Published in final edited form as:

Health Educ Behav. 2019 April ; 46(2): 349–359. doi:10.1177/1090198118798676.

Guardians of the Living Water: Using a Health Literacy Framework to Evaluate a Child as Change Agent Intervention

Vanessa W. Simonds, ScD,

Montana State University, Bozeman, MT

Frances L. Kim, MPH,

Montana State University, Bozeman, MT

Deborah LaVeaux, MS,

Montana State University, Bozeman, MT

Velma Pickett, BA,

Little Big Horn College, Crow Agency, MT

Jessica Milakovich, MS, and

Montana State University, Bozeman, MT

Jason Cummins, MEd

Crow Agency Public School, Crow Agency, MT

Abstract

Background: American Indian communities in the U.S. experience considerable health inequities including increased exposure to environmental contaminants. Consequently, community members of the Apsáalooke (Crow) Nation identified the lack of water-related environmental knowledge among children as an area of concern

Aim: The purpose of this study was to provide a feasibility evaluation of an increasingly sophisticated environmental health literacy program for children

Methods: A community-academic partnership developed and piloted the *Guardians of Living Water* program to increase environmental health literacy among children and their families on the Crow reservation. Nutbeam's framework for health literacy, a schema based on functional, interactive, and critical literacy, shaped the program evaluation. We utilized a within-subjects, quasi-experimental design without a control group. Interviews with children and parents were used to assess the feasibility of the program, while pre/posttests assessed changes in knowledge, skills, and behavior.

Results: Compared with pre-intervention responses, those from post-intervention indicated significant increases for selected knowledge and attitude components. Based on qualitative interviews with children and caregivers, the camp was a valuable experience and increased knowledge of water quality science and reinforced cultural knowledge.

Discussion: This success of our program stems from the trust initially built between partners and then expanded throughout the community. The program and the evaluation benefited from both the health literacy framework and from our integration of Apsáalooke values.

Conclusion: Our findings suggest a community-based intervention designed to increase environmental health literacy among youth and their social networks is feasible and acceptable to this American Indian community.

Keywords

Health Literacy; Native American; Environmental Health; Community-Based Participatory Research; Evaluation

INTRODUCTION

Water contamination and subsequent access to safe water are exigent global concerns (Villanueva et al., 2014). More than one-third of the planet's available freshwater is used for agricultural, industrial, and domestic purposes, all of which contributes to water degradation (Schwarzenbach, Egli, Hofstetter, von Gunten, & Wehrli, 2010). At the same time, environmental risks are disproportionately affecting the most vulnerable populations. American Indians (AI) face additional risks when relying on subsistence hunting and gathering, among other traditions, which increase their exposure to environmental contaminants (Fitzgerald, Hwang, Lambert, Gomez, & Tarbell, 2005). According to the U.S. Environmental Protection Agency, there are considerably more violations of health-based standards for public drinking water systems on tribal lands as compared to the rest of the U.S. (Office of Enforcement and Compliance Assurance, 2013). Regulation of water contamination proves even more complex because of conflicts between tribal jurisdiction and state and federal regulations (Hoover et al., 2012). We report on a unique effort undertaken by members of an AI tribal group to learn about and then inform their community about the quality of their water.

Background

The Bighorn and Little Bighorn rivers and Pryor Creek, all tributaries to the Yellowstone River, are a vital part of the health and well-being of the individuals and communities who live, work, and recreate on the Apsáalooke (Crow) reservation. The rivers serve as the municipal water sources for the two largest communities on the reservation. Moreover, Apsáalooke people rely on water from these rivers and local springs for ceremonial practices (Cummins et al., 2010; Doyle, Redsteer, & Eggers, 2013). Over ten years ago, tribal members formed the Crow Environmental Health Steering Committee (CEHSC) because they were concerned that water quality might be the cause of a disproportionate cancer burden that tribal members experience (Cummins et al., 2010). The committee established a community-based participatory research (CBPR) partnership to investigate water quality in their community, finding considerable contamination in home well-water (Eggers et al., 2018). Subsequently, community partners were eager to disseminate their findings to the broader community. The CEHSC identified the first author, an Apsáalooke tribal member and trained public health researcher, to extend their work into community-based efforts to

increase environmental health literacy (EHL). Although the CEHSC has collaborated with researchers for many years, the partnership is expanding to include new partners not familiar with the topics and/or participatory research process. Therefore, relationships and understanding between partners and with the broader community have taken time to develop.

