improved knowledge and enduring positivity, in this study, lend legitimacy to calls for increased climate change education with younger groups (Karpudewan et al., 2015; Taber & Taylor, 2009).

Some participants professed difficulty understanding climate change in SCA, expressing that they were still unaware what the term meant following the program. However, a comprehensive understanding of SCA content did not seem to be a prerequisite for inspired action. As noted by Chawla and Cushing (2007), "antecedents of action are much more complex than knowledge alone" (p. 437). Participants who expressed confusion nevertheless felt motivated to engage in personal pro-environmental behavior change and an eagerness to take

action in their communities. They, like other participants, left SCA feeling confident that they could make a difference.

### 5.3 Understanding Youths' Attitudes towards Climate Change

Most participants reported that learning about climate change made them feel concerned, yet capable and motivated to address climate change. A range of positive and negative emotions were reported by participants. Thinking about climate change made them feel sadness and fear, while knowing about solutions made them feel hopeful, even happy. Previous studies have found a positive correlation between knowledge about, and concern for climate change (Sundblad, Biel, & Gärling, 2007), including among adolescents (Ojala, 2012a; Stevenson et al., 2014). Further, a documented antecedent to young people's engagement with climate change solutions is a sense of hope (Ojala, 2012b). In a recent study by Stevenson and Peterson (2015), climate change concern and climate change hope were independent predictors of adolescents' pro-environmental behavior, suggesting that, "climate change concern among K-12 audiences may be an important antecedent to behavior which does not dampen the impacts of hope" (p. 1). Indeed, throughout SCA and in focus groups, youths' concerns about climate change seemed to coexist alongside their optimism.

In this study, youths' action-taking was described as alleviating their climate change worries. This finding resonates with the vast psychological literature on fear appeals, which recommends that messages likely to evoke fear be combined with constructive coping strategies offering receivers some degree of control to act in response to the problem (Mazur, 2011; Ruiter, Abraham, & Kok, 2001; Spence & Pidgeon, 2009). Problem-focused coping, through climate change action, has been documented as "regulating worry [and] promoting hope" among young people (Ojala, 2012a, p. 537). According to Ojala, "ways of handling negative feelings [about climate change] can either hinder or promote factual learning, ethical competence, and the

development of action competence" (p. 539). In the context of SCA, though concern about climate change undoubtedly offered motivation that spurred action, youths' concerns were tempered by the process. Taking action allowed for a positive reappraisal of the problem. As SCA participants saw it, the more people become aware and engaged (like them), the less of a threat climate change will be. That is, working to address climate change was understood to be a problem requiring the actions of many. Youth participants were 'pitching in,' helping to address a problem much bigger than themselves, and they felt others should do the same. In other words, taking action on climate change did not so much absolve as assuage their concerns. Addressing the problem, individually and collaboratively, inspired their feelings of optimism. Moreover, rather than impeding their climate change learning or action, youths' climate change concern strengthened their engagement.

Despite survey results suggesting a nonsignificant improvement to youths' connection with nature, focus groups offered some evidence that SCA enhanced participants positive attitudes towards the environment. One explanation for this survey finding is that youths' self-reported connectedness with nature prior to SCA was very high—perhaps a consequence of living on Colorado's Front Range. As a composite, youths' scores increased from 3.96 (on a 5-point scale) to 4.13, indicating that SCA was to some extent effective in this area. According to its authors, the Connection with Nature Index:

> …was based on four premises: (a) Students feel comfortable in the outdoors; (b) students feel that they are a part of nature, rather than separate from it; (c) students actively engage in observing their surroundings when in natural settings; and (d) students show interest in outdoor activities. (p. 34)

Following SCA, a number of youth described feeling more a part of nature, more caring about their impact on the environment, and more involved in outdoor play. Research has shown that children who develop a strong connection to the natural world are more likely to take

responsibility and behave in pro-environmental ways (Chawla, 2001; Tanner, 1998)—two outcomes on which SCA was indeed effective.

Following SCA, youth felt an enlarged sense of environmental responsibility. Within the six-item Environmental Responsibility scale (Powell et al., 2011), the largest single-item mean difference was found in youths' endorsement of whether their "actions impact the health of the environment." During focus groups, a number of youth discussed their heightened awareness of, and attentiveness to the ways their own behaviors and choices affected the environment. Rather than expressing guilt about their environmentally-significant behaviors or doubt in their abilities to change them, participants found hope and inspiration in the knowledge that they wielded influence over the well-being of the planet. They reported feelings of conviction and eagerness to have a positive impact. Further, their feelings of environmental responsibility and concern were not bounded by geography or temporality. They understood climate change as happening now, with impacts visible in melting glaciers and threatened coastlines. What is commonly a psychologically distant issue for adults (e.g., Leviston, Price, & Bishop, 2014) was an immediate and visceral problem for youth participants. To them, the health and well-being of shoreline and ocean dwellers—from people and their pets to penguins and polar bears—were under clear and present threat by climate change, requiring prompt action.

In these ways, youth participants' perspectives on climate change deviate widely from well-documented normative responses by adults to climate change awareness (van der Linden, Maibach, & Leiserowitz, 2015), calling into question whether dissonance, denial, and distance are in fact evolutionarily 'hard-wired', rather than learned (Marshall, 2015). A perhaps less controversial conclusion is that the current state of the social psychology of climate change, as adult-focused, has a blind spot for the unique perspectives and experiences of children and youth (Corner et al., 2015). It would be unwise to assume that the vast and growing literature on adult

climate change cognition, affect, and action readily translates into an understanding of young people. In this study, pre-teens absorbed knowledge, developed concern, maintained optimism, and pursued meaningful action in response to a more or less basic understanding of climate change. If this were the potential of most young people, the most alarmed and dedicated climate change researcher would take notice, and likely comfort as well.

### 5.4 Empowering Youths' Agency through Action

Perhaps even more than the effect of gaining knowledge, taking action on climate change strengthened youths' feelings of competence and self-efficacy to remedy environmental problems. Following SCA, participants reported increased engagement in personal environmentally-friendly behaviors (e.g., saving water, electricity). This survey finding was likely due in large part to participants' enthusiastic engagement in SCA's Carbon Footprint Contest, which involved the formulation and implementation of pro-environmental family action plans to reduce unnecessary energy use and waste at the household level. Several participants said that their daily routines had changed as a result.

Applying their climate change knowledge to ameliorative action gave participants a sense of accomplishment and a stronger belief in their capabilities to benefit the environment through their own behaviors and decisions. According to Schreiner and colleagues' (2005) characterization, the youth in this study were "environmentally empowered" (p. 8). As these authors define it:

> …empowerment is a prerequisite for action and includes content-specific skills, motivational patterns and personal value orientations. An empowered person feels capable of taking appropriate action to achieve what s/he aims for, and combines his/her cognitive resources (motivations, attitudes, hope and visions). Environmentally empowered persons feel that they can make a difference in the world. (p. 8)

In this study, youths' informed action was an extension of their knowledge and motivation, and was an exercise of their agency and ownership of the issue. Beyond greater self-efficacy to

protect the environment, nearly all participants left the program feeling more capable of making a difference overall. Initiating and carrying out their climate change action projects expanded youths' confidence in their own abilities to undertake and overcome challenges. In this way, action-taking fueled youths' sense of agency, while confidence in their agentic capabilities spurred further action.

A unique feature of the SCA program was its combination of individual and collective action projects. Whereas most environmental education programs promote personal, pro-environmental behavior change, others aim to strengthen collective engagement. According to Kenis & Mathijs (2012), these "contrary" approaches stem from "different visions on the root causes of environmental problems and their possible solutions, and on human beings and society" (p. 47). As a result, they are rarely combined. Given that psychological studies of climate change action have tended to focus on individual lifestyle and consumer-based behaviors and choices (Shove, 2010), a goal of SCA was to simultaneously contribute to, and extend research on modes of climate change action.

Having implemented action plans both personally and collaboratively, this study's participants described expanded agency in corresponding forms, referring to individual and collective senses of competence (Chawla & Cushing, 2007). The unique impacts on children's agency of these distinct modes of action make sense given the distinction made by Kenis and Mathijs (2012) between the "divergent conceptions of power" underlying individual and collective approaches, respectively:

> The first approach tends to understand power as a psychological phenomenon. It stresses the importance of, for example, "locus of control" and "perceived behavioural control", and tends to understand people's statements about experiences of powerlessness as expressions of their psychological barriers for engaging in individual behaviour change. The second approach, in contrast, conceives of power as an effective and relational social reality. (p. 47)

Chawla and Cushing (2007) have noted that the most effective youth-based environmental programming typically has an extended duration of time, which allows participants the opportunity to learn and to practice new skills, which in turn allows participants to experience success at achieving their goals. They further state that developing an individual sense of competence is critical because it sets the foundation for the development of collective competence—required for the most *environmentally strategic behaviors* (e.g., collective action). As they put it, "People are more likely to contribute to a group when they have confidence in themselves and their capabilities" (p. 445).

A possible explanation for SCA's effectiveness to cultivate youth agency is that participants' personal self-efficacy was strengthened through the Carbon Footprint Contest (i.e., individual actions), which was then followed by their engagement in collaborative action projects. The supportive atmosphere maintained by participants throughout the Carbon Footprint Contest may have further developed their sense of competence, both individually and collectively. According to Chawla and Cushing, "…individuals are more likely to feel self-confident when they are surrounded by a strong, supportive group" (p. 445). SCA's positive outcomes in this regard highlight the significance of climate change programming that fosters strong, positive group dynamics as a means to build youth self-efficacy and empowerment.

In addition to articulating their expanded sense of agency, youth participants of SCA presented substantial evidence that they were agents of change in their families and communities through individual and collaborative action projects. They disseminated information and mobilized others' concern and action, which in turn empowered their agency. As concerned, confident, and motivated change-makers, they knew that spreading the word and reaching more people could expand their impact.

The potential role of children and youth as knowledge-bearers and environmental messengers is commonly evoked in policy initiatives, in which children's "pester power" is seen as a possible way of transporting climate change education, concern, and action from classrooms to households (Satchwell, 2013, p. 298). This role is important, given the reality that, at present, it is "[youths'] parents and other adults in the community who have the immediate power to influence prevailing environmental policies and practices" (Ballantyne et al., 1998, p. 286). Participants' intergenerational influence was clear in narratives of their engagement with audiences both younger and older than themselves, as passionate advocates for a healthy planet. These findings resonate with those of previous studies, demonstrating that youth are both willing and able to assume the role of change agent through youth-based programming (Haynes & Tanner, 2015; Malone, 2013; Mitchell et al., 2008; Percy-Smith & Burns, 2013; Tanner, 2010).

Reflecting on their action projects, several participants explained that their accomplishments defied their own self-expectations, which were embedded in wider beliefs about the limited capabilities of young people. Their worldviews were challenged by their agentic experiences. Consequently, many participants left the program feeling personally capable, collectively competent, and more certain that their voices and actions mattered. By extension, many participants expressed greater certainty in the efficacy of children and youth to change the world.

### 5.5 Enhancing Youths' Science Interest and Engagement

A final goal of this evaluation study was to explore the impact of SCA on youths' science engagement, given its science-based content and non-traditional, action-based approach. Prior to SCA, participants' survey-based attitudes towards science were, on average, very positive. For more than a third of participants, joining SCA was at least partially due to their fondness for science. However, not everyone favored science prior to the program. Though few articulated an

explicit dislike for science during focus groups, many discussed their previous indifference. Some participants described inattention and poor performance in school science, while others said they completed class requirements satisfactorily, but with little enthusiasm. Following SCA, participants' attitudes towards science (i.e., in school, careers, and in society) improved significantly. The vast majority reported that SCA helped them to like science more, and more than half of participants aspired to a STEM career.

One reason for SCA's positive impact on youths' science attitudes could be that school science can often seem disconnected from real-world issues. As a socio-scientific issue, learning about climate change can crystallize the connection between "[school] science and students' lived experiences" (Sadler et al., 2007, p. 373). Moreover, school-based science curriculum is not often associated with action-taking on learned concepts, particularly in U.S. science classrooms (Roth & Lee, 2004). According to Birmingham and Barton (2014), a focus on the cognitive dimensions of science learning (e.g., knowledge acquisition), without connecting science topics to students' civic engagement, "isolates scientific knowledge and practices from individuals' lived experiences and the immediacy of community life" (pp. 287-288). These researchers have advanced the concept of *educated action in science,* which "requires both knowing and doing…the capacity to leverage scientific knowledge and practices to inform actions(s) taken" (p. 287). However, as pointed out by Barab and Leuhmann (2003), "implementing project-based science curriculum is challenging in the context of standardized tests, 45-min class periods, large class sizes, and the emphasis on individual grades" (p. 455).

The SCA program—having taken place outside the formal classroom—undoubtedly benefited from increased flexibility on these dimensions, which has been associated with successful science learning outcomes in informal contexts (Birmingham & Barton, 2014; Blythe & Harré, 2012; Hall, Howard, Easley, & Halfhide, 2013). In this study, participants reported that

they had fun during SCA activities, which made science enjoyable and approachable, rather than boring or intimidating. Moreover, SCA allowed students to engage with science on their own terms through voluntary participation, digital photography, and youth-designed action projects. According to Reimer and colleagues (2014), the most successful non-formal youth-based environmental engagement programs:

> … are designed in a manner that gives youth participants the ability to define the context of their participation and act as co-creators or partners in an activity that brings meaningful change to the participants (as individuals) and/or to the community the participants belong to. (p. 570)

Through SCA, science was seen as more interesting, accessible, and important. For many, this was due to an expanded view of the scope of science inquiry, who can be a scientist, and how science connects to their lives. Perspectives shifted beyond stereotypical views of scientists in the laboratory or building rockets, to scientists whose work takes place in the outdoors and deals with environmental aspects of everyday life. After SCA, some participants saw science all around them, in the sky and on the ground. This enlarged view of science made it fascinating, and its role in understanding and addressing climate change made it valuable. Although the connections between attitudes towards science and attitudes towards the environment and climate change are under-explored in research, they have been shown to have weak but positive correlations (Dijkstra & Goedhart, 2012). In this study, knowing about climate change made science important, a finding that resonates with previous studies documenting the expanded significance of science topics when implications are considered beyond the confines of the classroom (Faria et al., 2014; Karpudewan et al., 2015; Sadler, 2009).

