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Combating Climate Injustices: An Informal Science and Popular Education Approach to Addressing Environmental Health Disparities

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Abstract

As global warming worsens, addressing environmental health disparities and justice is increasingly important. This necessity is evident in southern metropolitan Tucson, Arizona, an area underserved and disproportionately experiencing the effects of climate change. Including underserved groups in problem solving can spur knowledge generation and the building of community capacity to address and mitigate environmental health challenges posed by climate justice. This article describes a community-based project that utilized a peer education framework coupled with citizen science design. Community health workers (*promotoras*) were trained in environmental health, climate change, and environmental monitoring protocols to then educate and train families about these same subjects. The study goal was to evaluate science and environmental health learning, awareness, and self-efficacy at the promotora and residential levels resulting from intensive 40-hour trainings, peer education via home visits, and environmental monitoring. Pre- and postsurveys were completed by the promotoras and the families they visited. Motivations for participation as well as changes in self-efficacy and knowledge were analyzed. Results revealed that the promotora's motivations were primarily internal and they were concerned with health. Using the Wilcoxon signed-rank test ($p=.05$), it was observed that for both study groups, knowledge of water and energy conservation statistically increased, as well as self-efficacy for environmental action and scientific learning. This article demonstrates that promotoras are critical in environmental health and climate science peer education. These findings can be used to further develop peer education citizen science projects in underserved communities, ensuring that efforts increase participants' learning, self-efficacy, and enhance social–ecological outcomes.

Keywords

peer education; community health worker; citizen science; climate justice

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Supplemental Material

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Climate change is a pressing issue for society as temperature increases will range from 0.03°C to 4.8°C by 2100, depending on mitigation strategies implemented (Pachauri et al., 2014). The effects of climate change on public health will be substantial as there is already a disproportionate distribution of risk in our society based on socioeconomic factors, such as education level, ethnicity, and poverty level. Thus, we can anticipate that climate change will only perpetuate these disparities in health (Frumkin et al., 2008). Climate justice stresses how those living in poverty contribute the least to climate change but suffer the most consequences (Cox & Pezzullo, 2016). This is further exacerbated by their voices being left out of solution discussions (Cox & Pezzullo, 2016). Climate justice seeks to remedy this by providing a platform for disadvantaged voices to be heard and to create community-based solutions (Cox & Pezzullo, 2016).

To stimulate and sustain change, the groups of interest must be part of the problem-solving dialogue. To do this, popular education has been proposed, which introduces democratic values and emphasizes that the groups that will be affected by an action must be part of the problem solving (Freire, 1970). This approach has inspired the methods of action research and participatory action research and resembles a co-created citizen science program (Ramírez-Andreotta, Brusseau, Artiola, Maier, & Gandolfi, 2014). This strategy has been employed in communities worldwide, and within Hispanic communities, a *promotora* (community health worker) model is implemented. A promotora is a female, Hispanic community member who is viewed as a community leader because she has been trained to address public health issues, partners with organizations to assist them in achieving common goals, and is indigenous to the community where she works (Ramírez et al., 2015). The promotora model has been implemented for decades to address public health disparities in Hispanic communities and has been leveraged to address pollution prevention efforts (Ramírez et al., 2015).

In parallel, citizen science is a method of research that is being increasingly used and a type of public participation in scientific research. At the core of citizen science is to include members of the public in the process of research to generate new knowledge (Shirk et al., 2012). Co-created citizen science projects, such as this study, involve citizens in the project design and most steps of the scientific method, such as data collection and analysis (Shirk et al., 2012). There are benefits to both the public participant and the researcher in the use of citizen science projects. For the citizen scientists, increased capacity for understanding scientific results can be observed as well as increased knowledge and awareness (Ramírez-Andreotta, Brusseau, Artiola, Maier, & Gandolfi, 2015). Citizen scientists can help broaden the impacts of scientific research (Dickinson et al., 2012), while increasing their own self-efficacy, meaning their own sense of confidence and ability to have control over their life (Janz, Champoin, & Strecher, 2007). Stepenuck and Green's (2015) synthesis on citizen science projects reports the following: increases in participant's knowledge, changes in participant's attitudes toward the subject, and participants taking the initiative to make the changes they want to see in their communities.

