

**Reducing emissions through education:
Children as agents of behavior change**

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April 10, 2017

I. Executive Summary

Today's children are part of a generation that will have to bear the brunt of climate change and its impacts, living out the adaptation and mitigation solutions being developed today. As current leaders and policymakers work to curb greenhouse gas emissions and protect the future for their children and grandchildren, younger generations are already growing aware of the challenge. Far from being "passive recipients of family and school delivered information about climate change science", they are "actively concerned, engaged in and enabled to change the world around them" (Roser-Renouf, Flora, Maibach, and Leiserowitz 2015 at 3).

Environmental education (EE) is an underutilized opportunity in California to ensure that younger generations have the knowledge, skills, and awareness to face the reality of climate change, while promoting energy efficient behaviors that could immediately reduce per capita emissions. Successful EE interventions around the world have mobilized the power of children as change agents, teaching them skills and habits that they can bring to their families and communities. By focusing on current action and local-level engagement rather than abstract concepts and distant threats, these programs have been demonstrated to motivate behavioral changes that might otherwise seem unattainable. Leading climate economists have started emphasizing the importance of children teaching their parents, pointing out that "they can elicit an emotional response that can motivate action" (Bawden 2015).

Political attitudes toward EE in CA are generally favorable, but there is no unified, statewide approach that uses established best practices to maximize the potential for conservation improvements. The Scoping Plan acknowledges the role of educational and outreach efforts in a comprehensive emissions reduction strategy, but does not outline specific policy steps that would improve the scope and effectiveness of EE. Many California schools are deploying sustainability initiatives with impressive results. However, there is significant room to improve EE from a curriculum perspective, combining emissions reduction and educational goals to create a simple, cost-effective solution. Given the number of students in California K-12 schools, an educational intervention that resulted in a modest reduction in energy consumption by a fraction of their families would have a significant impact on overall statewide emissions, without the need for complex regulation or technology deployment.

This comment outlines policy recommendations for an Action Resource Center for Science (ARCS), a proposed joint effort between the California Air Resources Board (CARB) and the California Department of Education (CDE). ARCS would pilot an updated EE curriculum that targets behavior change while meeting the state's updated science standards. An online portal containing professional development and networking resources, as well as links to informal EE opportunities, would help teachers implement the program. After evaluation of the pilot program, it could be scaled and integrated into the CDE's State Blueprint for Environmental Literacy.

A statewide approach to environmental education that is designed to integrate emissions reduction, education, and environmental justice is a powerful tool with the potential to inspire and motivate younger generations. This is an opportunity to create the kind of lasting, citizen-led change that would help propel California into a more sustainable future through 2040 and beyond.

II. Introduction

Educational interventions designed to target behavior change can encourage families to introduce habits and lifestyle changes that add up to reduce their overall carbon footprint. Now is an opportune time to introduce this type of education into CA public schools, drawing on established best practices from EE literature to align educational and emissions reduction goals in a powerful way.

There is “significant engagement with [EE] and sustainability” in CA public schools, but the current approach still consists of patchwork efforts by individual schools and districts, as well as third parties such as nonprofits, utilities, and informal education providers (Chapman 2014). The California Education and the Environment Initiative (EEI) is the main EE curriculum available in CA, as mentioned on page 142 of the Scoping Plan Update. It is of high quality, but focuses on knowledge and concepts rather than behavior change. Behavior-oriented EE is limited to informal and third party providers, as well as initiatives by individual schools and teachers.

This approach does not realize EE’s full potential as a simple, cost-effective, and lasting emissions reduction tool. The same attributes that make EE effective from a conceptual and knowledge-building point of view are also uniquely conducive to behavior change. Well-designed EE is action-oriented and community focused, and it can result in behavior change that does not stop at the student level. The effects spill over to parents and other family members through an intergenerational learning process (Boudet, Ardoin, Flora, Armel, Desai, and Robinson 2016; Duvall and Zint 2007).