Viewing science as more approachable and appealing translated into youths' increased confidence and performance in school science. They reported being more engaged. For some, greater self-confidence and enthusiasm made active participation in science class less effortful,

and science tests less daunting. A few participants attributed better grades in science to their participation in SCA, while surveys showed significantly improved science grades by participants following the program.

These findings are encouraging, given the gender composition of SCA, which had a female majority overall as well as a sizeable female majority in two of three research sites. Issues of equity, access, identity, and confidence still impede girls' science engagement (Brotman & Moore, 2008). From early adolescence, girls express less interest in math and science careers compared to boys (Hill, Corbett, & St. Rose, 2010), with gender differences in STEM self-confidence beginning to emerge in middle school and expanding at the high school level (Lapan, Adams, Turner, & Hinkelman, 2000). This makes upper elementary and early middle school, the age groups served by SCA, a critical stage for girls' science interest and confidence. In this context, youth climate change engagement became an avenue through which to markedly strengthen their overall science engagement.

**5.6 Limitations**

Findings of the present study should be viewed within the context of its many limitations. First, this study's non-experimental research design calls into question whether the effects attributed to SCA were, in actuality, due to the influence of the program. In future evaluations of SCA, survey administration to treatment and control groups is recommended. A strength of this study's mixed-methods design, however, was that qualitative analyses of focus group discussions clarified the diverse ways that youths' knowledge, attitude, and behavior change were directly tied to program content. A further limitation is this study's small sample size, which precludes robust analyses of effects by sub-group (e.g., research site; demographic characteristics).

Recruitment for this study took place in-person at research sites through conversations with potential participants and their parents. Since SCA's participants self-selected into the

program, it is likely that they arrived with interest in program content and motivation to engage. A question for future research is whether youth without some level of drive to participate in the program would also experience the positive impacts of SCA. This is especially important given that under-resourced schools without classes explicitly dedicated to science potentially leave students with less motivation to engage. Further, youth without access to, or interest in nature and the outdoors may feel less attracted to SCA upon first impression. Including additional youth in the program would provide more information about the efficacy of the program with less intrinsically-motivated youth. At the same time, SCA's digital camera incentive was successful in recruiting some youth who had little to no content-based interest in SCA.

Participation in SCA was voluntary and weekly attendance, though strongly recommended by the SCA research team, was not mandated by the BGC. Across research sites, the BGC offered a number of appealing alternatives taking place at the same time as SCA, including a range of other clubs, field trips, games, and outdoor sports. For this reason, maintaining consistent participation was sometimes challenging. While some participants had perfect attendance, others' participation was inconsistent. A possibility in future research would be to somehow require attendance, or to implement the program in a more structured environment such as a school, where youths' prior interest and motivation to participate would likely vary more widely, and where attendance could be guaranteed.

A limitation of this study's survey-based evaluation is that the wording of some items may have been too advanced, especially for younger participants. While instruments were chosen for their previous validation with younger participants, existing scales appropriate for SCA's age group did not cover the range of variables of interest. For this reason, a portion of the survey's instruments had been previously validated with youth ages twelve and above. Though some items were modified for age-appropriateness, it is likely that the failure of some scales to yield

appropriate levels of internal validity was due to difficult language. In future studies, greater efforts to simplify item-wording is recommended.

A further threat to the validity of this study's findings is the possibility that youth participants responded favorably to survey items due to a motivation to be viewed positively (Nederhof, 1985). Response effects due to social desirability bias could have taken place during the pre-survey—when participants were making first impressions, during the post-survey—after participants had fun during the program, or both. During survey administration, participants were informed that SCA surveys are not "tests," they will not be graded, and that the most important rule of surveys is to be as careful and honest as possible. At the same time, participants may nevertheless have expected to be evaluated based on their survey responses. In future evaluations of SCA, having unfamiliar staff administer pre- and post-surveys could minimize these concerns. Further, data that could otherwise be obtained from primary sources (e.g., utility bills; report cards) should be sought. Finally, to more accurately assess the impact of SCA, more comprehensive documentation of the content of participants' school-based education should be acquired. For example, if some participants are learning about climate change concurrently alongside SCA, this should be accounted for in evaluation analyses.

Lastly, since SCA was evaluated holistically, it is unclear which components of SCA influenced participants, and in which ways. For example, while a safe assumption might be that SCA's science activities strengthened participants' climate change knowledge, it is unclear whether SCA's photography component supported science learning. By implementing and evaluating specific SCA activities as mini-interventions, it could be possible to identify their individual or combined impacts.

## 5.7 Future Directions

### *5.7.1 Expanding the Evaluation*

To further examine the efficacy of SCA in producing intended outcomes, additional group-based analyses—by program-related variables, socio-demographic characteristics, and participant attributes—are planned. Program properties include research site and participants' level of participation. Questions for future research include: Was SCA similarly effective on outcomes of interest across research sites, and did effectiveness vary based on participants' level of participation? Socio-demographic variables of interest include age, gender, race/ethnicity, and socio-economic status. Group-based analyses will begin to answer the question, "*For whom* was SCA effective, and in which ways?" Identifying group-based differences will point to potential areas for program improvement. Finally, SCA effectiveness may vary along the lines of participant attributes such as motivation for SCA participation (e.g., free camera vs. liking science) or most favored SCA component (e.g., science, camera, or action). Given this study's small sample size, with many single-digit sub-groups, a combination of non-parametric statistics and qualitative analyses are planned.

This summative evaluation examined the outcomes of SCA without addressing questions of "Why?" or "How?" A formative evaluation, drawing from unexamined focus group and survey data, is planned. During focus groups, participants reported on which aspects of the program they enjoyed most, and made recommendations for program improvement. In post-surveys, they reported their favorite SCA component (e.g., science, camera, or action), as well as their favorite activities (e.g., Greenhouse Gas Tag). Open-ended survey items inquired about participants' "favorite thing that happened during SCA," and asked, "If you could change one thing about SCA to make it better, what would it be?" Finally, mini-surveys were administered following each SCA activity, tracking participants' views of program activities (e.g., Do

participants feel as if they learned something? Were activities fun?), participants' emotional response (e.g., Were activities motivating or discouraging?), and attitudinal variables, such as sense of agency (e.g., "I have the power to help protect the environment"). A comprehensive process evaluation will identify further areas for program improvement.

*5.7.2 Extending the Research*

In seeking to understand and advance the role of youth as agents of change in their families and communities, this dissertation provides initial evidence of the potential for pre-teen youth to take informed action on climate change, not only in spreading the word to those around them, but in leading the change by example and outreach. A question for future research is, how and to what extent were family and community members affected by youths' efforts? Did youths' awareness-raising lead others to seek more information about climate change, to feel greater concern about the issue, or to take action? Though this evaluation has explored these questions through discussions with youth, future studies should seek to follow up directly with those outside the program who may have been affected (e.g., family members). Additional questions for close others may explore their perspectives on, and knowledge about climate change, their previous and present concerns, and the root of their motivations for, and engagement in pro-environmental behaviors.

Beginning to explore these questions may shed light on whether outreach by youth held additional weight, given that climate change is an issue involving disproportionate impact on younger (and future) generations. Further, examining parents' perspectives may offer insight into the efficacy of the program for youth whose family members are invested versus indifferent. In other words, what is the role of family support in facilitating (or hindering) SCA's intended outcomes? By extension, though it was not an issue in this study, the possibility of participants' families to be staunchly opposed to SCA content is still very real in the U.S. Under these

circumstances, youth could be discouraged or prevented from participating in SCA altogether. In future studies taking place in informal settings where participation is voluntary (e.g., the BGC), reasons for non-participation and attrition should be documented, if possible. Finally, engaging youths' family members could offer additional perspectives on the impact of SCA on youth. For example, family members' observations could corroborate or call into questions participants' self-reported behavioral changes, or even bring to light new or unexpected effects of the program on youth.

An additional question for future research is whether youth participants' retained climate change knowledge, maintained positive environmental attitudes, and sustained their engagement in pro-environmental behaviors after the program ended. Investigating SCA's long-term impacts could shed light on its transformative potential. One-year follow-up data collection is planned in May of 2017 using surveys and semi-structured interviews. Surveys will allow for direct comparisons over three time points, while interviews will allow for the investigation of potentially unanticipated effects of the program over time.

Future research is also planned that investigates youths' sense-making about, and connections to climate change through SCA's photovoice component. Throughout the program, youth took hundreds of digital photographs and engaged in three audio-recorded photovoice sessions during which they discussed their perspectives on, and personal connections to SCA topics. Examining how participants related to the program, with attention to site-based and demographic variation, has the potential to generate new information with theory-building significance as to how youth think and feel about, and relate to, particular climate change topics. More generally, examining this data may offer reflections on the program and potential areas for improvement.

Finally, it is possible that SCA's program structure represents a useful model for engaging groups in the investigation and remediation of community issues beyond climate change, where the components of a problem are unknown, inaccessible, or little understood. Further investigating SCA's program components (i.e., educational activities, digital photography, collaborative action) for their unique contribution to its effects could be a first step in developing this model. An ideal outcome would be to provide a conceptual framework and guidelines for developing programs that involve hands-on engagement with critical issues and culminate in informed social change action.

### 5.8 Project Significance and Conclusion

This dissertation contributes to the growing psychology literature on climate change perceptions and action (Corlew, Center, Johnson-Hakim, & Team, 2013; Dittmer & Riemer, 2013). Although youth participation in climate change action has grown in recent years (Fisher, 2016), few psychological studies have explored youth perspectives or sought to facilitate their active engagement. Further, existing psychology theory and research on climate change action has focused disproportionately on individual consumer behaviors and lifestyle choices, rather than on public-sphere behaviors or forms of collective action for broader social change (Fielding et al., 2014; Rees & Bamberg, 2014). This study both contributes to, and extends research on the nature and practice of climate change action in both individual and collective contexts, and from the understudied perspective of youth.

The results of this study suggest that the SCA program was effective in strengthening youths' climate change knowledge, as well as enhancing their environmental concern, responsibility, and stewardship. Findings also provide valuable information about the effectiveness of this program in empowering youth as agents of change in their families and communities, as well as in supporting their science interest and engagement. In sum, youth

participants of SCA received diverse psychosocial and educational benefits, while simultaneously playing an active role in the sustainable transformation of their families and communities. This study's results and methods are useful in educational settings, youth organizing, and interventions aimed to support youths' active engagement with important issues that impact their lives.

Climate change is occurring now, and will continue to present significant challenges to the well-being of individuals and the social functioning of societies for generations to come. In the U.S., climate change will disproportionately impact the most marginalized and vulnerable, including the socially and economically disadvantaged, the young and the old. The relevance of psychology as a field now depends on how psychologists respond to these challenges (De Young, 2013). As articulated by Fielding and colleagues (2014):

> Although social psychology can offer a wealth of theoretical and empirical tools, the social psychology of climate change is still young, and more needs to be done before we have established a solid set of frameworks and theories that are specific to climate change. Until we achieve this, the voice of social psychology is likely to be marginalised at the table of climate scientists. (p. 418)

By broadening its scope of inquiry and understanding, psychology will be more equipped to play an ameliorative role in years ahead. As climate change continues to take on greater significance in the minds of researchers, policymakers, and the public, so too will applied methods for increased stakeholder engagement and community transformation. In this way, the present research anticipates the future while simultaneously seeking to change it, by researching with youth—the changing climate's real key stakeholders.

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APPENDIX A: Consent and Recruitment Materials

*Letter to Parents:*

Department of Psychology
1876 Campus Delivery
Colorado State University
Fort Collins, CO 80523-1876

Dear Parents/Guardians,

My name is Carlie Trott, and I am a graduate student researcher from Colorado State University in the Psychology Department. Under the guidance of my advisor, Jennifer Harman, Ph.D., I am conducting a research study to better understand how youth think about climate change, and how to support their confidence to make a difference in their families and communities. The study is an after-school program designed to support youth science knowledge, interest, and self-confidence. The title of the project is "Science, Camera, Action!: Program Implementation and Evaluation". The Principal Investigator is Jennifer Harman, Ph.D., Professor in the Psychology Department, and I am the Co-Principal Investigator.

I am asking for your permission to have your child participate in this program and research study. We would like your child to participate in weekly, one-hour, activities to take place at the Boys and Girls Club. This program is called "Science, Camera, Action!" and it lasts for 20 weeks (January – May, 2016). Your child will engage in hands-on science activities, take and discuss photographs related to these activities, and collaborate with a group of youth to design a project to benefit the environment. Cameras and project supplies will be provided by the program. Your child will also be asked to complete surveys before and after the program and after each activity, and participate in audio-recorded group discussions to evaluate the program's content. The total time commitment for your child's participation will be 25 hours over a period of 20 weeks. Your child's participation in this research is voluntary. If your child decides to participate in the study, s/he may withdraw their consent and stop participation at any time without penalty. There is no cost to participate in the program.

The direct benefits to your child include activities designed to support knowledge and interest in science, and to empower their confidence to make a difference in their community. We also hope to gain more knowledge on how best to support youth science interest and empowerment. Your child's information will be combined with information from the other students taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. Your child will not be identified in these written materials.

There are no known risks associated with participation in this research. It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

Attached to this letter is a detailed description of the study for you and your child to read and sign. If you consent for your child to participate in the program, please sign and date the attached form and then return it to the Boys and Girls Club by January 3rd, 2016. If you have any questions about the research, please feel free to contact me at: carlie.trott@colostate.edu; (440) 476-3885 or my advisor, Jennifer Harman, Ph.D. at jennifer.harman@colostate.edu; 970-491-1529. If you have any questions about your rights as a volunteer in this research, contact the CSU IRB at: RICRO_IRB@mail.colostate.edu; 970-491-1553.