This article involves a health education and outreach intervention. Using the health impact pyramid (Frieden, 2010), a framework that describes the impact of varying public health interventions, this project is working within the following pyramid tiers:

- *Socioeconomic factors* by providing environmental educational experiences and cost-saving options that are informed by the community's ecology
- *Counseling and education* where university and community-based organizations trained promotoras to then provide families counsel and education on ways that global warming can affect their health (e.g., heat island effect and the formation of ozone), as well as energy and water conservation interventions and healthy alternatives (e.g., rainwater harvesting, products that use less energy)

This project describes the role of the promotora with a citizen science program to increase environmental health literacy within historically underrepresented populations that will be disproportionately affected by climate change in Pima County, Arizona. Within the above frameworks, we evaluate (a) whether a public health peer education model using promotoras could be applied to the field of environmental science, (b) the knowledge and efficacy outcomes of a bilingual sustainability and climate change curriculum, and (c) whether promotoras would be successful in environmental monitoring efforts. We hypothesized that coupling peer education with a citizen science approach would be an effective environmental education and efficacy building model to apply in climate justice communities.

Method

The study protocol for programmatic evaluation was submitted to and approved by the University of Arizona Human Subjects Protection Program.

Site Description

The targeted community was South Tucson, an urban community of 5,715 people (U.S. Census Bureau, 2015) within the city of Tucson, Arizona. When compared with the United States, over 90% of the target area is low income, minority, linguistically isolated, and disproportionately neighboring environmental hazards (U.S. Environmental Protection Agency, 2015). This area also lacks tree canopy and has high surface temperatures and heat vulnerability (Pope, 2013). Furthermore, the Arizona Department of Health Services has designated the area as medically underserved, and nearly 60% of the residents are children and elderly (U.S. Census Bureau, 2015). Over 40% of adults lack a high school education, compared with 15.8% for the Tucson area (U.S. Census Bureau, 2015).

Training and Education

The Sonora Environmental Research Institute, Inc. (SERI, Tucson, Arizona), a nonprofit, community participatory research institute partnered with the University of Arizona to address climate change and build resiliency in the southern metropolitan Tucson area. SERI has been engaged in environmental health work since its inception in 1994. In March 2016, the Climate Change and Environmental Sustainability Promotora Certificate Program was held. This program encompassed aspects of sustainability and climate change and was informed by the targeted population's ecological and social context. Promotoras received a comprehensive training in environmental quality, climate science, and soil and water sample collection. The training time was 40 hours total (5 hours a day for 2 weeks; Monday to Friday). Topics covered included climate change; water and energy conservation; public

health issues such as the spread of vector-borne diseases, food security, and air quality effect on health; and soil and water sampling (for a full list, see Supplemental Material 1). In addition, the training included two 5-hour sessions on field sampling and laboratory methodologies. During these sessions, promotoras collected harvested rainwater and soil samples from residents living in the targeted area and prepared the samples for analysis at the University of Arizona's Integrated Environmental Science and Health Risk Laboratory.

Promotoras ($n = 19$) were paired up (nine groups total, with one group of three) and conducted up to five home visits. They selected homes to visit based on their existing network of acquaintances. For those who had never been a promotora before, it was advised that they pick the home of someone they knew for their first visit. During each home visit, the promotora would consent the participant and provide the presurvey. During each home visit, the promotoras gave an informational packet to the home visit participants ($n = 32$) and described the green-house effect, climate change, how climate change may affect health, and ways to conserve water and energy in and around their homes (see Supplemental Material 2). Three months later, the postsurvey was administered by a SERI-employed promotora.

Surveys

To evaluate the outcomes of the program, pre- and postsurveys were designed for both the promotoras (those who completed the training described above) and the home visit participants (those who were visited by the promotoras after the training). The promotoras took the survey before and after the March 2016 training. The home visit participants took the presurvey at the beginning of the home visit and the postsurvey 3 months later.