An updated curriculum for CA K-12 schools that meets the state’s new science standards while introducing behavior change targets has the potential to reach millions of students and their families. If simple energy efficiency habits were adopted by only a fraction of the six million children in public schools, this could scale to massive energy savings across the state. The California Air Resources Board (CARB) should coordinate with the California Department of Education (CDE) to pilot an updated curriculum and other resources that would create mutual reinforcement between the agencies’ respective goals. This pilot program should be accompanied by rigorous evaluation to determine whether it should be scaled to statewide K-12 schools.

This comment will discuss how EE in public schools could be used to reduce emissions. It outlines recommendations for a pilot program based on needs and opportunities identified in California’s current EE framework, and connects these with specific actions that CARB should fund as part of the AB 32 Scoping Plan.

III. Literature Review

a. Theoretical Background

Changing behavior is difficult, but entirely possible. Despite the high potential for energy efficient behavior to reduce overall energy consumption, there is a “gap from knowledge

to behavior” where improved environmental knowledge and awareness does not translate to action (Kollmuss & Agyeman 2002). Programs that focus on improving knowledge or changing attitudes should not be expected to also change behavior (Stern, Powell, and Hill 2013). However, there is growing evidence that well-implemented programs designed for behavior change are consistently able to achieve their intended outcomes. This has led to a proposed theory of change in which children are taught new, pro-environmental behaviors, leading them to promote these behaviors within their families and communities (Ballantyne, Connell, & Fien 1998; DiMatteo 2014 at 99).

The phenomenon of children acting as agents of change is not new. Children’s influence within their families – often called “pester power” – has been studied from a consumer marketing perspective for decades (Caruana and Vassallo 2003; Jenkins 1979; Lawlor and Prothero 2011; Rose, Boush, and Shoham 2002). Consumer behavior research has found that children tend to have more influence over purchasing decisions in families if parent-child communication is based on concept-oriented parenting styles, where children are encouraged to think independently about the world. This is opposed to socio-oriented communication styles, focused on obedience and familial harmony (Caruana and Vassallo 2003). Children’s influence is also not limited to products that are directly relevant to their experiences (such as food and toys); recent research has found that they have growing influence on “non-traditional areas” such as home décor, cars, and electronics (Flurry 2007).

Interestingly, EE research shows that intergenerational learning (where children teach their parents) tends to occur when educational activities encourage family dynamics that resemble concept-oriented parenting styles. For example, projects that involve both parents and children can allow children to redefine their status within the family, becoming the “experts” on a new subject (Duvall and Zint 2007). This observation is supported by anecdotal evidence: a former EE student at Menlo-Atherton High School explained in an interview that her peers were “motivated to have someone listen to them or to do something of their own volition.” They were inspired by “the idea that [they] could be listened to and taken seriously by adults at a time when that was a little more rare, that they could pass along something interesting and relevant that others would be interested in”.

Literature reviews of EE programs support the conclusion that they are successful at changing behavior, as long as they are designed with this objective in mind (Stern et al. 2013; Zelezny 1999). Case studies and experiments around the world have demonstrated this theory of change at work, finding that parents modified health and conservation behaviors in response to educational interventions aimed at their children (Baur & Haase 2015; Damerell, Howe, and Milner-Gulland 2013; Onyango-Ouma, Aagaard-Hansen, and Jensen 2005; Vaughan, Back, Solorazano, and Ray 2003). Students at a UK school reported thinking that they should enforce environmental behaviors their parents did not have the discipline to apply on their own (Percy-Smith and Burns 2013).

Recently, Stanford University researchers collaborated with Girl Scouts to pilot an EE curriculum targeting behavior change. The Girls Learning Environment and Energy (GLEE) program was implemented as an RCT in 30 Girl Scout troops in Northern California. It consisted of two five-session interventions: one focused on Residential Energy (RE), and one focused on food and transportation (FTE). The RE intervention targeted various one-time (changing light bulbs, adjusting hot water heater temperature, etc.) and habitual (unplugging power strips, air drying dishes, etc.) energy-saving behaviors among fourth- and fifth-grade girls and their parents (Boudet et al. 2016). The RE intervention found a significant increase in overall energy efficiency by both students and parents, both at post-test measurement and at 7-8 months of follow-up. These self-reported behaviors were both one-time and habitual, and were estimated to result in avoided emissions of approximately 160-300 pounds of CO₂ per household per year (Boudet et al. 2016).