Environmental Health Literacy with Children and Families.—Increasing EHL ensures that people possess the skills to make responsible decisions about the environment and its effects on their health. Environmental educators emphasize that understanding humans' role in environmental health should begin with children (Chepesiuk, 2007). Apsáalooke community members felt that an intervention for children focused on improving literacy skills related to protecting water quality in their environment might provide an opportunity to improve the ability of students, their families, and members of community to take steps to reduce health risks associated with poor water quality on the Crow reservation.

Project partners also hoped children would 'take home' information, share skills, and participate in community efforts to safeguard water. Children have successfully increased knowledge, changed attitudes and practices, and opened channels of communication among their peers, families, and unrelated adults in their communities on topics ranging from nutrition and physical activity and cancer to HIV/AIDS (Gadhoke, Christiansen, Swartz, & Gittelsohn, 2015; Kamo, Carlson, Brennan, & Earls, 2008; Onyango-Ouma, Aagaard-Hansen, & Jensen, 2005; Sparks, Tiger, & Tiger, 2016). Although, several studies have used summer camps to increase environmental literacy among children, none explicitly trained children as change agents. These programs, though lacking specific attention to health, impacted attitudes and behavior but were not as effective in increasing knowledge (Erdogan, 2011, 2015; Mittelstaedt, Sanker, & VanderVeer, 1999; Zelezny, 1999).

Program Development and Framework.—Our program drew from a concept of health literacy articulated by Nutbeam, an eminent public health leader (Nutbeam, 2008). See figure 1 for listing of topics by year and their fit within the framework. Nutbeam's concept was itself based on the pedagogy of the educator Paulo Freire (2000). The first level of literacy within this schema is **functional literacy** focused on reading, writing, speaking, listening, and math skills and people's ability to apply these skills to everyday tasks. The second level in Nutbeam's schema is **interactive literacy**, focused on people's capacity to interact with others sharing information and engaging in activities to build skills and apply new knowledge. Our programs included informative newsletters with activities that children and their family could do together. The third level in Nutbeam's concept highlights **critical literacy** with an emphasis on creating knowledge, enhancing skills, and engaging in collaborative action for change. Our programs implemented projects undertaken by children – collecting and interpreting data to build new knowledge and determine needed action. This paper evaluates a series of summer camp and afterschool programs designed to enhance the three levels of EHL: functional, interactive, and critical.

METHODS

Sample and Setting

The intervention took place at the local elementary school and surrounding areas on the Crow reservation. We implemented our pre-pilot summer camp in 2015 with students entering 5th or 6th grade (ages 9–12 years). In the fall of 2015, we recruited a new cohort of 4th graders (ages 9–11 years) for an afterschool program. These students were then invited to continue in our summer camp 2016, afterschool 2016–17 program, and our summer camp 2017. Additional students were invited to join each new session. Community staff members led recruitment efforts, which included letters to parents, flyers, social media posts, and an ad in a local newsletter.

Design

We used a one-group, repeated measures design across two summer programs. Prior to the first session, children and their parents provided informed consent. Children completed a pre-and post-test, and we conducted in-depth semi-structured interviews with both children and their parents. Study procedures were approved by the Institutional Review Boards at Montana State University and Little Big Horn College.

Intervention

See figure 1 for timeline and progression of EHL activities for each program. At least one experienced local educator observed and provided feedback on all programs.

Summer Camps.—For the first two summers, we implemented a five-session day camp running from 9am-4:00pm. AI and non-AI students from Montana State University and local Crow tribal college students facilitated program activities under the direction of the principal investigator and project coordinator. Daily activities included basic water-related science activities, art-based activities, and local community members as guest speakers. Our 2017 program lasted four days, and included the most successful aspects of previous programs. We increased critical literacy activities, with children collecting and testing their own water samples and presenting results to their families.