Sincerely,

*Carlie D. Trott, M.S.*
*Doctoral Candidate*

*Jennifer J. Harman, Ph.D.*
*Associate Professor*

*Youth Assent Verbal Script:*

***Science, Camera, Action!* – After-school Program at the Boys and Girls Club**
**Assent for Children 7 – 13 Years Old (Intended for Youth Ages 10-12)**

**Hi!**

**I'm a student at Colorado State University. I study how people think about science. This is called research. My research is about what helps kids connect to science and use their knowledge to help their families and communities. I am asking you if it is OK that I study you while you are taking part in the Science, Camera, Action! program.**

**If you say it is OK, I'll ask you to do two worksheets before the program starts. They will ask questions about science topics, like weather and climate. It is OK if you don't know the correct answers --- you may not have learned it before. The worksheets will also ask about how you feel about nature and science. For these questions, there isn't a right or wrong answer --- it is just about what you think. No one will grade your answers. Each worksheet will take 20 minutes. You can complete them on different days. Then, during the program, I will tape record you and other kids to see what you think and feel about science and nature. I will also ask you to fill out short, five-minute worksheets after each activity. The program will include hands-on science activities, photo-taking, and teamwork to do a project based on your ideas. After the program, I will ask you to fill out another two worksheets, like the first two, to see if you have new knowledge or feelings. Also after the program, I will ask you and the other kids to have a tape-recorded conversation with me about what you liked about the program. Your name won't be on the worksheets or the tape recordings, so no one will know how you answered or what you did.**

**We do not believe there is anything in this study that will harm you, but we think you may learn about science and have some fun. It might also help you to like science better and to feel more confident in your abilities. You will receive a camera and you might win other prizes (like a t-shirt) during the program. You don't have to do it. If you say "yes" now but later change your mind, you can stop being in the research any time by just telling me.**

**I will ask your parents if it is OK that you do this, too. If you want to be in this research, sign your name and write today's date on the line below.**

_____ _____
**Name** **Date**

_____ _____
**Researcher** **Date**

*Parental Consent Form:*

## Consent to Participate in a Research Study
## Colorado State University

**TITLE OF STUDY:** Science, Camera, Action! Program Implementation and Evaluation

**PRINCIPAL INVESTIGATOR:** Jennifer J. Harman, Ph.D., Department of Psychology, jennifer.harman@colostate.edu, (970) 491-1529

**CO-PRINCIPAL INVESTIGATOR:** Carlie D. Trott, M.S., Doctoral Candidate, Department of Psychology, carlie.trott@colostate.edu, (440) 476-3885

**WHY IS YOUR CHILD BEING INVITED TO TAKE PART IN THIS RESEARCH?** The *Science, Camera, Action!* after-school program is designed for youth ages 10 to 12. Your child is invited to participate in this program and research study because she/he is in this age group.

**WHO IS DOING THE STUDY?** Carlie D. Trott, M.S., a Doctoral Candidate of Applied Social Psychology, is doing this study for her dissertation project. Jennifer J. Harman, Ph.D., a psychology professor and Ms. Trott's graduate advisor, is supervising this research. This project has been funded by the National Oceanic and Atmospheric Administration. It has also been funded by the Society for the Psychological Study of Social Issues.

**WHAT IS THE PURPOSE OF THIS STUDY?** This study aims to better understand how youth think about climate change, and how to support their confidence to make a difference in their families and communities. The program will also be tested for its success in building youths' science knowledge, interest, and self-confidence.

**WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?** The 20-week program will begin in January and end in May, 2016. All activities will take place after school at the Boys and Girls Club. Before the program, your child will be asked to complete two 20-minute surveys to be completed at separate times. After the program, they will be asked to complete an additional two 20-minute surveys. These confidential surveys will ask about your child's knowledge and feelings about science and program content. During the program, your child will participate in weekly 1-hour activities. At the end of each activity, they will be asked to complete a 5-minute survey about the activity. After the program, your child will be asked to take part in a 45-minute small group discussion about their views and experiences of the program. Group discussions will be audio-taped to later evaluate the program. The time commitment for all program activities will be 25 hours over 20 weeks.

**WHAT WILL YOUR CHILD BE ASKED TO DO?** There are three main parts of the program.

Science: This part consists of seven hands-on science activities and games, themed "Making the Invisible Visible." Four activities are intended to show the connections between Earth's climate, plants, animals, and people. Three activities are intended to explore examples of environmentally-friendly actions.

Camera: This part consists of photograph-taking and discussion, which is called photovoice. In photovoice, youth will be given cameras and asked to take photos about their thoughts and feelings about each science activity. Later, group photo discussions will explore youths' views. Photos will aid in the design of youth projects.

Action: The final part focuses on teamwork and leadership. First, youth will design and act upon plans to lower their energy use through small, everyday behaviors. Later, youth will work as a group to develop and carry out a larger project to benefit the environment. Youth will be supported to act as pioneers of positive change in their families and communities.

CSU#: 15-6112H
APPROVED: 11/21/2015 * EXPIRES: 10/12/2016

Youth will be asked to complete surveys before and after the program, as well as mini-surveys after each activity. They will also be asked to participate in a small group discussion about their experiences once the program has ended.

**ARE THERE REASONS WHY YOUR CHILD SHOULD NOT TAKE PART IN THIS STUDY?** All 10, 11, and 12 year-olds are invited participate in this study. There are no known reasons why your child should not take part in this study.

**WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?** There are no known risks associated with being a part of this study. It is not possible to identify all potential risks in research procedures, but the researchers have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

**ARE THERE ANY BENEFITS FROM TAKING PART IN THIS STUDY?** This study is designed to benefit your child in several ways. First, activities aim to support your child's science knowledge and interest in science. The program is also designed to promote your child's confidence in their abilities to make a difference in their community. Your child's participation will also benefit future youth participants by providing feedback to improve the program. Finally, your child's participation will contribute to research on how best to support youth science interest and empowerment.

**DOES YOUR CHILD HAVE TO TAKE PART IN THE STUDY?** Your child's participation in this research is voluntary. If he or she decides to participate in the study, he or she may withdraw his or her consent and stop participating at any time without penalty or loss of benefits to which he or she are otherwise entitled. If you decide at any time that you do not want your child to participate in the study, you may also withdraw your consent at any time and your child will stop participating in this study.

**WHO WILL SEE THE INFORMATION THAT I GIVE?** We will keep private all research records that identify you, to the extent allowed by law.

For this study, we will assign a code to your child's data (for example: G1-567) so that the only place your child's name will appear in our records is on the consent and in our data spreadsheet which links your child to their code. Only the research team will have access to the link between your child, their code, and their data. The only exceptions to this are if we are asked to share the research files for audit purposes with the CSU Institutional Review Board ethics committee, if necessary. In addition, for funded studies, the CSU financial management team may also request an audit of research expenditures. For financial audits, only the fact that your child participated would be shared, not any research data. When we write about the study to share with other researchers, we will write about the combined information we have gathered. Your child will not be identified in these written materials. We may publish the results of this study; however, we will keep your child's name and other identifying information private.

**CAN MY CHILD'S PARTICIPATION IN THE STUDY END EARLY?** If your child does not attend the program regularly, they may be removed from the study.

**WILL MY CHILD RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY?** Your child will receive a camera as compensation for their 20-week participation in this study. They may also win prizes (like a t-shirt) through program activities and games. Snacks will also be provided.

**WHAT IF I HAVE QUESTIONS?** Before you decide whether to accept this invitation for your child to take part in the study, please ask any questions that might come to mind now. Later, if you have questions about the study, you can contact the investigator, Carlie Trott at carlie.trott@colostate.edu; (440) 476-3885. If you have any questions about your rights as a volunteer in this research, contact the CSU IRB at: RICRO_IRB@mail.colostate.edu; 970-491-1553. We will give you a copy of this consent form to take with you.

CSU#: 15-6112H
APPROVED: 11/21/2015 * EXPIRES: 10/12/2016

**WHAT ELSE DO I NEED TO KNOW?** To participate in this program and research study, your child must be permitted to participate in all parts of the program. Below is a summary of all components of this program and research study:

Program Activities:

- Science (Educational activities)
- Camera (Photo-taking and group discussion)
- Action (Youth-designed projects)

Research and Evaluation Activities:

- Surveys (Paper worksheets, before and after the program; After each activity)
- Photovoice (Audio-taped group discussions, during the program)
- Focus Group (Audio-taped group discussion, after the program)

To accept this invitation for your child to take part in this program and research study, please indicate your approval by signing below.

PARENTAL SIGNATURE FOR MINOR

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing 3 pages.

As parent or guardian I authorize _____ (print name) to become a participant for the described research. The nature and general purpose of the project have been satisfactorily explained to me by Dr. Jennifer Harman and Carlie Trott and I am satisfied that proper precautions will be observed.

_____

Minor's date of birth

_____

Parent/Guardian name (printed)

_____ _____

Parent/Guardian signature Date

CSU#: 15-6112H
APPROVED: 11/21/2015 * EXPIRES: 10/12/2016

*Photo/Video Release Form:*

Science, Camera, Action!
Release Form for Use of Photograph/Videotape

Carlie D. Trott, M.S.
Jennifer J. Harman, Ph.D.
Department of Psychology
(440) 476-3885
carlie.trott@colostate.edu

Please print:

Name of Participant: _____

Address: _____

I hereby give my permission to Carlie Trott to use any photos or videotape material taken of myself during her research on the *Science, Camera, Action!* program. The photos and videotape material will only be used for research purposes and for the presentation of the research. My name will not be used in any publication. I will make no monetary or other claim against CSU for the use of the photograph(s)/video. As with all research consent, I may at any time withdraw permission for photos or video footage of me to be used in this research project.

Signature: _____ Date: _____

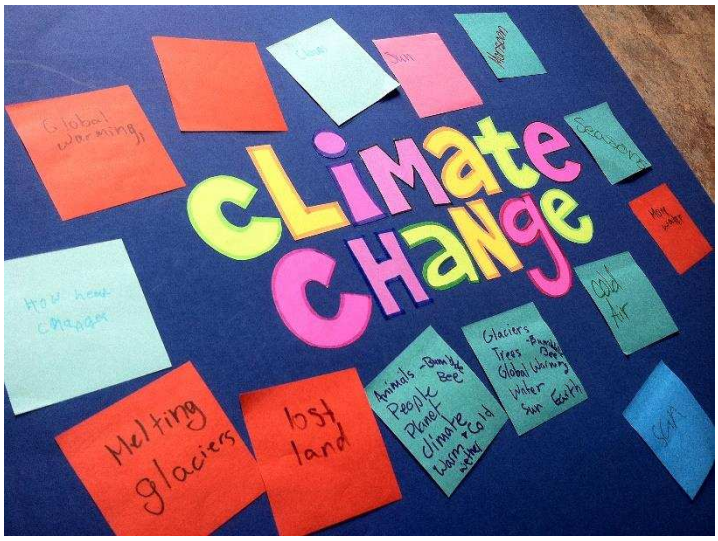
**If Participant is under 18 years old, consent must be provided by the parent or legal guardian:**

Printed Name: Date:

Parent/Guardian Signature: _____

IRB No.: 15-6112H
Date of IRB Approval: 10/23/2015

**Week 1: Gallery Walk (GW)**




***Order of Activities:***

**Part 1:**

- Introductions **– 5 minutes**
- Administering pre-survey **– 25 minutes**
- Taking a nametag & selecting a sticker upon turning in survey
- *(filling up participant ID chart)*
- Give GW prompts and post-it notes; Work on these until all surveys complete

**Part 2:**

- Gallery Walk **– 20 minutes**
- Ask about food allergies & hand out snacks
- Discussion **– 10 minutes**
- Collect nametags

***Part 1:*** The first week of SCA will be introductory in nature. It will begin with the pre-survey (Part 1) and end with a gallery walk. When participants arrive, the research team will introduce themselves, and I will discuss the program and the day's agenda. Participants will then be asked to begin working on a survey. (Tell them they can choose a sticker *after* they are finished!)

When participants complete the survey, 1-2 RAs will check to make sure sections are completed, and then the participant may choose a sticker to be their participant ID badge for the duration of the program. These 1-2 staff will help kids choose a sticker, place it on their completed survey, place a matching sticker next to their name on the participant ID chart, and then—after filling in the nametag with their preferred name/nickname—give them a lanyard of their choice.

***Part 2:*** Participants will then be directed to one of 4 tables, where they work in small groups to respond to a series of topics poster boards placed around the room in 'stations.' At each station, they will be asked to address the following questions:


*"What ideas, questions, or images come to mind when you think of:*

1. *Life in [city]*
2. *Science*
3. *Nature*
4. *Climate Change*

*Draw a picture, or write down your ideas or questions."*

Colorful post-it notes and markers will be provided on each table. Participants will be given approximately 5 minutes at each station (depending on time available). As participants progress to each subsequent station, they will review the responses already contributed by previous groups and add their own before moving on. When all surveys are complete, RAs will observe 1-2 tables, answer questions, help out, etc. As each group returns to where they began, groups will be asked to summarize the main themes and contrasts on the poster board. All groups will be asked to discuss other themes they notice.