All surveys were administered in Spanish and then translated to English for analysis. The promotora pre- and postsurveys consisted of demographic data, open- and closed-ended questions, drawings, and mental mapping. Demographic questions included date of birth, ZIP code, gender, race, highest education level completed, family size, and approximate income. Closed-ended survey statements were divided into six categories: Motivation for: Science Learning, Science Engagement, and Environmental Action, and Self-Efficacy for: Learning Science, Doing Science, and Environmental Action (Cornell Lab of Ornithology, 2015). Participants were asked to decide whether they agreed or disagreed with the statements, and answers were on a Likert-type scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). There were 48 total statements of this type; postsurvey statements were identical (see Supplemental Material 3).

The pre- and postsurveys for the home visit participants were similar to those of the promotoras but significantly shorter in length. There were 12 Likert-type scale statements that fell into two categories, Self-Efficacy for: Learning Science and Self-Efficacy for Environmental Action (see Supplemental Material 3). Postsurveys for the home visits were identical to the presurveys, with the exception of four new Likert-type scale statements pertaining to programmatic evaluation.

Each pre- and postsurvey for the promotoras and home visit participants also contained two images of a house. One was a semidetached image of the outside of a house and the other was a layout of the inside of a house, with rooms labeled. In these drawings, the promotoras were

asked to draw or write what they could do outside and inside the house to reduce the impact of climate change, and the home visit participants were asked to draw or write activities that could be done to protect the environment and conserve water and energy.

Analysis

All promotoras and home visit data were de-identified, numbered, and logged in Microsoft Excel (Microsoft Corporation, Redmond, WA), and then exported to IBM SPSS (Statistical Package for the Social Sciences) Statistics 24 (IBM Corporation, Armonk NY) for analysis.

Using SPSS, the average and standard deviation was calculated for each Likert-type scale statement in the pre- and the postsurveys responses for both the promotoras and home visits. The significance was then tested using the Wilcoxon signed-rank test ($p=.05$), as the differences between the two surveys was not normally distributed as determined by the Shapiro–Wilk test of normality. In addition to analyzing each statement individually, self-efficacy statements were grouped by the following categories: doing science, learning science, and environmental action. The mean responses of each category were calculated for all participants, combined, and pre- and postvalues were compared.

When analyzing the images (inside and outside of house) for pre- and postsurveys, written and drawn items were cataloged. Drawn items were logged as they appeared. Though most were clear, a few needed to be inferred (e.g., bubble shapes on the ground inferred to be bushes). When a writing and drawing were adjacent and listed the same activity, the writing was not a new item, but a label. When a drawing or any written material could not be deciphered, it was not used in the analysis.

To analyze changes between the pre- and postimages, all drawn and written information were coded by topics covered in the training (see Training and Education), including water conservation, energy conservation, plants, health, and other. For example, activities that fell under the category *water conservation* could be “take short showers” or “rainwater harvesting.” The numbers of items listed by category were counted and compared with each other and between the pre- and postsurveys.

Results

The Promotoras

Demographics.—Nineteen promotoras completed the pre- and postsurveys. All were of Latino/Hispanic background, and all were women. Seven promotoras listed trade or technical school as their highest education level completed. Four completed university, two had completed some university, and four had completed secondary or preparatory school. One promotora completed postgraduate education, and one declined to answer.

Fifty-three percent of the promotoras ($n = 10$) were born between 1971 and 1980. Five promotoras were born between 1961 and 1970, three between 1950 and 1960, and one promotora was born between 1981 and 1990.

Motivations.—There were no significant changes between the pre- and postsurvey data regarding motivation for science learning, science engagement, or environmental action. However, when comparing internal versus external motivations, promotoras are primarily motivated by internal factors (such as an enjoyment of science activities) rather than external (such as being required to participate).

Efficacy.—When comparing the pre- and postmean responses for the self-efficacy categories, statistical significance was observed in the following groups: doing science ($p = .002$) and environmental action ($p = .002$). In the self-efficacy category for learning science, the pre- to postmeans were not significant at the $p < .05$ level, but were at the $p < .1$ level ($p = .068$). Next are details by statement.