b. Best Practices

Successful EE programs have several key characteristics that are conducive to empowering children as change agents. Several of these best practices are outlined here as criteria for a school-based intervention that could successfully combine emissions reduction and educational goals:

- *Local focus:* The importance of focusing on local issues has been widely discussed in EE literature (Duvall and Zint 2007). When scientific concepts are presented as distal and vast, students often find them difficult to relate to. A current EE teacher at Menlo-Atherton High School noted that it is “hard to make [climate change] come alive in the classroom”. Environmental education presents unique place-based and experiential learning opportunities (STAC 2013). These can help connect problems such as climate change to students’ own lives, by pointing out the local effects of drought, flooding, or sea level rise, and encouraging students to think of solutions they can implement. Thinking about these solutions and connecting them to behavioral actions bridges the gap between abstract science and local action. Kyra Brown, the Social Justice Program Director at Youth United for Community Action in East Palo Alto, observed that connecting education to local challenges and solutions “gives kids something to hold onto, but also work to do” (2017).
- *Action-oriented:* Action-oriented and hands-on activities encourage adoption of new behaviors within a controlled classroom environment, before encouraging students to continue these behaviors at home. These types of activities are more successful at facilitating intergenerational learning (Duvall and Zint 2007). A Girl Scouts program director explained that GLEE was intentionally designed so girls could monitor their behavior changes over time at each session. They practiced energy conservation behaviors together as a community prior to continuing these behaviors in their families. This made it easier to continue habits at home.

- *Parental involvement:* Projects that involve both parents and children are more likely to result in lasting behavior change. Parent involvement in activities and homework can have great success in encouraging change within the home (Duvall and Zint 2007). The GLEE intervention was designed with parental involvement in mind, but also included behaviors that girls could adopt on their own. It was important to foster a sense of community and support within each Girl Scout troop, partially in order to make sure the sense of community extended to girls whose parents were not present at each meeting.

These best practices should be prioritized when designing a curriculum that targets behavior change. They are characteristic of effective and engaging science education, and should serve as the foundation of a school-based pilot program. .

IV. EE in California: Current Challenges and Opportunities

Currently, EE in California consists of “varied but often disjointed experiences” (ELTF 2015 at 12), with students’ access to EE depending on where they live. A survey of existing EE initiatives and state education policy shows that now is an opportune time to integrate environmental education more strongly into CA science literacy efforts. State education policy is “increasingly coherent and aligned” and support for environmental education is high. 89% of Californians consider it “very important or somewhat important that local K-12 schools include environmental education” (ELTF 2015 at 18). In 2015, State Superintendent of Public Instruction Tom Torlakson’s Environmental Literacy Task Force (ELTF) published “A Blueprint for Environmental Literacy”, which aims to achieve “environmental literacy for all”.

Generally, EE in CA currently comes from three sources: formal environments, third parties involved in schools (such as nonprofits and utilities) and informal environments. Integration of EE into the formal curriculum is limited and challenging for teachers, while third parties and informal education providers have limited reach and unequal availability between school districts.

a. Formal environments

A survey of CA public schools found that there is strong support for EE and sustainability among administrators, faculty, and students, and across all communities in the state. Many schools have adopted facility and operations initiatives such as recycling, waste reduction, and energy efficiency. A great deal of funding for these types of structural improvements is available through Proposition 39 (Zuckerman, Deason, and Benami 2013). Federal and private initiatives have provided support for sustainability in CA schools. The U.S. Department of Energy’s Green Ribbon Schools Program granted awards to five CA high schools last year, mostly for campus sustainability initiatives (U.S. Department of Education 2016). Generally, schools have a strong interest in EE and sustainability and are making impressive efforts to green their campuses and promote conservation while students are at school. However, without a

corresponding effort to promote behavior change, the impact of these efforts may be largely confined to school grounds.