If time allows, potential discussion questions are:

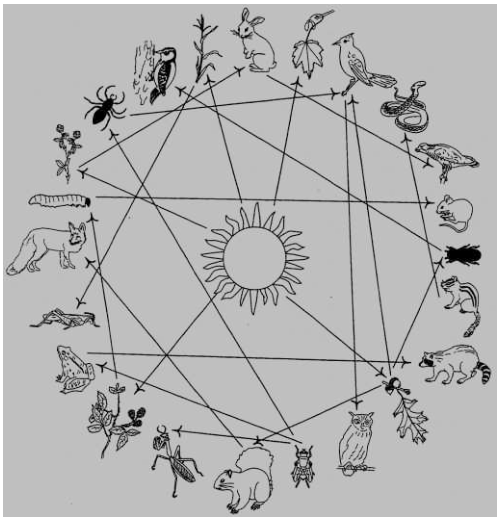
1. *What are the common responses to [each topic, in turn]?*
2. *What is an interesting response to [each topic, in turn]?*
3. *What are some ways that these topics connect [or relate] to each other?*
4. *What personal connections can you make? Do these topics relate to your life?*
5. *What have you learned about these topics in school? [Specifically climate change.]*

Inform the groups that our first science activity will take place next week, and that next week is when they will get to take their camera home for the first time. Next week is also when we'll go over the camera check-out process and the purpose of the photos.

Other things to do on Week 1:

- ***Ask if anyone has any food allergies!*** Record names, if any.
- Ensure each participant has chosen a camera color and a camera tag.

**Topic 1: Ecosystems**



***Order of Activities:***

**Part 1:**

- Hand out nametags; Record absences
- Administer pre-survey (Part 2) **– 25 minutes**
- Place sticker on completed survey (reference participant ID chart as needed)

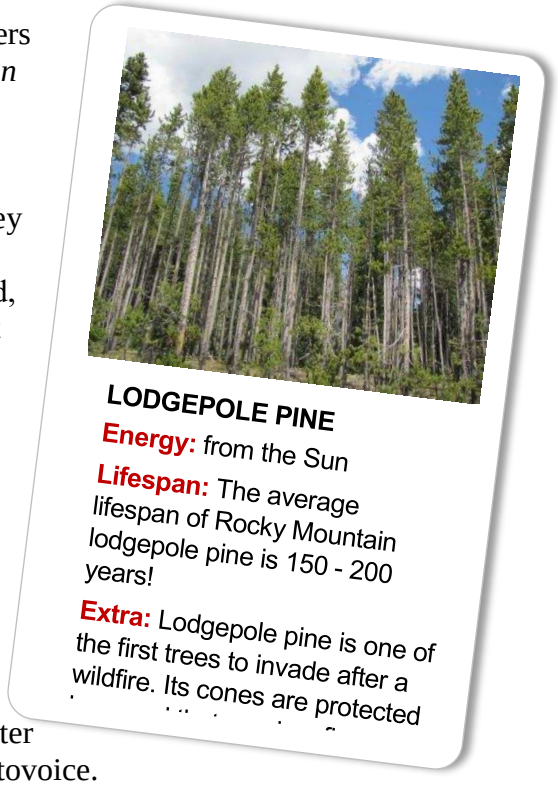
**Part 2:**

- Ecosystems activity: "Weaving the Web" **– 25 minutes**

**Part 3:**

- Photovoice introduction with handout
- Camera Agreement + Mini-Survey **– 10 minutes**
- Hand out cameras
- Collect nametags

***Part 1:*** The second week of SCA will consist of pre-survey administration (Part 2) and our first science activity. It will end with an overview of photovoice and handing out cameras. When Participants arrive, the research team will hand out nametags, and I will discuss the day's agenda. Participants will then be asked to begin working on the second portion of the pre-survey. (Tell them they can add their sticker *after* they are finished!). When participants complete the survey, 1-2 RAs will check all sections to make sure surveys are complete, and give participants their stickers to place on the survey. *[Stop after 25 minutes, and plan to re-administer next week if needed.]*




***Part 2:*** Next, participants will be directed to a table of card-necklaces, laying face down on a table, where they will randomly choose an ecosystem component. RAs will be given special "event" cards (i.e., drought, flood, wildfire, humans). *Always make sure one participant is the sun, plenty of others are plants and insects, and that not all participants are top-level predators. Commence activity and explore discussion questions as time allows. As the activity ends, announce that this week's main idea was that plants, animals, and people are all interconnected within ecosystems—that plants, animals, and people depend on one another for survival. (See Activity Overview below.)

***Part 3:*** This week ends by introducing photovoice. After handing out prompts, review what is expected for photovoice.

Emphasize that there is no such thing as a "wrong photo," that they can take as many photos as they like, and be sure to pick 1-2 favorites to print out on photovoice day. Finally, administer mini-surveys and distribute cameras.

***Other things to do on Week 2:***

- Ensure Camera Agreements are complete
- Have participants "check out" their cameras using the clipboard
- Collect nametags.

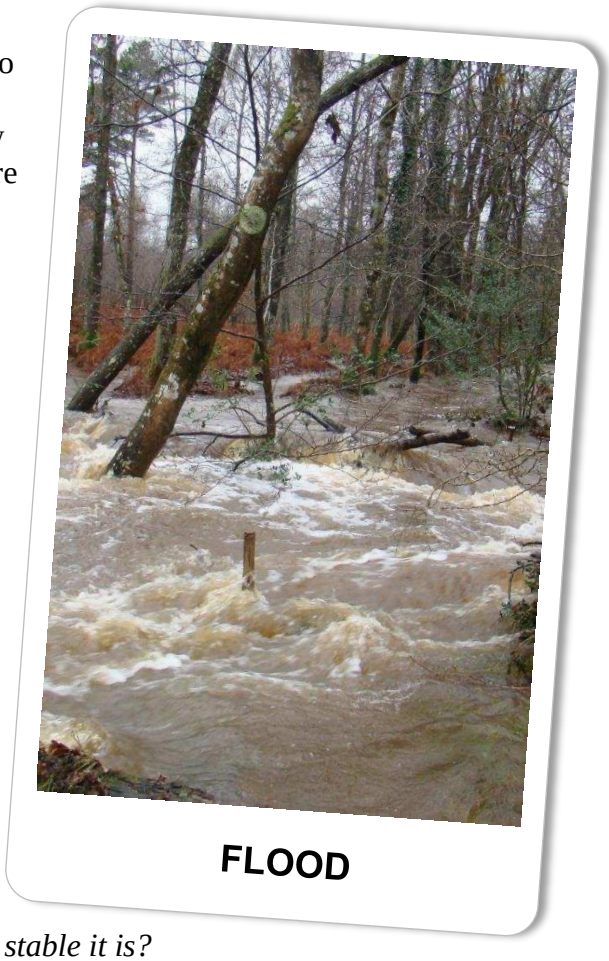
***Activity Description: "Weaving the Web"***

1. Create a set of cards with various ecosystem components. Examples: Sun, grass, mosquito, rattlesnake, elk, bear, cougar, eagle, etc. Use some of the yarn to make a necklace with each card.
2. Distribute one necklace card to each participant.
3. Everyone should now stand in a circle. Ask the participants to think about which card represents the resource that all life needs to grow (the sun). Hand the end of the yarn to the student with the "sun" card. This participant should wrap an end around their hand.
4. Now ask, "What would be next in the chain?" or, "What uses the sun directly to grow?" Participants should decide that the answer is a plant. The person holding the sun card, while still holding onto one end of the yarn, should then toss the other end to someone with a plant nametag. You may then ask a question such as, "Who eats the plants?" in order to have participants think of where the yarn will go next. Continue through the list in the same manner until all of the labeled cards have been used and each person is holding a piece of string.
5. Ask the group to step back until the string is taught.

**WHITE-TAILED DEER**

**Height:** 1.7 – 3.9 ft. (Adult, At Shoulder)
**Adaptation:** can run as fast as 40 mph & leap 15 – 20 ft. forward when frightened
**Diet:** leaves, twigs, fruits, nuts, grasses
**Predator(s):** humans, wolves, mountain lions, bears, jaguars, and coyotes.

6. The participant with the original end of string (sun nametag) should now gently begin tugging. If someone feels a tug during this time, they should tug in response. This should progress until everyone is tugging, which will also cause the web to shake. You may now note that *all things in the ecosystem are connected*.
7. At this time, a stressor should be introduced (e.g., wildfire, flood, drought).
8. Ask participants how the stressor impacts the entire ecosystem when one of the links is damaged by stress. Have one or more links drop out of the circle due to the introduction of the stressor. Have participants continue their discussion on how the entire ecosystem is affected if one or more organisms are lost. Repeat this process until enough links have dropped out to illustrate the effect stressors have on the ecosystem.
9. Switch cards, repeat, and introduce an alternate stressor. (In the second round, let participants choose their card. Likely, the ecosystem will have fewer component parts.)
10. After playing a couple of rounds, potential discussion questions are:
    Q: *What happens when we remove a link in the ecosystem?*
    Possible Answer: Organisms that depend on it are affected.
    Q: *Were the changes more dramatic when the system was composed of many parts or when it had fewer parts?*
    A: Fewer.
    Q: *What can we say about the relationship between how many parts the system has (its complexity or diversity) and how stable it is?*
    Possible Answer: In general, complexity makes it more stable.




**Activity Link:** https://www.epa.gov/sites/production/files/documents/weboflifeactivity.pdf

**Topic 2: Climate vs. Weather**

***Order of Activities:***

- Introductions – **5 minutes**
- Hand out nametags [record absences.]
- Activity – **40 minutes**
- Mini-survey – **5 minutes**
- Photovoice handout + overview – **10 minutes**
- Collect nametags
- Ask about food allergies & hand out snacks


*The expected range of skittles in the bag is the climate. What actually comes out is the weather.*

The fourth week of SCA will be more comfortable in terms of time management—and more representative of the program schedule going forward. It will begin with handing out nametags and recording absences, and proceed directly into the activity.

When participants arrive, they will be asked to sit at 1 of 4 tables in groups. Their table will be given a single fun size bag of skittles. Commence activity (see attachment) with 4 – 5 bags of skittles (1 per group). The first round will establish the meaning of each skittle color, and communicate the basic difference between climate and weather. In the second phase, every participant will be given their own bag (original flavors). Each skittle will represent a day of the month, and each participant will represent a different year (in their city). We will see that day-to-day weather fluctuates, but averages (i.e., climates) remain pretty constant. In the third and final phase, we will introduce different flavor-typed bags. These represent different climates—a very cold climate with few warm or sunny days, and a very warm climate with few cold or rainy days. We might ask the participants to think about where these climates might exist in the world. We can reinforce the idea that even though we don't know which skittle might come out of the bag next (tomorrow's weather), we can predict pretty confidently that it won't be very cold in a warm climate or very hot in a cold climate.

Potential Discussion questions:

- *Why does the climate matter? Why do we care about predictable ranges in temperature and weather patterns? – Agriculture, etc.*
- *Has anyone visited a different climate?*
- *Has anyone lived in a different climate?*
- *How does the climate affect the plants, animals, and people living in a place?*
- *Think of some different climates. What kinds of ranges to they have that are different from ours? What types of plants are in the desert? What types of animals are in the arctic?*
- *Mark Twain once said that "Climate is what we expect, weather is what we get." What does he mean?*

As the activity ends, announce that this week's main idea was that climate and weather are different things, and that climate is much easier to predict (compared to weather). So, whereas weather is what it's doing *right now*, climate is average temperature ranges and weather patterns in a region. Climate is determined by looking at trends over long periods of time—usually 30 years or more.

Then, hand out photovoice prompts. Make sure everyone knows they are to take a few photos related to the prompt, that there is no limit to the number of photos they can take, that no photo is "wrong," and be sure to have 1-2 favorite photos picked out for next week's photovoice activity. Finally, have everyone fill out the mini-survey (with sticker) before signing their camera out.

Other things to do on Week 3:

- Have participants "check out" their cameras using the clipboard.

***Activity Description:* "Weather vs. Climate"**

*What's the Difference between Weather and Climate?*

**Overview:** That's a good question! Sometimes the words get used almost synonymously, but there's a real difference. And we can illustrate the difference with a pack of M&Ms.

**Necessary materials:**

- Bags of "fun size" candy (e.g., M&Ms)

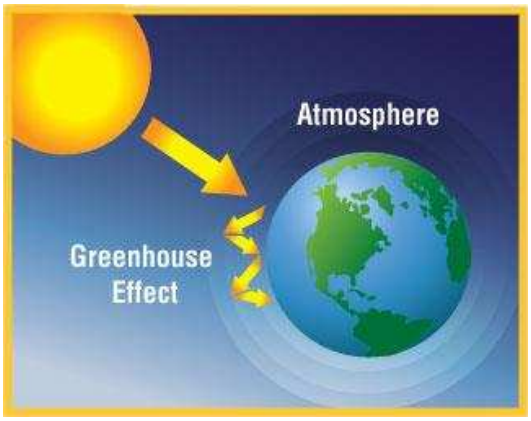
Other types of candy will work as well, of course. You just need a little bag of candy with many— but not too many—different kinds of candy in the bag. If you choose not to use candy, beads make a very nice substitute.

**Theory:** Weather is what it is doing *right now*. It might be raining, it might be sunny. Climate is a bit harder to define. Here are a couple of characteristics:

- Climate describes the range of what you might expect in a given location—the limits of what the weather might be. In Fort Collins, where we are, it might be cold in March or it might be hot. It might be 25°F or it might be 75°F. But it's never 0°F or 100°F in March.
- Climate describes average weather. On any given day, it might be hot in Denver and cool in Miami, but, on most days, it's hotter in Miami than it is in Denver.
- Climate describes long-term trends. If it's cold for a few days, that's weather. If it's an ice age, that's climate.
- In Colorado, our weather is pretty changeable. It might be rainy one minute and sunny the next. But our climate is pretty stable. It's warm in the summer, cool in the winter, and, overall, pretty dry.