Afterschool Programs.—The 2015–16 afterschool program consisted of 12, two-hour sessions from October through May, with tribal college partners delivering science-based activities similar to the pre-pilot, focusing mostly on functional literacy. We concentrated on developing more interactive and critical literacy skills by carrying out a Photovoice project in the second afterschool program, which included 14-sessions from October 2015 through May 2016 (described in detail in another publication).

Measures

Functional Literacy Survey: Water-related Basic Knowledge.—We developed survey questions to evaluate changes in knowledge specific to each session. See figure 1 for topics.

Interactive Literacy—Sharing with Family: Newsletter Activities.—Using surveys and open-ended questions, we asked children about their ability to share information in their social networks. We also measured interactive literacy by requesting that children return signatures from parents verifying completion of take-home activities. In subsequent programs, we requested tangible evidence of their completion, such as collecting stories from their family.

Functional, Interactive, & Critical Literacy: Behavior and Attitude Survey.—Since most validated measures focus on environmental literacy more generally (Leeming, O'Dwyer, & Bracken, 1995; Smith, 2009; Zimmerman, 2010), we selected relevant water-related questions from across these measures. In each subsequent program, we modified survey questions to improve comprehension and to better measure critical and interactive literacy, while still considering response burden.

Qualitative Interviews

For each program, we conducted 15–20 minute interviews with all participants in groups of one to three and asked questions about what they liked, what could be improved, and what they had learned. After each summer program, we interviewed selected parents and asked them whether they had talked to their child about the program activities and for their feedback on the program. Parent interviews lasted 20–45 minutes. Tribal project staff, trained in qualitative methods, conducted interviews.

Quantitative Analysis

Although this study was not powered for statistical testing of program impact, we conducted paired one-sided t-tests to compare pretest and posttest scores ($P < 0.05$). We also conducted an ANOVA test on the attitude and behavior scores to determine if there was variance in responses between pretests and posttests. All statistical analyses were conducted in R version 3.3.2 (R Core Team, 2017).

Qualitative Data Analysis

After interviews were recorded and transcribed, we conducted inductive content analysis separately for parent and child transcripts (Patton, 2002). Two members of the project staff reviewed transcripts for emergent codes and then met to compare codes. The listing of codes was then grouped into themes and presented to the rest of the project team. We made minor revisions and then presented themes to the project steering committee for further refinement. One of the initial coders grouped the final themes into the overarching categories from our health literacy framework and confirmed these themes with a second team member.

RESULTS

Participant Characteristics

Over the course of our program we have reached 44 children, fourteen (32%) of whom have attended two or more programs. Across all programs, participants were between 9–13 years old and 57% were female. Summer camp attendance was higher compared to our afterschool session attendance; shown in table 1.

Quantitative Pre/Post Survey Data

Functional Literacy: Water-Related Knowledge.—The summer 2015 pre-pilot surveys were used to develop the measures. In summer 2016, for the ten children who completed pre/posttests, knowledge (percent correct) significantly increased for two of the nine questions. In summer 2017, we asked two knowledge questions, one of which significantly increased; see table 2.

Interactive Literacy: Sharing Information with Parents.—For the 2016 summer program, four children brought signed slips stating that they shared information from camp with their parents for all eligible four days, three children brought them back for three days, and three children brought them back for two days. Overall, children returned 31 signed sheets, mostly by mothers (76.7%), but also grandmothers (10%), grandfathers (6.7%), and sisters (6.7%). In the 2017 four-day summer camp, all children who were present for the first day of camp (n=15, 100%) brought back water samples from a water source of their choice. On the second day, fewer than half the children (n=8, 47.1%) brought back stories from their relatives about springs and fewer children (n=4, 21.1%) brought back surveys on private wells, with some children of those four bringing back multiple surveys. For both years, evidence of sharing diminished over the course of the program; see table 3.