Significant changes ($p < .05$) were observed in two of the four responses to statements related to self-efficacy for learning science. There were significant increases in the promotora's confidence that they could understand the issues of environmental science and climate change (PS1) and that they could understand these topics quicker than other people their age (PS2).

In the category of self-efficacy for doing science, 9 of the 12 statements changed significantly after the training (Figure 1). There were significant increases in self-confidence for following instructions on sampling water and soil (PS5), conserving water (PS6), and reducing the heat island effect (PS8), as well as in promotora's confidence to explain to others how to conserve water and energy (PS14 and PS15). The promotoras also saw themselves as needing less time to understand topics of environmental quality (see decrease in statements: PS9, PS10, PS11, PS12).

For the category of self-efficacy for environmental action (Figure 2), a significant change was observed when promotoras were asked whether they believe that, compared with others, they could make a positive impact on the quality of water and soil (PS17), energy and water conservation (PS19 and PS20), and reducing the heat island effect (PS18). They reported feeling more confident in their ability to work with others to help reduce the urban heat island effect (PS22) and help solve energy conservation challenges (PS24). Finally, there was a significant decrease in agreement that it would be difficult to imagine themselves helping protect environmental health and quality (PS25, PS26, PS27, PS28).

Drawings.—In the *outside house* drawings and writings, the topic plants had the most activities listed, in the presurvey ($n = 28$). They were planting trees for shade, flowers, and using native vegetation. Energy conservation had the most activities in the postsurvey ($n = 26$), and the top energy conservation activities were double-pane windows, adding solar panels, and painting the roof white (see Supplemental Material 4). Energy conservation and health activities increased in the postsurveys while plants and water conservation decreased. In terms of health activities, the activities listed were keeping a clean yard, making sure there was no stagnant water for mosquito growth, and removing outdoor fireplaces/ovens.

For the *inside house* drawings and writings, energy conservation had the most activities listed in the presurvey ($n = 33$), and the top energy conservation activities were unplugging

electronics when not in use, replacing bulbs with energy-efficient models, and turning off lights (see Supplemental Material 5). The categories of health ($n = 6$) and other ($n = 5$) had the fewest number of activities listed and water conservation fell in the middle ($n = 14$). In the postsurvey, energy conservation activities were again stated the most ($n = 72$), followed by water conservation ($n = 37$).

The Home Visit Participants

Thirty-two participants completed the home visit pre- and postsurveys.

Efficacy.—When comparing the home visit pre- and postmean responses for selected self-efficacy categories (self-efficacy for doing science was not measured with home visit participants), statistical significance was observed for environmental action ($p = .027$), while there was no statistical significance for the learning science category. However, two statements in the self-efficacy for learning science category had significant changes (Figure 3). There was a significant decrease in agreement ($p < .016$) that it would take a long time for the participant to understand new topics about climate change (HS3), and a significant increase in self-confidence ($p < .038$) in the participant's ability to conserve water (HS6). In the category of self-efficacy for environmental action, there was an increase in the participant's belief that they could work with others to help solve the environmental quality problems (HS10, HS11, HS12; Figure 4).

Drawings.—For the *outside house* drawings and writings, the category with the most activities listed in the presurvey was plants ($n = 36$), with the majority of activities listed being “planting trees” (see Supplemental Material 6). In the postsurvey, the category with the most activities stated was water conservation ($n = 40$), including activities such as water harvesting and using gray water, and health activities were not stated at all, while plants slightly decreased ($n = 34$) and energy conservation, with items such as shading windows and adding roof coating, increased (from $n = 27$ in the presurvey to $n = 33$ in the postsurvey).

For the *inside house* drawings and writings, activities in the category of energy conservation were stated more in both the pre- ($n = 55$) and the postsurveys ($n = 78$) than the category of water conservation (Supplemental Material 7), although the frequency of water conservation activities stated almost doubled from the pre- to the postsurveys ($n = 30$ and $n = 54$, respectively), with activities such as taking shorter showers and avoiding leaks.