**Activity Link:** http://littleshop.physics.colostate.edu/activities/atmos1/WeatherClimate.pdf

**Topic 3: The Greenhouse Effect**




***Activity Description:*** **"Greenhouse Gas Tag"**

**Objectives:**
Participants will…
1. Learn why Earth, unlike other planets, is warm and livable
2. Learn how humans are contributing to Earth's warming
3. Be able to give examples of greenhouse gases and explain where they come from
4. Identify ways they can reduce their $CO_2$ impact
5. Be active

**Overview:** In an open space, indoors or outdoors, props symbolizing the sun and the Earth will be placed as far from one another as possible. In between, a visible boundary will be laid on the floor to represent Earth's atmosphere. In the first round, all kids will play the role of "energy" (i.e., solar radiation) coming from the sun into Earth's atmosphere. They will be instructed to run from the sun to the Earth, then back out into space. In a second phase of the game, one or two kids will represent greenhouse gases (GHGs). They will stay within the boundary of the Earth's atmosphere, and be instructed to 'tag' kids attempting to leave the atmosphere after touching Earth. In this second phase, kids representing energy will move from the sun towards the Earth (as before), and quickly try to leave Earth's atmosphere. If they are tagged, they must stay within the atmospheric boundary line. In later phases, more kids will represent GHGs—and tag greater numbers of other kids—to demonstrate that the more GHGs in the atmosphere, the more heat is trapped. Discussion will follow.

**Discussion Questions:**
- *What is the greenhouse effect?*
  - When the Earth's atmosphere (GHGs) traps solar radiation to heat the Earth (about 70% is absorbed, and 30% is reflected)
- *Where does the term "greenhouse effect" come from?*
  - A greenhouse used for gardening traps heat to help plants grow indoors in colder climates like the greenhouse effect where gases are trapped heating the earth. You can also compare it to a car parked in a sunny spot that warms up and the windows don't allow all the solar radiation to escape.
- *Where do they come from?*
  - Transportation, Industry, Electricity, Agriculture (see link for specifics)
- *Where in your community do you see greenhouse gases used?*
- *What can we do to reduce the emissions of GHGs?*

**Activity Link:** http://eco-schoolleaders.weebly.com/uploads/1/4/3/5/14352270/greenhouse_gas_tag-_esli_lesson_plan_(1).docx

**Topic 4: Climate Change and Ecosystems**

**Activity 1 Description*: "Oh Deer!"***

- Identify ***food, water, shelter***, and ***space*** as four essential components of habitat.
- Understand the importance of good ***habitat*** for animals and plants.
- Discuss the relationship between an animal species and its resources.
- Understand how changes in environmental conditions affect habitats and animals.

In this activity, youth are split into two groups. The first group consists of deer (or some other animal) and the second group consists of essential components of a habitat (e.g., food, water). Lined up and facing away from one another, the deer pick one habitat component they "need," while the habitat components pick what they want to "be." When the kids turn to face each other, the deer must quickly find a match. Those who are successful get to "reproduce" by converting their habitat component into a deer. For those who cannot meet their need, they die (or are "recycled" back into the earth) and become a habitat component. The game continues for several rounds. In later stages, forest fires, floods, and droughts make some habitat components scarce. A group discussion follows.

**Processing:** The group will gather in a circle and discuss what the activity demonstrated.

- What happened when the habitat did not meet the needs of the deer?
    - What happened when there had been a forest fire and no shelter available?
    - What happened when there was a drought and no water available?
- How might this affect animals other than deer?
- Thinking back on previous weeks' activities, can anything be done to change this outcome?

*Video Demonstration:* https://www.youtube.com/watch?v=G_79b-8y8vY

**Activity 2 Description: *"Glaciers: Then & Now"***

Students compare photographs of glaciers to observe how Alaskan glaciers have changed over the last century.

***Learning Outcomes:***

- Students will understand how alpine glaciers have changed rapidly over the past century.
- Students will understand possible reasons for glacier retreat over long and short periods of time.
- Students will learn about possible impacts of global glacier retreat.

***Preparation:***

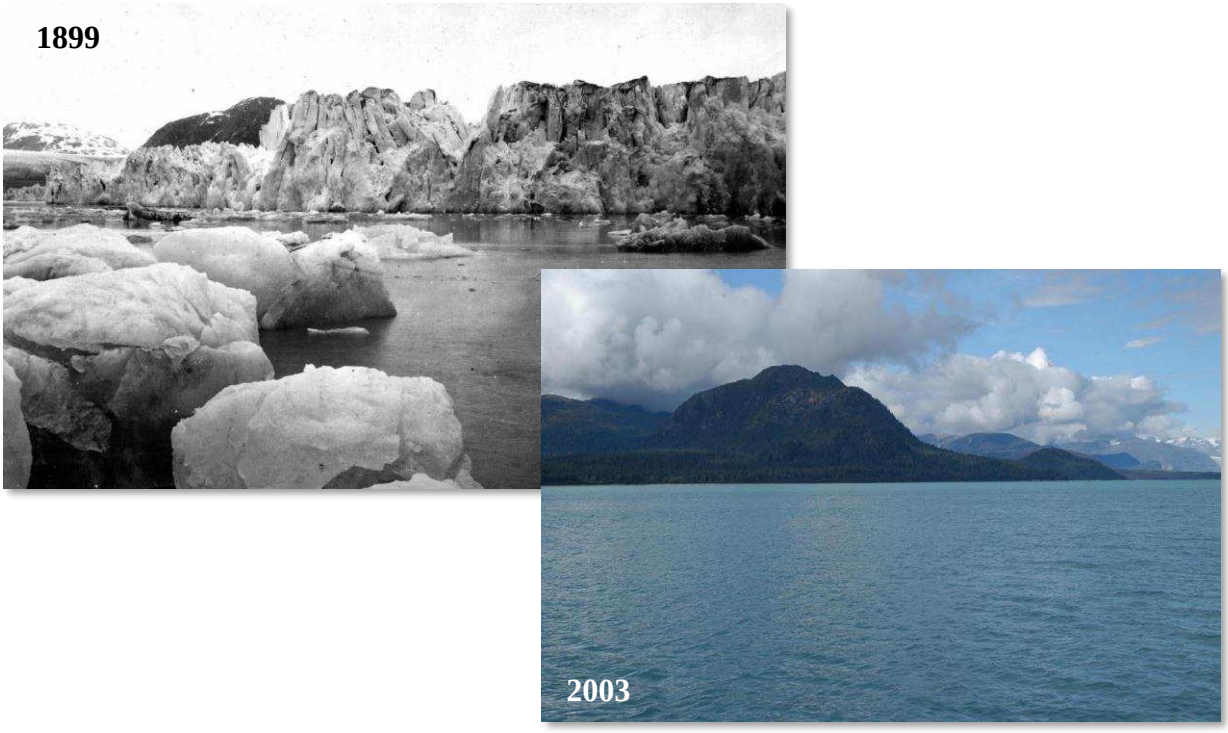
1. Print copies of "Glaciers: Then and Now" image pairs (one for each student group)
2. Cut each sheet of paper in half to separate the glacier photos.
3. Optional: Laminate all photos to make the sets more durable for repeated use.
4. *Note:* Do not share the first page with students until they have matched the pairs of photographs.

***Overview:***

1. In groups of three or four, have participants try to match the glacier images from the past and present. Give them approximately 10 minutes to accomplish the task. (Note: Do not share the key until they have matched pairs.)
2. Give participants 5 minutes to compare their matches to those made by the other groups.
3. Discuss the images and reveal the correct matches.
4. Have participants fill in the worksheet to record their observations.

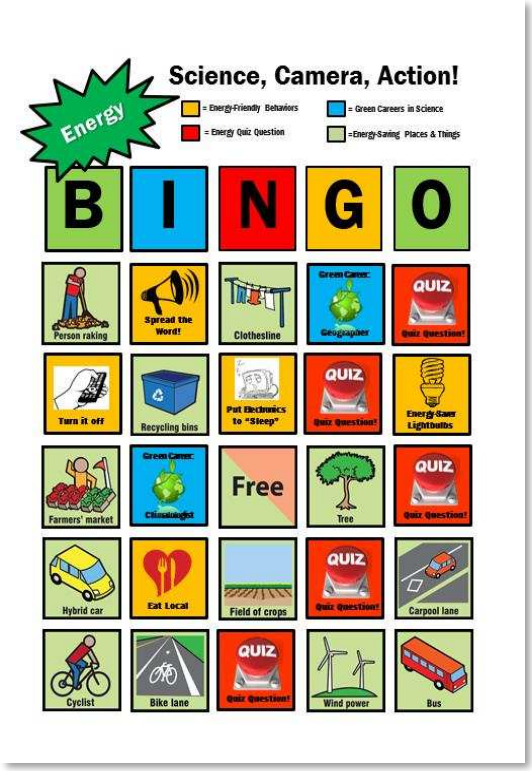
***Discussion Questions:***

- What stayed the same? What changed?
- Do all the glaciers in this sample follow the same pattern? Are they growing,
- retreating, or staying the same?
- What climate conditions encourage glacier growth and glacier retreat?
- What might account for glacier retreat today?
- As glaciers get smaller, how might this affect the Earth?
- Are humans affected by melting glaciers? What are the risks and benefits to human populations?



**Topic 5: Sustainable Solutions – Energy**

**Activity 1 Description: *"Energy Bingo"***




**Overview:** This is an introductory activity designed to familiarize participants with common energy-saving practices.

**Objective:** Students will learn about:

- Common energy-saving practices that they may incorporate into their Family Action Plans
- "Green" Science careers
- Energy-friendly places and things to notice in everyday life

**Rules:**

- Activity leader picks a random card from a bucket and announces its content
- Quiz questions need to be answered correctly to mark it off
- 5 in a row wins!
- Play as many rounds as time allows

**Activity 2 Description: *"What is a Carbon Footprint?"***


**Summary:** Participants determine their carbon footprints by answering questions about their habits. Then they design plans to reduce them. Participants learn about their personal impacts on global climate change and how they can help the environment with their everyday behaviors.

After this activity, participants should be able to:

- Define a carbon footprint.
- List several ways to reduce their carbon footprints.
- Describe why it is important to have as small a footprint as possible.
- Finish by designing Family Action Plans for the Carbon Footprint Contest.

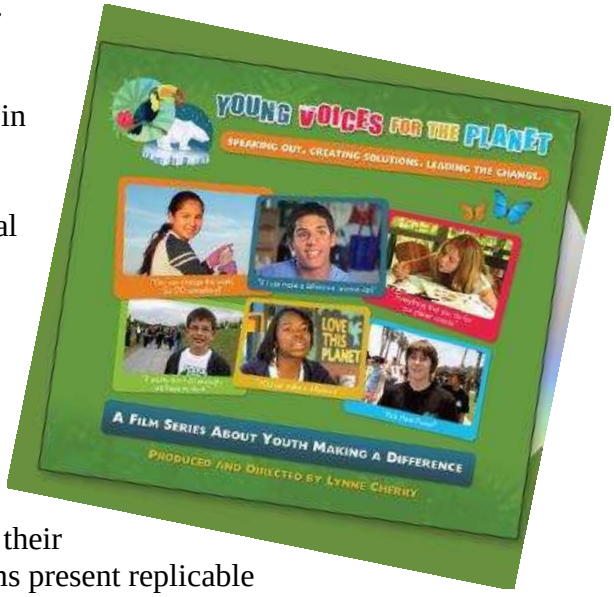
**Activity Link:**
https://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_whatkindoffootprint/cub_footprint_lesson1.xml

**Topic 6: Sustainable Solutions – Teamwork and Leadership**

**Activity Description:**

***"Young Voices for the Planet: Speaking Out, Creating Solutions, Leading the Change"***

**Overview:** In this activity, participants will watch a series of short videos and have a discussion about their own collaborative action project ideas.




**Objective:** Students will…

1. See examples of kids making a difference in their communities on climate change
2. Think about how taking action on climate change means more than changing personal behaviors
3. Discuss examples of community action projects
4. Consider ways that they can make a difference in their own communities

**Description:** *Young Voices for the Planet* is a series of short films featuring young people using science and data to reduce the carbon footprint of their homes, schools, communities, and states. The films present replicable success stories. *Young Voices for the Planet* allows young voices to be heard and inspires action, the best antidote to fear. These young voices reach our hearts and minds.

**Viewing Options (5-10 minutes each):**

- *Kids vs. Global Warming*: 12-year-old Alec Loorz created Kids vs. Global Warming, the Sea Level Awareness Project and the Declaration of Independence from Fossil Fuels campaign.
- *Girl Scouts:* With support from the Sierra Club, these Girl Scouts go door-to-door distributing thousands of free energy efficient compact fluorescent light bulbs (CFLs).
- *Green Ambassadors:* Teenagers from Environmental Charter High School in Lawndale, CA recycle, compost, plant trees, educate students about sustainability and more to reduce their carbon footprint.
- *Plant for The Planet:* As a 9-year-old boy, Felix founded Plant for the Planet and has planted more than a billion trees in Germany and worldwide to sequester CO2.
- *Olivia's Birds and The Oil Spill:* This film documents an 11-year old's deep connection with the Gulf of Mexico, and how her love of birds moved her to raise $200,000 for rescue efforts.
- *Save Tomorrow:* Inspired by the other Young Voices for the Planet films, three 9-year-old girls realize that they might be able to make a difference, too. These youth in Lexington, MA team up together to change a town law (with unanimous support!) to allow solar panels on public buildings. They then turn their passion towards protecting the local forest habitat.

**Activity Link:** http://www.youngvoicesonclimatechange.com/climate-change-videos.php

APPENDIX C: Photovoice Materials

## Photovoice Prompts

Each science activity is followed by a photovoice exercise, with prompt. See examples below.

1. **Photovoice #1 – Ecosystems**

   This week, we thought about how people, plants, and animals depend on one another for survival. In your own life, what examples of this can you find? What does this make you think about? How does it make you feel? Take a few photos of these ideas.

   ***Extra (Optional):***

   *We also thought about how major events—like wildfires, flood, and drought—can affect people, plants, and animals. In your own life, what examples of this can you find? What does this make you think about? How does it make you feel? Take a few photos of these ideas.*

2. **Photovoice #2 – Weather & Climate**

   This week, we thought about the difference between climate and weather. What does this make you think about? How does it make you feel? Take a few photos about these ideas.