Teaching students behavior changes that persist in their own lives and families is challenging, and rarely integrated into formal classroom instruction. Introducing EE into school curricula “is beginning but is not well developed” (Chapman 2014). EE is available through AP Environmental Science courses (available in 14% of high schools), elective classes (17%), or integrated throughout the curriculum (34%). Many of these classes are taught using teacher-created materials, with 46% using the FOSS (Full Option Science System) curriculum, and only 13% using EEI (Chapman 2014). Most teachers do not have the curricular resources or training to teach EE with the type of behavioral focus that has been demonstrated to work in other experiments. The EEI is currently the only official EE curriculum available to teachers, and it was designed to focus on concepts and knowledge development instead of behavior change (Ardoin 2017).

Teachers’ surveyed responses illustrate their perception of the limitations facing successful EE in California. They explain their need for “Curricular materials that can be incorporated, not as an add-on”, and “finding time to incorporate environmental resources with the standards-based Common Core and NCLB requirements” (Chapman 2014). The recently introduced Next Generation Science Standards (NGSS) pose both an opportunity and a challenge. The Standards include “human sustainability” as a category topic recommended for high school science education” (Feinstein & Kirchlaser 2015). This is a step in the direction of including EE in more schools, but teachers point out “Curriculum resources are not aligned to NGSS standards” (Chapman 2014). EEI was developed to meet California’s 1998 science standards, meaning that unless it is updated, teachers must take on the responsibility of modifying the content to comply with NGSS (EEI n.d.).

Teachers pointed out that lack of “training opportunities / PD (professional development)” is also an important obstacle (Chapman 2014). Finances are another constraint, and the “financial, personnel, and curricular resources available for environmental education and sustainability are not equally distributed, making it more difficult for financially disadvantaged schools and districts to become greener” (ELTF 2015 at 12).

b. Third parties in formal environments

In addition to direct classroom teaching, nonprofits and utilities provide climate change and energy-efficiency related resources to students and teachers. The Alliance for Climate Education (ACE) provides a one-hour entertainment-education assembly to high school students, with the goal of changing knowledge, attitudes, and behaviors related to climate change. The presentation includes specific actions students can take, such as individual conservation behaviors and discussion with family and friends. A program evaluation found that knowledge and beliefs did change after the assembly, as well as behaviors. In terms of behavior change, the effect size for interpersonal

discussion with parents and friends was strongest, with smaller effect sizes for recycling, turning off lights, taking shorter showers, and unplugging unused electronics (Flora, Saphir, Lappé, Roser-Renouf, Maibach, Leiserowitz 2014).

Utilities also provide resources for teachers and students aimed at teaching energy efficiency and conservation, but these are only available in a limited number of schools. For example, PG&E has educational resources such as games and activities for children available on its website, as well as curriculum materials for teachers (PG&E n.d.). The Sacramento Municipal Utility District (SMUD) works with the Sacramento City Unified School District to pair students and teachers in a one-week summer course on energy conservation (SCUSD 2015). Southern California Edison (SCE) has partnered with the Alliance to Save Energy (a coalition of organizations) to implement the PowerSave Schools Program (PSP) in seven CA school districts (SCE n.d.). An evaluation of PSP in two East Coast school districts found that there was significant improvement in energy conservation knowledge and specific behaviors in one district, but not the other. The evaluation report discussed implementation challenges (such as lack of parent involvement and teacher accountability) that could explain this difference in results (DiMatteo et al. 2014). If these programs have not been evaluated in CA, they should be evaluated and compared to the results of the GLEE study. This evaluation could be further compared to the recommended pilot program to determine whether it makes sense to work with the CDE to expand formal EE, or to focus on informal programs.

c. Informal environments

Aside from formal K-12 schooling, California has a wealth of informal educational environments. Places such as the Chabot Space and Science Center, the Monterey Bay Aquarium, and the California Academy of Sciences provide opportunities for children to experience environmental science in an exciting and impactful way. Informal environments can be especially well equipped to provide locally focused and action-oriented EE experiences. Informal experiences “are believed to lead to further inquiry, enjoyment, and a sense that science learning can be personally relevant and rewarding” (National Research Council 2009 at 11). Due to the unique strengths of informal educational opportunities, working to establish links between formal and informal EE is recommended as part of this pilot project.