Discussion

This project set out to determine (a) whether a peer education model using promotoras, a traditionally used public health model, could be applied in the field of environmental science and (b) whether promotoras would be interested and successful in environmental monitoring. To determine whether such a promotora environmental science program could be effective, it is imperative to assess outcomes related to promotora's and participant's (home visits) knowledge, self-efficacy, and motivation.

Motivation

Promotoras.—The lack of any significant changes in promotora motivation from the pre- to the postsurveys likely stems from the short duration of the program (2 weeks). The difference between external and internal motivations in the presurvey, however, shows that the promotoras are internally motivated to learn and engage in environmental protection activities. This is illustrated by the time commitment and involvement necessary to become a promotora. With the level of knowledge required and minimum compensation, it would be unlikely that a promotora would be strongly influenced by external motivators. To engage in a program like this, it is likely that a promotora has a vested interest or desire in climate change and environmental sustainability. Jordan, Gray, Howe, Brooks, and Ehrenfeld (2011) discuss the Galaxy Zoo citizen science project, an online project where participants looked at pictures of deep space to help classify galaxies and examine motivations of the participants. An interest in the subject matter was the most commonly cited motivation for participation after a desire to contribute.

Furthermore, Wright, Underhill, Keene, and Knight (2015) report value and recreation driven (indicating a prior interest) as participant motivations in the Second Southern African Bird Atlas Project. Thus, the promotoras may follow this trend as well, having interest in environmental science before participating in the program. In other citizen science projects, concern for one's health can be a motivating factor. In Ramírez-Andreotta et al. (2015), residents near a contaminated site in Arizona expressed concern over consuming vegetables from their gardens and a desire to participate in a citizen science program that would characterize the contamination. In fact, concern for health is not just a strong internal motivator for citizen science, but informal science learning overall (Dickerson et al., 2004).

Efficacy

Promotoras.—Changes in the promotoras' sense of self-efficacy and confidence were major outcomes of participation in the program. The training covered many environmental science and climate change topics, took place in culturally relevant and community-centered locations (church), and was entirely in Spanish. Instructors were recruited and invited to be part of the training for their ability to speak Spanish and cultural competency. The familiarity of the location and the lack of a language barrier may have attributed to their increased efficacy regarding environmental science and climate change. Jones (1997) states that science learning in informal settings is particularly impactful to people of color, often underserved individuals, by providing a learning environment that is open and friendly (Jones, 1997). Training people in their own environment rather than in a new, potentially daunting one can increase the success of the program. Non-classroom settings, such as museums or science centers, can also increase enjoyment of the program, which may influence participant attitudes toward the subject (Hofstein & Rosenfeld, 1996).

Increases in self-confidence related to soil and water sampling were linked to the step-by-step field sampling methodology that was provided during the training. Other programs that have hands-on training programs have also demonstrated increases in participant knowledge and behavioral changes, such as making specific choices when shopping or volunteering (Jordan et al., 2011). The behavioral changes are associated with changes in

self-confidence and efficacy. In addition, it has been demonstrated that hands-on training is a more effective learning method than classroom setting training. For example, field trips (Hofstein & Rosenfeld, 1996) or a classroom laboratory setting (McCarthy, 2005) can often increase efficacy (Paris, Yambor, & Packard, 1998). The significant increase in self-confidence for following instructions on conserving water most likely stems from the hands-on water conservation training sessions. An entire training day (5 hours) was dedicated to water harvesting, where promotoras built a passive water harvesting system at someone's home. However, although there were four sessions on conserving energy, and few on reducing the heat island effect, there was a significant increase in self-confidence for following instructions on reducing the heat island effect but no increase in self-confidence for following instructions on saving energy. This might be due to prior knowledge on how to conserve energy, as their initial Likert-type scale score was high (Figure 1). The increase in self-confidence in the promotoras' ability to explain environmental health and quality topics is likely also due to the very involved curriculum and hands-on training, which also increased belief that the promotoras, compared to others, could positively affect environmental quality. These findings are in agreement with other studies, where promotoras have also shown increased confidence in their abilities after participating in hands-on programs (Squires & O'Brien, 2012).