   ***Questions to help you think of what to photograph:***

   - *How does the weather relate to your life?*
   - *Does it shape what types of things you can do?*
   - *What do you like or dislike about the weather?*
   - *If you could, would you live in a different climate?*

3. **Photovoice #3 – The Greenhouse Effect**

   This week, we thought about how Earth's atmosphere retains heat and keeps the planet warm enough for people, plants, and animals to live on it. What do you love about where you live? What does this make you think about? How does it make you feel? Take a few photos about these ideas.

   ***Extra (Optional):***

   *We also thought about how greenhouse gases—like carbon dioxide—trap heat in the atmosphere and warm the planet even more. A major source of these heat-trapping gases is burning fossil fuels—like coal, oil, and natural gas. In other words, human activities are changing the Earth's climate. What does this make you think about? How does it make you feel? Take a few photos of these ideas.*

**4. Photovoice #4 – Earth's Changing Climate**

This week, we thought about how changes to Earth's climate can also change ecosystems. Plants, animals, and people—and how they relate to each other—can be changed when the average temperature is hotter. How does this relate to where you live? What does this make you think about? How does it make you feel? Take a few photos of these ideas.

***Extra (Optional):***

*We also thought about how a changing climate is not the same everywhere. Life may get harder for people in some places, and easier in others. For example, some places will get wetter. Other places will become drier. Around the world, some countries will become hotter than others. People may need to move away from places that are too hot and dry. People may begin farming in places that were once too cold. What does this make you think about? How does it make you feel? Take a few photos of these ideas.*

**5. Photovoice #5 – Sustainable Solutions: Energy**

This week, we thought about how changes to the ways people use energy can help solve the problem. What examples of problems and solutions do you see around you? What does this make you think about? How does it make you feel? Take a few photos of these ideas.

***Questions to help you think of what to photograph:***

- *What changes to your everyday behaviors are part of your plan for the Carbon Footprint Contest?*
- *Will your family members help you? Will they join you?*
- *What is hard about changing these habits? What is easy?*
- *What energy-friendly places and things do you see around you?*
- *What problematic things do you see around you?*

**6. Photovoice #6 – Sustainable Solutions: Teamwork & Leadership**

This week, we thought about how teamwork and leadership in your community can help solve the problem. What does this make you think about? How does it make you feel? Take a few photos of these ideas.

***Questions to help you think of what to photograph:***

- *What makes you feel connected to your community?*
- *What examples of teamwork do you see around you?*
- *What examples of leadership do you see around you?*
- *How have you made a difference in your community in the past?*
- *Working as a leader in your community, what would you do to help protect the environment?*

**Photovoice Discussions:**

Each participant will be encouraged to select one to three photos that they feel are most significant for discussion. These photos will be printed and given to each participant. While photographs are being printed, each youth will be asked to prepare a "bumper sticker" (title and caption) on a post-it note to accompany their photos.

Photovoice group discussions for topics 1-4 will follow a modified version of the "SHOWeD" method (Wang et al., 2004; Cook & Quigley, 2013). Specifically, these discussions will explore what photographs "SHOW":

- What do you **S**ee here?
- **H**ow does this relate to **O**ur lives? Had you thought about this connection before?
- **W**hat does it mean to you? In other words, what may not be clear about your photo but is important for you to explain?

Photovoice group discussions for topics 5-6 will follow a more traditional version of the "SHOWeD" method. Specifically, these discussions will explore what photographs "SHOW," as well as what can be done about it. That is, these discussions will also consider solutions to problems:

- What do you **S**ee here?
- What is really **H**appening? In other words, what may not be clear about your photo but is important for you to explain?
- How does this relate to **O**ur lives? Had you thought about this connection before?
- **W**hy does this problem or strength **e**xist?
- What can we **D**o about it? What are the challenges? What are the opportunities?

In a large group, each participant will be encouraged to tell stories about their photos. If participants notice any common issues or themes, they will be encouraged to voice them. Below are examples of questions to be used in the discussion:

- Can you tell me about the story behind your photograph?
- What made you choose this particular photograph or scene?
- What was going through your mind when you took this photograph?
- Can you tell me how your photograph captures what you think or feel about the topic?

After discussion, participants will be given two raffle tickets. One ticket rewards their own participation and the other must be 'given' to someone else. Names must be written on the raffle tickets. They will anonymously donate their extra ticket to another participant by writing their name on their second ticket. Aside for not voting for oneself, there are no rules for allocating extra tickets. Another's photograph may be chosen because of photo quality, aesthetics, meaning, or connection.

**Formatted Photovoice Handouts (below)**

# Science, Camera, Action!

**Photovoice #1 – Ecosystems**

Instructions:

**This week, we thought about how people, plants, and animals depend on one another for survival. In your own life, what examples of this can you find? What does this make you think about? How does it make you feel? Take a few photos of these ideas.**

*There are no "right" or "wrong" photographs. Take pictures of anything you want that relates to our activity. There is no limit to the amount of photos you take, but make sure to pick 1 or 2 favorites to print!*

***Extra (Optional):***

We also thought about how major events—like wildfires, flood, and drought—can affect people, plants, and animals. In your own life, what examples of this can you find? What does this make you think about? How does it make you feel? Take a few photos of these ideas.

# Science, Camera, Action!

**Photovoice #2 – Weather & Climate**

Instructions:

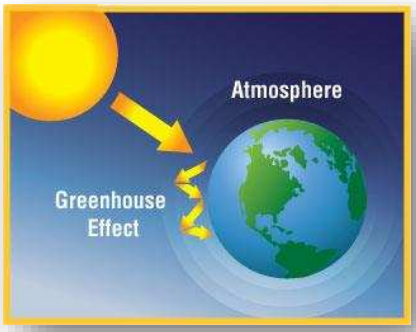
**This week, we thought about the difference between climate and weather. What does this make you think about? How does it make you feel? Take a few photos about these ideas.**

*There are no "right" or "wrong" photographs. Take pictures of anything you want that relates to our activity. There is no limit to the amount of photos you take, but make sure to pick 1 or 2 favorites to print!*

Questions to help you think of what to photograph:

- How does the weather relate to your life?
- Does it shape what types of things you can do?
- What do you like or dislike about the weather?
- If you could, would you live in a different climate?

# Science, Camera, Action!




## Photovoice #3 – The Greenhouse Effect

Instructions:

**This week, we thought about how Earth's atmosphere retains heat and keeps the planet warm enough for people, plants, and animals to live on it. What do you love about where you live? What does this make you think about? How does it make you feel? Take a few photos about these ideas.**

*There are no "right" or "wrong" photographs. Take pictures of anything you want that relates to our activity. There is no limit to the amount of photos you take, but make sure to pick 1 or 2 favorites to print!*

***Extra (Optional):***

We also thought about how greenhouse gases—like carbon dioxide—trap heat in the atmosphere and warm the planet even more. A major source of these heat-trapping gases is burning fossil fuels—like coal, oil, and natural gas. In other words, human activities are changing the Earth's climate. What does this make you think about? How does it make you feel? Take a few photos of these ideas.

# Science, Camera, Action!

## Photovoice #4 – Earth's Changing Climate

Instructions:

**This week, we thought about how changes to Earth's climate can also change ecosystems. Plants, animals, and people—and how they relate to each other—can be changed when the average temperature is hotter. How does this relate to where you live? What does this make you think about? How does it make you feel? Take a few photos of these ideas.**

*There are no "right" or "wrong" photographs. Take pictures of anything you want that relates to our activity. There is no limit to the amount of photos you take, but make sure to pick 1 or 2 favorites to print!*

***Extra (Optional):***We also thought about how a changing climate is not the same everywhere. Life may get harder for people in some places, and easier in others. For example, some places will get wetter. Other places will become drier. Around the world, some countries will become hotter than others. People may need to move away from places that are too hot and dry. People may begin farming in places that were once too cold. What does this make you think about? How does it make you feel? Take a few photos of these ideas.

# Science, Camera, Action!


**Photovoice #5 – Sustainable Solutions: Energy**

Instructions:

**This week, we thought about how changes to the ways people use energy can help solve the problem. What examples of problems and solutions do you see around you? What does this make you think about? How does it make you feel? Take a few photos of these ideas.**

*There are no "right" or "wrong" photographs. Take pictures of anything you want that relates to our activity. There is no limit to the amount of photos you take, but make sure to pick 1 or 2 favorites to print!*

Questions to help you think of what to photograph:

- What changes to your everyday behaviors are part of your plan for the Carbon Footprint Contest?
- Will your family members help you? Will they join you?
- What is hard about changing these habits? What is easy?
- What energy-friendly places and things do you see around you?
- What problematic things do you see around you?

# Science, Camera, Action!

**Photovoice #6 – Sustainable Solutions: Teamwork & Leadership**

Instructions:

**This week, we thought about how teamwork and leadership in your community can help solve the problem. What does this make you think about? How does it make you feel? Take a few photos of these ideas.**

*There are no "right" or "wrong" photographs. Take pictures of anything you want that relates to our activity. There is no limit to the amount of photos you take, but make sure to pick 1 or 2 favorites to print!*

Questions to help you think of what to photograph:

- What makes you feel connected to your community?
- What examples of teamwork do you see around you?
- What examples of leadership do you see around you?
- How have you made a difference in your community in the past?
- Working as a leader in your community, what would you do to help protect the environment?

# Science, Camera, Action!

## After-School Program Worksheet: Part 1


The following questions ask about what you think and how you feel about science and nature. **This is not a test.** There are no right or wrong answers. We are just interested in what you think. The answers you give will be kept private. No one will ever know what you say unless you tell them. Your name will never be used.

**Please be as honest as you can.**

# Science, Camera, Action!

## After-School Program Worksheet

1. **What grade are you in?** _____

2. **How old are you?** _____ **years old**

3. **Are you a girl or a boy?** ☐ **Girl** ☐ **Boy**

4. **How do you describe yourself?** (You may check more than one.)

   ☐ **Hispanic or Latino**
   ☐ **Black or African American**
   ☐ **White**
   ☐ **Asian or Pacific Islander**
   ☐ **American Indian or Alaska Native**
   ☐ **Other, please write it below:**

   _____

5. **What was your most recent grade in science class?** (Circle one.)

   **A -** **A** **A+**

   **B -** **B** **B +**

   **C -** **C** **C+**

   **D** **F** **Something else:** _____

6. **What made you want to join *Science, Camera, Action*?**

   _____

**INSTRUCTIONS:** Please **CIRCLE** your answer. There are no right or wrong answers. We are interested in what you think.

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **I feel comfortable in the outdoors.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Humans are a part of nature, not separate.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **When I'm outside, I pay close attention to different plants and animals.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I'd rather play outside than inside.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I'd rather visit a national park than see a movie.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I'd rather play video games than explore the woods.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I'd rather go to a shopping mall than Rocky Mountain National Park.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

**INSTRUCTIONS:** Please **CIRCLE** your answer. Please be as honest as you can.

| **How much do you know about climate change?** | **A lot** | **A little** | **Some** | **Not a lot** | **Nothing** |
|---|---|---|---|---|---|
| **How much have you thought about climate change before today?** | A lot | A little | Some | Not a lot | Not at all |

**INSTRUCTIONS:** Please **CIRCLE** your answer. There are no right or wrong answers. We are interested in what you think.

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **Plants and animals have as much right as people to live.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **There are too many (or almost too many) people on earth.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People are clever enough to keep from ruining the earth.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People must still obey the laws of nature.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **When people mess with nature it has bad results.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **Nature is strong enough to handle the bad effects of our modern lifestyle.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People are supposed to rule over the rest of nature.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People are treating nature badly.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People will someday know enough about how nature works to be able to control it.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **If things don't change, we will have a big disaster in the environment soon.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |

**INSTRUCTIONS:** Please **CIRCLE** your answer. There are no right or wrong answers. We are interested in what you think.

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **My actions impact the health of the environment.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I have the power to help protect the environment.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I can make a change in my community.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I feel it's important to take good care of the environment.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **It's important to protect as wide a variety of animals and plants as we possibly can.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

How **interested** are you in these activities?

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **Learning about how to protect the environment.** | Very interested | Pretty interested | A little interested | Hardly interested | Not interested |
| **Working to make my community a better place.** | Very interested | Pretty interested | A little interested | Hardly interested | Not interested |

**INSTRUCTIONS:** Please **CIRCLE** your answer. There are no right or wrong answers. We are interested in what you do.

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **I am careful not to waste water.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I am careful not to waste food.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I separate most of my waste for recycling.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I prefer to use public transport or bicycle over car.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I always switch off the lights when I leave a room.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I always turn off the computer when I do not use it.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I try to save energy.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I talk to my friends and family about the environment.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

How **often** do you do this?

| **I work as a volunteer in my community.** | **Always** | **Often** | **Sometimes** | **Hardly ever** | **Never** |
|---|---|---|---|---|---|

# Science, Camera, Action!

## After-School Program Worksheet: Part 2


The following questions ask about what you think and how you feel about science and nature. **This is not a test.** Your answers will not be graded. We are just interested in what you think. The answers you give will be kept private. No one will ever know what you say unless you tell them. Your name will never be used.

Please be as honest as you can.

**INSTRUCTIONS:** Please **CIRCLE** your answer. There are no right or wrong answers. We are interested in what you think.

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **I learn interesting things in science lessons.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I would like to do <u>less</u> science at school.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I look forward to science lessons.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **What I learn in science lessons is useful for me.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Science lessons are fun.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Science is one of the interesting school subjects.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Science lessons bore me.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

**INSTRUCTIONS:** Please **CIRCLE** your answer. There are no right or wrong answers. We are interested in what you think.