Interactive & Critical Literacy: Behavior and Attitudes towards Engaging in Action.—Across all programs, children generally demonstrated positive attitudes regarding the environment and their abilities to share information, which remained positive for the posttest. Both afterschool programs were excluded due to the substantial variability in attendance. There were no significant differences from pretest to posttest; see table 4.

Qualitative Interviews with Parents and Children

In the 2015 pre-pilot summer program, we interviewed 28 children. Although we requested interviews with all parents, only seven were available. In the 2015 afterschool program we interviewed all children who were in attendance on the last session (n=14). With fewer participants in the summer of 2016, we only interviewed six children individually and seven parents. See table 5 for specific quotes from children and their parents.

Functional Literacy: Water-Related Science Knowledge and Skills.—For both years, when asked what they had learned, many children discussed the sacredness of water. All other main topics were also reported by children and their parents. In the first year, parents confirmed the camp's impact on their child's interest in water-related science but did not elaborate on specific activities from camp sessions. In 2016, we specifically asked about each activity.

Interactive Literacy Skills: Sharing Information with Parents and Community.—Most of the child participants told us they discussed what they were learning at camp with their family and their teachers. Some participants also described how they would tell other children to come to the camp to learn more about water. Participants also stated that they wanted to tell their community that water is important for health, that people should pick up trash when they see it, and should keep local springs clean. When asked what they wanted to

say to tribal leaders, children said *“People are disrespecting it [River]...some people just dump their trash into it, like manure and stuff.”* One student mentioned he would tell the tribal leaders, *“to clean the water and have the rivers checked every month.”* Parents affirmed that their children had shared some of the basic science activities, the stories, and information about the contamination of the local water sources. In addition, according to the parents interviewed, the concept of children serving as change agents fits with core Apsáalooke values.

Children talked about the personal confidence they had gained through camp activities. However, they also discussed barriers, which included having caregivers that were busy and hard to connect with after the camp day. They were also concerned that tribal leaders and other children may not listen to them because of their age.

Critical Literacy: Attitudes towards Engaging in Action.—Although all children agreed that they felt comfortable discussing what they learned at camp with their family, they acknowledged that they had not asked others about what they could do to protect local water sources. They shared many ideas for reaching other children, such as presenting at school assemblies. They also discussed examples of how they were engaging in more environmentally responsible actions because of what they had learned at camp.

Program Evaluation: Camp Activities.—Responses from both children and their parents were exceptionally positive. Most children reported that they liked listening to stories, learning about water, and taking field trips. Several parents reported that their children were eager to attend the camp each day. However, as one parent explained, her child decided to quit the camp because of the distance to the field trip site (1 hour away). Several children disliked the pre/posttests, stating that, *“they were confusing and hard to read.”* Although, one child’s response was positive stating that they *“test your mind before you wake up”*

DISCUSSION

This pilot study, inspired by Nutbeam’s three level concept for health literacy, stimulated environmental health-related learning and action among Apsáalooke children and their families. Although quantitative measures suggested limited changes in knowledge, qualitative findings were promising, with both parents and children discussing concepts they had learned through the programs. Evidence of interactive literacy was demonstrated through the return of take-home activities, with the most success on the first days of camp. We will continue to investigate methods for sustaining child-parent interaction throughout program sessions. We were most successful at generating community interest in 2017, where we had students present water quality test results from the local area. The presentations prompted some parents to ask to have their well-water tested. One parent posted on Facebook about her daughter’s role in testing the local river, which garnered over 20 posts from the local community discussing the need for action. Our Photovoice project also allowed community members to see the community’s water challenges from their children’s perspectives and was displayed in the tribal building for several months. According to participants, the camp was a valuable experience, increasing children’s basic water-related

science literacy and reinforcing water-related cultural knowledge. Our project provides several lessons to be learned from our implementation process.