V. Proposed solution

The findings of GLEE and other studies demonstrate a clear link between educational interventions that target behavior change and a reduction in emissions. EE that focuses on increasing knowledge is not likely to directly result in behavior change, but there is an opportunity to expand and improve formal EE in CA through an updated curriculum designed with behavior change in mind, combined with resources to support implementation.

The State Blueprint for Environmental Literacy explains how “the level of funding for programs that build environmental literacy in California is insufficient to implement scaled, effective, statewide efforts.” Currently, state-level EE funds come from the Environmental License Plate (ELP) and the Office of Education and the Environment (OEE), with both sources totaling less than \$3 million per year. Other constraints include lack of resource coordination by government agencies and NGOs, and inequitable distribution across the state (ELTF 2015). Despite this, the state is “in the midst of a unique and historic period of education policy coherence and alignment” – meaning that the CDE’s primary goal “is to integrate environmental literacy efforts into the increasingly coherent and aligned landscape of state educational priorities” (ELTF 2015 at 18).

This comment advocates for the creation of a pilot “Action Resource Center for Science (ARCS)”, that builds on existing initiatives and adds new resources. It would address the current limitations on formal EE while utilizing its potential to reduce per capita emissions in line with AB 32 and SB 32’s ambitious goals. ARCS would be a joint effort between CARB and the CDE, using CARB funding to implement CDE EE goals in a way that incorporates behavior change. This comment recommends that CARB reach out to the CDE with these preliminary ideas to discuss the feasibility of a pilot program that could be incorporated into the Scoping Plan.

ARCS should consist of two implementation strategies:

- *Curriculum:* Update the EEI curriculum to comply with the Next Generation Science Standards, while incorporating behavior change as an educational goal. If it is determined that the EEI materials cannot be effectively updated to reflect this goal, a new curriculum should be created that complies with NGSS while aiming to create behavior change. Guidance should be taken from EE best practices, the GLEE materials, and other sources of knowledge about how to best align these goals. The focus should be on local, action-oriented EE that encourages parent involvement.

This curriculum should be adaptable to local communities, with certain required components that are key to behavior change outcomes. Striking the right balance between flexibility and rigor is important. On one hand, teachers should be able to adapt lessons to local needs, environmental issues, and informal opportunities. At the same time, they should maintain the techniques and activities that will lead to behavior change, in order to avoid the implementation failures seen in the PSP evaluation.

- *Online Portal for Teachers:* This curriculum should be made available through an online portal where it can be easily downloaded. This portal should also contain resources for PD and training, official connections with informal education providers, and a support network for teachers to share resources and commentary.

This suggestion was independently developed through interviews and discussions with Stanford faculty and researchers. Fortunately, such a network already happens to exist in CA – in a very underfunded and limited form. The California Regional Environmental Education Community (CREEC) is a network of local agencies and organizations that works to coordinate teacher resources and PD opportunities. They also maintain “an online searchable database of standards-based enrichment programs, field trips, online resources and professional development opportunities from over 500 informal education providers across the state.” (ELTF 2015 at 27). The State Blueprint already envisions revising CREEC into a role very similar to that described here: to connect formal and informal educators, to provide high-quality EE, and to help teachers implement the NGSS curriculum standards.

CREEC should be brought under the umbrella of ARCS, funded, and expanded to perform these functions effectively, while adhering to the dual goals of ARCS: environmental literacy and emissions reduction.

The ARCS pilot program should be evaluated according to the established CPUC protocols for similar behavior-driven programs.

VI. Conclusion

The same dynamics of parent-child communication and influence that have given rise to “pester power” over toys and cereal can also lead to significant reductions in energy consumption by families. Connecting EE to students’ daily experiences can transform schools into a powerful platform to incentivize behavior change. It is important not to underestimate the power of a motivated and curious younger generation that has grown up in a world defined by climate change. An EE intervention such as the ARCS pilot program has significant potential to cut per capita emissions in California over the next several decades, and any reduction in emissions would likely be accompanied by even greater long-term benefits. This program would also inspire future leaders to live sustainably and consider environmental solutions, looking toward the future and finding reasons to be hopeful at a time when we need it most.

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