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **Science helps to make life better.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Government decisions should be more based on what scientists say.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Science can help to make the world a better place in the future.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **I would like being a scientist after I leave school.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **When I leave school, I would like to work with people who make discoveries in science.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Working in a laboratory would be interesting.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **A job as scientist would be interesting.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **A career in science would be dull and boring.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

**INSTRUCTIONS:** Please **CIRCLE** your answer. Your answers will not be graded. We are interested in what you think.

| | 1  | 2  | 3  | 4  |
|---|---|---|---|---|
| **Climate means average weather conditions in a region.** | Definitely True | Probably True | Probably False | Definitely False |
| **Climate and weather mean pretty much the same thing.** | Definitely True | Probably True | Probably False | Definitely False |
| **The Earth's climate has been pretty much the same for millions of years.** | Definitely True | Probably True | Probably False | Definitely False |
| **Earth's climate is changing now.** | Definitely True | Probably True | Probably False | Definitely False |

Which of the following are **"fossil fuels"?** [CIRCLE **ALL**.]


**(a) Oil**


**(b) Nuclear Power**


**(c) Wood**


**(d) Natural Gas**


**(e) Solar Energy**


**(f) Coal**

**INSTRUCTIONS:** Please **CIRCLE** your answer. Your answers will not be graded. We are interested in what you think.

| | 1  | 2  | 3  | 4  |
|---|---|---|---|---|
| **Climate change will cause some places to get wetter, while others will get drier.** | Definitely True | Probably True | Probably False | Definitely False |
| **Climate change will make weather hotter by the same amount in all countries.** | Definitely True | Probably True | Probably False | Definitely False |

**The "greenhouse effect" refers to:**

a. Gases in the atmosphere that trap heat
b. The Earth's protective ozone layer
c. Pollution that makes acid rain
d. How plants grow

**Which one is a "greenhouse gas"?:**

a. Oxygen
b. Hydrogen
c. Helium
d. Carbon dioxide

**Which country produces the most greenhouse gases per person?**

a. The United States
b. China
c. India
d. Germany
e. Japan

**INSTRUCTIONS:** Please **CIRCLE** your answer. Your answers will not be graded. We are interested in what you think.

**Which one of the following do you think contributes the most to climate change?**

a. Cars and trucks
b. Burning fossil fuels for heat and electricity
c. Toxic wastes
d. Deforestation
e. The hole in the ozone layer
f. Nuclear power
g. Aerosol spray cans
h. Acid rain
i. Cows

**Which of the following actions can people take to help reduce climate change?** [CIRCLE **ALL**.]

**(a) Walk or bicycle instead of driving**

**(b) Unplugging TVs and computers when not in use**

**(c) Turning off the lights when leaving a room**

**(d) Flying instead of driving**

**(e) Turning off the tap while brushing teeth**

**(f) Taking a bath instead of a shower**

**(g) Stop using aerosol spray cans**

**(h) Eating less meat**

**INSTRUCTIONS:** Please **CIRCLE** your answer. There are no right or wrong answers. We are interested in what you think.

| | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **People should care more about climate change.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Climate change should be given top priority.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **It is annoying to see people do nothing for the climate change problems.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **People worry too much about climate change.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **The seriousness of climate change has been exaggerated.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Climate change is a threat to the world.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

**INSTRUCTIONS:** Please **WRITE** your answer. Please be as honest as you can.

**What is one example of when you had a positive impact on others?**

**How did it make you feel?**
(Circle one.)

# Science, Camera, Action!

## After-Program Worksheet: Part 1


The following questions ask about what you think and how you feel about science and nature. **This is not a test.** There are no right or wrong answers. We are just interested in what you think. The answers you give will be kept private. No one will ever know what you say unless you tell them. Your name will never be used.

**Please be as honest as you can.**

# Science, Camera, Action!

1. **How old are you?** _____ years old

2. **What do you want to be when you grow up?** _____

3. **What grade will you receive in science class this year?** (Circle one.)

| | | |
|---|---|---|
| **A +** | **A** | **A -** |
| **B +** | **B** | **B -** |
| **C +** | **C** | **C -** |
| **D** | **F** | **Something else:** _____ |

4. **What was your favorite part about *Science, Camera, Action*?** (Circle one.)

   a. Science Activities
   b. Photography
   c. Action Projects

| **Circle your <u>TOP THREE</u> favorite things about *Science, Camera, Action*!:** | | |
|---|---|---|
| **1.** | **"Weaving the Web"** | Ecosystems activity with yarn |
| **2.** | **"Weather vs. Climate"** | Skittles activity |
| **3.** | **"Greenhouse Gas Tag"** | Outdoor activity running from the sun to Earth |
| **4.** | **"Oh Deer!"** | Survival game to find food, water, or shelter |
| **5.** | **"Glaciers: Then & Now"** | Photo-matching game |
| **6.** | **"Energy Bingo"** | Game about energy-saving behaviors |
| **7.** | **"Young Voices for the Planet"** | Videos about kids taking environmental action |
| **8.** | **"Photovoice"** | Taking pictures and printing them for discussion |
| **9.** | **"Carbon Footprint Contest"** | Saving energy by changing daily habits |
| **10.** | **"Action Project"** | Working together on a climate action project |

| **Please <u>CIRCLE</u> your answer. There are no right or wrong answers. We are interested in what you think.** | **1**  | **2**  | **3**  | **4**  | **5**  |
|---|---|---|---|---|---|
| **I feel comfortable in the outdoors.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Humans are a part of nature, not separate.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **When I'm outside, I pay close attention to different plants and animals.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I'd rather play outside than inside.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I'd rather visit a national park than see a movie.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I'd rather play video games than explore the woods.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I'd rather go to a shopping mall than Rocky Mountain National Park.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

**INSTRUCTIONS:** Please **<u>CIRCLE</u>** your answer. Please be as honest as you can.

| **How much do you know about climate change?** | **A lot** | **A little** | **Some** | **Not a lot** | **Nothing** |
|---|---|---|---|---|---|
| **How much have you thought about climate change before today?** | A lot | A little | Some | Not a lot | Not at all |

| Please CIRCLE your answer. There are no right or wrong answers. We are interested in what you think. | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **Plants and animals have as much right as people to live.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **There are too many (or almost too many) people on earth.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People are clever enough to keep from ruining the earth.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People must still obey the laws of nature.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **When people mess with nature it has bad results.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **Nature is strong enough to handle the bad effects of our modern lifestyle.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People are supposed to rule over the rest of nature.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People are treating nature badly.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **People will someday know enough about how nature works to be able to control it.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |
| **If things don't change, we will have a big disaster in the environment soon.** | Strongly Agree | Agree | Not Sure | Disagree | Strongly Disagree |

| **Please <u>CIRCLE</u> your answer. There are no right or wrong answers. We are interested in what you think.** | **1**  | **2**  | **3**  | **4**  | **5**  |
|---|---|---|---|---|---|
| **My actions impact the health of the environment.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I have the power to help protect the environment.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I can make a change in my community.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I feel it's important to take good care of the environment.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **It's important to protect as wide a variety of animals and plants as we possibly can.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

How **interested** are you in these activities?

| | **1**  | **2**  | **3**  | **4**  | **5**  |
|---|---|---|---|---|---|
| **Learning about how to protect the environment.** | Very interested | Pretty interested | A little interested | Hardly interested | Not interested |
| **Working to make my community a better place.** | Very interested | Pretty interested | A little interested | Hardly interested | Not interested |

How **often** do you do this?

| **I work as a volunteer in my community.** | **Always** | **Often** | **Sometimes** | **Hardly ever** | **Never** |
|---|---|---|---|---|---|

| **Please <u>CIRCLE</u> your answer. There are no right or wrong answers. We are interested in what you do.** | **1**  | **2**  | **3**  | **4**  | **5**  |
|---|---|---|---|---|---|
| **I am careful not to waste water.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I am careful not to waste food.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I separate most of my waste for recycling.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I prefer to use public transport or bicycle over car.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I always switch off the lights when I leave a room.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I always turn off the computer when I do not use it.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I try to save energy.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I talk to my friends and family about the environment.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

| **If you could change one thing about *Science, Camera, Action!* to make it better, what would it be?** (Write a sentence or two.) |
|---|
| |

# Science, Camera, Action!

## After-Program Worksheet: Part 2


The following questions ask about what you think and how you feel about science and nature. **This is not a test.** Your answers will not be graded. We are just interested in what you think. The answers you give will be kept private. No one will ever know what you say unless you tell them. Your name will never be used.

**Please be as honest as you can.**

| Did *Science, Camera, Action!* help you to feel like you can make a difference in the world around you? | Yes | No |
|---|---|---|
| **Why?** | | |

| Please CIRCLE your answer. There are no right or wrong answers. We are interested in what you think. | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **I learn interesting things in science lessons.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I would like to do less science at school.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I look forward to science lessons.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **What I learn in science lessons is useful for me.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Science lessons are fun.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Science is one of the interesting school subjects.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Science lessons bore me.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

| **Please <u>CIRCLE</u> your answer. There are no right or wrong answers. We are interested in what you think.** | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **Science helps to make life better.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Government decisions should be more based on what scientists say.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Science can help to make the world a better place in the future.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **I would like being a scientist after I leave school.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **When I leave school, I would like to work with people who make discoveries in science.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Working in a laboratory would be interesting.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **A job as scientist would be interesting.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **A career in science would be dull and boring.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

| **Did *Science, Camera, Action!* help you to like science more?** | **Yes** | **No** |
|---|---|---|
| **Why?** | | |

| Please **CIRCLE** your answer. Your answers will not be graded. We are interested in what you think. | **1**  | **2**  | **3**  | **4**  |
|---|---|---|---|---|
| **Climate means average weather conditions in a region.** | Definitely True | Probably True | Probably False | Definitely False |
| **Climate and weather mean pretty much the same thing.** | Definitely True | Probably True | Probably False | Definitely False |
| **The Earth's climate has been pretty much the same for millions of years.** | Definitely True | Probably True | Probably False | Definitely False |
| **Earth's climate is changing now.** | Definitely True | Probably True | Probably False | Definitely False |
| **Climate change will cause some places to get wetter, while others will get drier.** | Definitely True | Probably True | Probably False | Definitely False |
| **Climate change will make weather hotter by the same amount in all countries.** | Definitely True | Probably True | Probably False | Definitely False |
| **How will climate change affect your life?** (Write a sentence or two.) | | | | |
| | | | | |

Which of the following are **"fossil fuels"?** [Circle your answers.]

**(a) Coal** **(b) Oil** **(c) Nuclear Power** **(d) Wood** **(e) Natural Gas** **(f) Solar Energy**

| **The "greenhouse effect" refers to:** | | | |
|---|---|---|---|
| e. Gases in the atmosphere that trap heat | f. The Earth's protective ozone layer | g. Pollution that makes acid rain | h. How plants grow |

| **Which one is a "greenhouse gas"?:** | | | |
|---|---|---|---|
| e. Oxygen | f. Hydrogen | g. Helium | h. Carbon dioxide |

| **Which country produces the most greenhouse gases <u>per person</u>?** | | | | |
|---|---|---|---|---|
| f. Germany | g. Japan | h. The United States | i. China | j. India |

| **Which <u>one</u> of the following contributes the most to climate change?** (Circle one.) | | | | |
|---|---|---|---|---|
| a. Acid rain | b. Toxic wastes | c. Burning fossil fuels for heat and electricity | d. Deforestation | |
| e. The hole in the ozone layer | f. Nuclear power | g. Aerosol spray cans | h. Cars and trucks | i. Cows |

**Which of the following actions can people take to help reduce climate change?** (Circle your answers.)

**(a) Walk or bicycle instead of driving**

**(b) Unplugging TVs and computers when not in use**

**(c) Turning off the lights when leaving a room**

**(d) Flying instead of driving**

**(e) Turning off the tap while brushing teeth**

**(f) Taking a bath instead of a shower**

**(g) Stop using aerosol spray cans**

**) Eating less meat**

| Please CIRCLE your answer. There are no right or wrong answers. We are interested in what you think. | 1  | 2  | 3  | 4  | 5  |
|---|---|---|---|---|---|
| **People should care more about climate change.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Climate change should be given top priority.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **It is annoying to see people do nothing for the climate change problems.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **People worry too much about climate change.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **The seriousness of climate change has been exaggerated.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
| **Climate change is a threat to the world.** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |

**Tell me about your favorite thing that happened during *Science, Camera, Action!*:**

**How would you rate *Science, Camera, Action!* overall?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|

# Science, Camera, Action!

## Carbon Footprint Contest


Place Your Sticker Here

Score:

Pounds of $CO_2$ per Year

Your total "carbon footprint" is the number of pounds of carbon dioxide ($CO_2$) that is linked with your current daily habits. From your answers to this worksheet, a number will be calculated. The lower the number, the fewer greenhouse gases are put into the atmosphere.