Increased efficacy to take action in their communities has also been seen in prior studies involving promotoras. Once promotoras saw behavioral changes in the community after resident engagement due to their actions, they felt an increased sense of self-efficacy (Squires & O'Brien 2012). They also felt more connected and involved with their communities and experienced higher self-worth (Jorge, 2003). Self-efficacy is closely linked to self-confidence, as visualizing oneself being able to create desired outcomes creates incentive to do so (Stajkovic & Luthans, 1979).

Home Visits.—When comparing between the home visit participants and the promotoras for the self-efficacy category “learning science,” statistical significance ($p < .05$) was observed for the promotoras but not with the home visit participants. This outcome could be expected since the home visit participants did not collect environmental samples or work in a university laboratory. The promotoras conducted field work and prepared soil and water samples in the laboratory, which gave them a hands-on learning experience and more exposure to the scientific method.

Nonetheless, for the home visit participants, statistical significance was observed for environmental action ($p = .027$). There was significant decrease in agreement that it would take a long time to understand new topics about environmental science and climate change is likely due to the peer teaching with a Spanish-speaking community member and learning in their own homes. The home visit participants can effectively learn in a low-pressure, culturally relevant environment, as demonstrated in other promotora programs dealing with health and disease prevention (Dietrick et al., 2010; Forster-Cox, Mangadu, Jacquez, & Corona, 2007). The significant increases in agreement that the participants can work with others to solve the urban heat island effect and challenges of energy and water conservation is likely due to the increase in knowledge from the home visits and the communal structure of the program. In addition, the repeated visits by the promotoras may have led to the

changes in efficacy. Increased contact with peer educators was shown to positively influence behavior as compared with increased contact with professionals in public health studies, as those who were visited could connect better with their peer educators (Jay, DuRant, Shoffitt, Linder, & Litt, 1984). The home visit participants received individualized effort and education by the promotoras and can be better equipped to make behavioral choices to better their own health and that of the environment.

Knowledge

Promotoras.—For both the promotoras' *inside* and *outside house* drawings, the increase in number of activities stated in the category of energy conservation is likely due to two full training days (10 hours total) dedicated to climate change and energy conservation. This, as stated in the previous section, may also be due to prior knowledge on energy conservation. In the presurvey, the average score for self-confidence on following instructions on saving energy was high. Water conservation was also high likely due to many training sessions on the subject, including a full day taught by an employee of Tucson Water (city water supplier), and a full day on rainwater harvesting. For the *outside house* drawings, the category plants had the most activities written/drawn likely because of prior knowledge.

Home Visits.—For the home visits, *outside house* drawings, the category plants also had the most activities written/drawn in the presurvey due to prior knowledge of plants in the environment. The increase in activities in the water conservation category can be explained by the information sheets, brochures, and pamphlets given by the promotoras to the home visit participants regarding rainwater harvesting and other water conservation strategies. Four out of 15 handouts provided involved water conservation. For the *inside* of the house, the increase in activities listed under energy conservation was likely due to all the information given as well. This large increase was especially prominent in the *inside house* drawings rather than the *outside* because most of the information focused on indoor energy use, such as appliances and lighting.

The health category had no activities stated in the postsurvey despite information being handed out and training sessions dedicated to health subjects. Initially, it was thought that the training did not clearly connect climate change to health. In reflection, the survey tool itself focused on specific actions, not content-based questions. In this case, the drawing questions were “What can you do outside of the house to reduce the impacts of climate change?” and “What can you do inside the house to protect the environment, conserve water, or conserve energy?” However, most activities have a direct link to health outcomes. For example, in the postdrawings, there was an increase in the number of times participants stated they could strategically plant trees near the home to shade and cool, properly cover windows, install double-pane windows, and add white reflective roof coatings. All of these stated activities can lower indoor temperatures, which can decrease heat-related disease and mortality, demonstrating a connection between health and climate change adaptation. It has been observed that the promotoras dedicate most of their time during the home visit to action-based messaging, which additionally explains why home visit participants were able to list many items to address and mitigate climate change versus explain the effects of climate change on health. In future climate change health promotion efforts using peer

educators, it will be important for the promotoras to balance their time on the health effects associated with climate change and mitigation practices.