**To win the Carbon Footprint Contest, you must lower this number!**

| **INSTRUCTIONS:** Please **CIRCLE** your answer. Please be as **honest** as you can. | | | | |
|---|---|---|---|---|
| Right now, do you live in: | Apartment | House | Trailer home | Somewhere else: _____ |
| Does your family own a car, van, or truck? | No | Yes, one | Yes, two | Yes, three |
| How many computers (PCs, Macs or laptops) does your family own? | None | One | Two | More than Two |
| During the past 12 months, how many times did you travel away on vacation with your family? | Not at all | Once | Twice | More than twice |

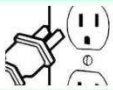
| **Circle all of the things your home has:** | | | | |
|---|---|---|---|---|
| Internet access | A bed just for you | Washing machine (for clothes) | Outdoor space attached (a yard or garden) | Dishwasher |

# Science, Camera, Action!

## Carbon Footprint Contest

**INSTRUCTIONS:** Please **CIRCLE** your answer.
Please be as **honest** as you can about your daily habits.

| In a normal school week, how many days do you: | | | | | | |
|---|---|---|---|---|---|---|
| Walk or bike to school | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |
| Take the bus to school | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |
| Share a ride to school (Carpool) | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |
| Get a ride to school | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |

| How often do you: | | | | | | |
|---|---|---|---|---|---|---|
| Turn off lights when you leave a room?  | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Unplug chargers when you're not using them?  | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Hang clothes to dry instead of using the dryer?  | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Turn off the water when brushing your teeth?  | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Turn off the TV when you're not watching it?  | There is no TV in my home. | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Turn off your video game system when you're not using it?  | There is no video game system in my home. | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Put the computer in "sleep" mode when you're not using it?  | There is no computer in my home. | Never | Hardly Ever | Half the Time | Most of the Time | Always |

# Science, Camera, Action!

## Carbon Footprint Contest


How many people live in your home? _____

How many bathrooms are in your home? _____

Do you have your own bedroom for yourself? Yes No

Does your family compost their garbage? Yes No

Does your family garden? Yes No

| How often do you recycle: | | | | | |
|---|---|---|---|---|---|
| Magazines | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Newspaper | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Glass | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Plastic | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Aluminum and Steel Cans | Never | Hardly Ever | Half the Time | Most of the Time | Always |

| How many <u>days per week</u> do you: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Eat meat?  | 0 (Never) | 1 | 2 | 3 | 4 | 5 | 6 | 7 (Every day) |
| Drink from a reusable water bottle?  | 0 (Never) | 1 | 2 | 3 | 4 | 5 | 6 | 7 (Every day) |

| How many <u>days per week</u> do you: | | | | | |
|---|---|---|---|---|---|
| Eat out (Fast Food, Delivery, Restaurant) | 0 (Never) | 1-2 days per week | 3-4 days per week (Half the Time) | 5-6 days per week | 7 (Every day) |
| Eat home cooked food | 0 (Never) | 1-2 days per week | 3-4 days per week (Half the Time) | 5-6 days per week | 7 (Every day) |

Name: _____

# Science, Camera, Action!

## Carbon Footprint Contest


What changes can you make in your life to **lower your carbon footprint**? Try to make some of these changes in the next few weeks. Use the space below to map out a plan to reduce your carbon footprint.

| **Carbon Footprint Challenge: Family Action Plan** | |
|---|---|
| **Things I will turn off or unplug:** | |
| **How I will get to school:** | |
| **What I will eat:** | |
| **How I will lower the amount of water I use:** | |
| **What I will recycle:** | |
| **Other things I will do:** | |

# Science, Camera, Action!

## Carbon Footprint Contest

## Scoring Card

$CO_2$

Score:

**10,475.5**

Pounds of $CO_2$ per Year

Your total "carbon footprint" is the number of pounds of carbon dioxide ($CO_2$) that is linked with your current daily habits. From your answers to this worksheet, a number will be calculated. The lower the number, the fewer greenhouse gases are put into the atmosphere.

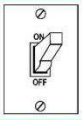
**To win the Carbon Footprint Contest, you must have lowered this number!**

| How often do you recycle: | | | | | |
|---|---|---|---|---|---|
| **Responses:** | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Magazines | 15 | 11.25 | 7.5 | 3.75 | 0 |
| Newspaper | 90 | 67.5 | 45 | 22.5 | 0 |
| Glass | 7 | 5.25 | 3.5 | 1.75 | 0 |
| Plastic | 19 | 14.25 | 9.5 | 4.75 | 0 |
| Aluminum and Steel Cans | 86 | 64.5 | 43 | 21.5 | 0 |

| How many days per week do you: | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Responses:** | 0 (Never) | 1 | 2 | 3 | 4 | 5 | 6 | 7 (Every day) |
| Eat meat? | 0 | 344.14 | 688.29 | 1032.43 | 1376.57 | 1720.71 | 2064.86 | 2409 |
| Drink from a reusable water bottle? | 141.05 | 120.9 | 100.75 | 80.6 | 60.45 | 40.3 | 20.15 | 0 |

| How many days per week do you: | | | | | |
|---|---|---|---|---|---|
| **Responses:** | 0 (Never) | 1-2 days per week | 3-4 days per week (Half the Time) | 5-6 days per week | 7 (Every day) |
| Eat out (Fast Food, Delivery, Restaurant) | 0 | 1204.5 | 2409 | 3613.5 | 4818 |
| Eat home cooked food | 0 | 157.25 | 314.5 | 471.75 | 629 |

| In a normal school week, how many days do you: | | | | | | |
|---|---|---|---|---|---|---|
| **Responses:** | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |
| Walk or bike to school | - | 0 | 0 | 0 | 0 | 0 |
| Take the bus to school | - | 26.2 | 52.4 | 78.6 | 104.8 | 131 |
| Share a ride to school (Carpool) | - | 91.8 | 183.6 | 275.4 | 367.2 | 459 |
| Get a ride to school | - | 223 | 446 | 669 | 892 | 1115 |

| How often do you: | | | | | | |
|---|---|---|---|---|---|---|
| **Responses:** | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Turn off lights when you leave a room?  | | 268 | 234.25 | 200.5 | 166.75 | 133 |
| Unplug chargers when you're not using them?  | | 18 | 15.75 | 13.5 | 11.25 | 9 |
| Hang clothes to dry instead of using the dryer?  | | 750 | 562.5 | 375 | 187.5 | 0 |
| Turn off the water when brushing your teeth?  | | 274 | 197 | 120 | 77 | 34 |
| Turn off the TV when you're not watching it?  | There is no TV in my home = 0 | 140 | 116.75 | 93.5 | 70.25 | 47 |
| Turn off your video game system when you're not using it?  | There is no video game system in my home = 0 | 90 | 74.75 | 59.5 | 44.25 | 29 |
| Put the computer in "sleep" mode when you're not using it?  | There is no computer in my home = 0 | 235 | 205.75 | 176.5 | 147.25 | 118 |

# Science, Camera, Action!

## Carbon Footprint Contest

$CO_2$

Place Your Sticker Here

Score:

Pounds of $CO_2$ per Year

Your total "carbon footprint" is the number of pounds of carbon dioxide ($CO_2$) that is linked with your current daily habits. From your answers to this worksheet, a number will be calculated. The lower the number, the fewer greenhouse gases are put into the atmosphere.

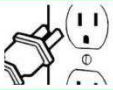
**To win the Carbon Footprint Contest, you must have <u>lowered</u> this number!**

| **Over the past few weeks, how often did you recycle:** | | | | | |
|---|---|---|---|---|---|
| Magazines | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Newspaper | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Glass | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Plastic | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Aluminum and Steel Cans | Never | Hardly Ever | Half the Time | Most of the Time | Always |

| **Over the past few weeks, how many <u>days per week</u> did you:** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Eat meat?  | 0 (Never) | 1 | 2 | 3 | 4 | 5 | 6 | 7 (Every day) |
| Drink from a reusable water bottle?  | 0 (Never) | 1 | 2 | 3 | 4 | 5 | 6 | 7 (Every day) |

| Over the past few weeks, how many <u>days per week</u> did you: | | | | | |
|---|---|---|---|---|---|
| Eat out (Fast Food, Delivery, Restaurant) | 0 (Never) | 1-2 days per week | 3-4 days per week (Half the Time) | 5-6 days per week | 7 (Every day) |
| Eat home cooked food | 0 (Never) | 1-2 days per week | 3-4 days per week (Half the Time) | 5-6 days per week | 7 (Every day) |

| Over the past few weeks, how many <u>days</u> did you: | | | | | | |
|---|---|---|---|---|---|---|
| Walk or bike to school | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |
| Take the bus to school | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |
| Share a ride to school (Carpool) | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |
| Get a ride to school | 0 (Never) | 1 | 2 | 3 | 4 | 5 (Every day) |

| Over the past few weeks, how often did you: | | | | | | |
|---|---|---|---|---|---|---|
| Turn off lights when you leave a room?  | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Unplug chargers when you're not using them?  | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Hang clothes to dry instead of using the dryer?  | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Turn off the water when brushing your teeth?  | | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Turn off the TV when you're not watching it?  | There is no TV in my home. | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Turn off your video game system when you're not using it?  | There is no video game system in my home. | Never | Hardly Ever | Half the Time | Most of the Time | Always |
| Put the computer in "sleep" mode when you're not using it?  | There is no computer in my home. | Never | Hardly Ever | Half the Time | Most of the Time | Always |

Name: _____

# Science, Camera, Action!

## Carbon Footprint Contest


Over the past few weeks, what changes did you make in your life to **lower your carbon footprint**? Use the space below to describe how you reduced your carbon footprint.

| **Carbon Footprint Challenge: Family Action Plan** | |
|---|---|
| **Things I turned off or unplugged:** | |
| **How I got to school:** | |
| **What I ate:** | |
| **How I lowered the amount of water I use:** | |
| **What I recycled:** | |
| **Other things I did:** | |

APPENDIX E: Focus Group Guide

Introduction

1. Welcome

   [Script]

   *Thank you for being a part of today's focus group discussion. I'm very interested to hear your valuable opinions on how this program has impacted you.*

   - *The purpose of today's discussion is to learn about how your experiences in SCA affected you. I hope to learn things that will help me to reflect back on this program and to improve future programs.*
   - *I would like to audio record the focus groups so that I can make sure to capture the thoughts, opinions, and ideas I hear from all of you. Your name will not be attached to what you say during the focus group.*
   - *Everyone's views are valuable and there are no "right" or "wrong" answers to any of my questions. However, if you do not feel comfortable answering a question, you may choose not to answer and you are free to withdraw from the discussion at any time.*
   - *Do you have any questions for me right now? [Answer.] Okay, feel free to ask me questions throughout the discussion. If you have any questions later on, you can always ask me later.*

2. Explanation of the process

   Ask the group if anyone has participated in a focus group before. Explain that focus groups are being used more and more often in programs like this to make sure they're effective or to make improvements.

   *About focus groups*
   - I learn from you (positive and negative)
   - Not trying to achieve consensus, I'm gathering information
   - Review of methods

   *Logistics*
   - Length of discussion
   - Moving around; Using the restroom
   - Snacks and refreshments

   [Script]

   *Has anyone here participated in a focus group before? [Allow for response.] Focus groups are being used more and more often for programs like this one. Focus group discussions can*

*help program organizers to know whether or not a program was effective and also how to make improvements.*

*I want to review a few more things before we get started. First, you all are the experts! Your thoughts are valuable no matter what they are. I am here to learn from you, whether your views are positive or negative. As I mentioned, there are no "right" or "wrong" answers to the questions I ask. Second, I would like to hear the thoughts of everyone who is here today, even if your opinion differs from someone else's. The more perspectives I hear, the better! Finally, as you know, this project is using surveys and focus groups. The reason I am using both is because questionnaires give us lots of useful information, but focus groups allow me to go further in-depth and to fill in the gaps about why your survey responses are what they are. Does that make sense? Any questions so far? [Answer.]*

*Alright, our discussion today should last about 45 minutes. Feel free to move around if you need to, or excuse yourself to use the restroom at any time without asking. Please also help yourself to snacks and drinks.*

3. Ground Rules

   Review the ground rules.

   [Script]

   *One of the first things I'd like for us to do is review some ground rules. In order to have the best conversation we can today, here are a few things that are important to remember:*

   - *Everyone should participate*
   - *Be respectful and do not criticize others' opinions*
   - *Only one person should speak at a time*
   - *Stay with the group and please don't have side conversations*
   - *Turn off cell phones*
   - *Have fun!*

4. Ask the group if there are any questions before we get started, and address those questions.

   [Script]

   *Okay, any final questions before we get started? [Answer.]*

5. Turn on Audio Recorder

Questions:

1. Let's start the discussion by talking about how you feel about the program. What are some ways that your participation in this program impacted you?
    a. What did you think about climate change before the program? Had you heard of it?
    b. What do you think about it now?
    c. Had you thought about science the same way before the program? Did it change how you feel? How?
    d. Do you think about the world in a different way now? How so?
    *See Question #5 if you have extra time.*

2. Okay, now let's talk about your experiences with the program overall.
    a. What did enjoy about Science, Camera, Action? Why?
    b. What would make this program better (more fun)? Why?
    c. If there's one thing you would change about the program, what would it be? Why?
    d. If there's one thing you would keep the same about the program, what would it be? Why?
    *See Question #5 if you have extra time.*

3. Okay, now let's talk about your experiences with the action projects.
    a. What did enjoy about them? Why?
    b. What was difficult about them? Why?
    c. What did you learn about yourself from participating in this program?
    *See Question #5 if you have extra time.*

4. Next, let's talk about how this program made you feel about yourself and others.
    a. First, did this program change how confident you are in yourself? In your abilities? How so? Can you think of some examples?
    b. Did this program help you to feel like you can make a difference in the world around you? In your family? In your community? Why?
    c. Did this program impact your relationships with others? In your family? In your community? How?
    *See Question #5 if you have extra time.*

5. Alright, before we finish up, let's go around the circle and hear from everyone one last time. What's the most important thing you heard during this part of the discussion today? Why? What made it important to you?

Conclusion:

Okay, I think we've covered everything! Thank you so much for sharing your thoughts and opinions with me. If you have additional information that you did not get to say in the focus group, please feel free to write it down and hand it in to me afterward. You may also come see me with any additional questions or comments. Thank you again for your important contribution today!

# LIST OF ABBREVIATIONS

BGC – Boys and Girls Clubs

CAP – Climate Action Plan

CfE – Climate Education for Empowerment

CDE – Colorado Department of Education

UNCRC – United Nations Convention on the Rights of the Child

EfS – Education for Sustainability

IPCC – Intergovernmental Panel on Climate Change

NOAA – National Oceanic and Atmospheric Administration

NSF – National Science Foundation

PAR – Participatory Action Research

SCA – *Science, Camera, Action!*

SCRA – Society for Community Research and Action

SPSSI – Society for the Psychological Study of Social Issues

SSI – Socio-scientific issue

STEAM – Science, technology, engineering, arts, and mathematics

STEM – Science, technology, engineering, and mathematics

UNCRC – United Nations Convention on the Rights of the Child

UNCYCC – United Nations Joint Framework Initiative on Children, Youth and Climate Change

UNFCCC – United Nations Framework Convention on Climate Change

WWF – World Wildlife Fund