Increases in knowledge of the home visit participants can be attributed to the promotora peer education method. As those in the South Tucson community are underserved, undereducated, and linguistically isolated (U.S. Environmental Protection Agency, 2015), it can be difficult for traditional educators to reach them. Peer educators can bridge this gap by providing linguistically and culturally relevant information (Rhodes, 1994). In addition, the peer educators can often be more successful than their professional counterparts because community members can identify with them better, as they are part of the community themselves, and as such, their message is seen as more credible than the same message coming from an outsider (Clements & Buczkiewicz, 1993).

Limitations

A limitation of this project is that while the promotoras represent the targeted underrepresented demographic group, lower income Latina women, they did not have equal professional experience. For example, nine of the promotoras have served in the health educator role for other environmental health efforts in the past, while this was the first training and set of home visits conducted by the remaining 10. It was recommended for the new promotoras to conduct a home visit with an acquaintance, which did not allow for random selection of community members. In addition, sample sizes for both the promotoras and the home visit participants were small. In some cases, while paired-promotoras visited five homes each, the home visit participants were not always available to complete the postsurveys. In these cases, the presurvey for that home visit was not used in the analysis. Last, for both the promotora and home visit participant drawings, inference was needed at times. If a drawing or writing could not be deciphered, it was not used in the analysis. In most cases, it could be inferred (e.g., rocks and landscaping on the ground with arrows and water droplets were inferred to be passive water harvesting, or earthworks).

Conclusion

The effects of climate change, including drought, increased spread of vector-borne diseases, and heat-related mortality, will be devastating to all (Pachauri et al., 2014). No population is exempt from these catastrophic consequences; however, underserved communities will suffer the most (Costello et al., 2009). For example, with the urban heat island effect, temperatures in cities can be up to 11°C warmer than in surrounding areas, increasing extreme heat events and heat-related mortality for residents (Patz, Campbell-Lendrum, Holloway, & Foley, 2005). Concomitantly, Arizona is at high risk for water scarcity (Gober & Kirkwood, 2010). Already a dry and drought-prone area, the Southwest will become even more so, as falls elsewhere (Trenberth, 2011). Measures to address the consequences of climate change must be implemented to create more resilient communities. The first step is to engage and educate the communities so they can be part of the dialogue and encourage them to be a part of the solution process.

This study demonstrates the many outcomes of a promotora training program coupled with a citizen science approach, which provided a tiered health promotion effort in the southern

metropolitan Tucson area. Self-efficacy for environmental action increased across the promotoras and the home visit participants, while the promotoras gained efficacy in doing science, indicating that citizen science approaches can be effective tools in science literacy. These increases in efficacy can be tied to the participants being able to see behavioral and attitudinal changes in their communities, and this in turn, increasing their confidence in their abilities. Both saw increases in knowledge as demonstrated with the *inside* and *outside house* drawings, especially in regard to energy and water conservation. Future work could involve studying the lasting effects of the project, including what additional steps the groups have taken in their communities regarding climate change and environmental action.

This study suggests that the program was successful in training the promotoras and that the promotoras were then able to go into their communities and effectively educate others. These changes can be instrumental in creating more resilient communities, especially those that are disproportionately vulnerable to the effects of climate change. Based on the study described here, more attention may need to be given to educate the community on the health implications of climate change. Having access to environmental health education like this will continue to be prudent for those in the southern metropolitan Tucson area and other climate justice areas. The targeted area is seeking to achieve climate justice and is gaining awareness and self-efficacy to address the effects of climate change. These results can be applied to not just Southern Arizona, but across the globe where underrepresented populations will most feel the brutal consequences of climate change.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Promotora self-efficacy for doing science.
Note. An asterisk (*) denotes a significant change.

Figure 2.
Promotora self-efficacy for environmental action.
Note. An asterisk (*) denotes a significant change.

Figure 3.
Home visit self-efficacy for learning science.
Note. An asterisk (*) denotes a significant change.

Figure 4.
Home visit self-efficacy for environmental action.
Note. An asterisk (*) denotes a significant change.