Relationships are Important Building Blocks to Intervention Feasibility and Acceptability

First, and foremost, consistent with previous literature, trust was integral to the success of our partnership (Blacksher et al., 2016; Christopher, Watts, McCormick, & Young, 2008). Trust had to be built between project partners and then expanded throughout the community. Our project coordinator's relationships within the community were essential to recruitment and retention. Because of the age range of caregivers and children, we used a variety of communication strategies, including in-person, print, and social media. We struggled with scheduling conflicts which was especially difficult in the academic year. In the 2016–17 afterschool program, several children missed nearly half of the sessions. However, we kept them engaged through in-person visits to the school, with all but one completing the final Photovoice project. Inviting children to attend successive programs allowed us to build upon the skills and knowledge they had accrued so that they were ready to move beyond functional literacy to interactive and critical literacy activities. Returning children also served as role models for children new to the program.

Intervention Development and Evaluation Can Benefit from a Health Literacy Framework

This study provides insight into the use of health literacy as a framework for health intervention development, implementation, and evaluation. The goal of our program was to increase EHL, to promote a child-as-change-agent model, and to reach beyond children to their social networks including their family and their community. The EHL framework directed us in the development of program components for each level. We began at the first level—increasing functional literacy—by teaching water-related concepts to youth. Then we moved to interactive literacy where the change agent disseminates those concepts through their social networks. At the third level, we addressed critical literacy, where the child is the change agent working with others to take action as needed.

In our initial partnership meetings, our goal was to share findings from previous water quality research conducted on the reservation with community members by educating and training 4th-5th grade change agents. We soon realized that developing age-appropriate actionable messages related to the water quality issues would be a challenge. Like many other environmental health issues, water quality on the Crow reservation is complex with many mitigation challenges. The magnitude of concepts that increasing EHL requires—science literacy, health literacy and even legal literacy—led us to scale down our ambitious plans and to develop feasible alternatives in which children could participate in.

Integrating Cultural Strengths with an Environmental Health Literacy Framework

In addition to using the EHL framework, a strength of our program is the integration of Apsáalooke traditional knowledge and Western science into the EHL framework. Although grounding our program in Crow cultural values was central to our agenda, during our pre-pilot, we realized we needed to better integrate these two ways of knowing. One of our community partners explained to the children how he integrates Western science with his cultural worldview, and we continue to make this discussion a foundation of our program.

Consistent with previous studies, direct experiences, such as field trips to local springs and rivers, seemed to have more impact on knowledge, attitudes, and behavior than indirect experiences such as reading about these sites (Duerden & Witt, 2010). Our steering committee emphasized to us the value of visiting water sources in the local mountains as something the children would always remember.

Our research design included a mixed-methods approach which allowed us to analyze multiple sources of data. We acknowledge recruitment methods may have biased our sample to highly motivated children and engaged parents. However, our initial goal was to identify these types of children, those with the potential to be change agents in their community. Given the pilot nature of this study, the intervention was not evaluated for fidelity. We adapted and responded to participant, staff, and community feedback throughout the implementation of our pilot phase. Although our revisions to survey procedures limited comparability across years, it allowed us to develop more appropriate measures. For example, we modified previously validated survey items that included confusing response patterns, complex terminology, and/or abstract examples (Smith, 2009). We also learned to focus our learning objectives each day on fewer topics. Therefore, by our third summer camp we refined our focus on water quality related to springs. Future studies may build on this work by including other community settings, a larger sample size, and/or introducing a control group.

CONCLUSION

Given the pressing need to address environmental pollution in waterways, our intervention shows promise for intergenerational learning and action in this area. While our program has successfully increased the first two levels of EHL among children and their social networks, our future research will focus on further increasing critical literacy among program participants by asking them to co-lead research projects investigating water-related issues in their community. Based on our findings we recommend educational programming designed to excite and connect children with their environment as an avenue for increasing EHL within the broader community. Enhancing a community's level of EHL may increase that community's capacity to recognize and address environmental hazards, thereby minimizing negative health outcomes as well as redressing environmental injustices.

References

- Blacksher E, Nelson C, Van Dyke E, Echo-Hawk A, Bassett D, & Buchwald D (2016). Conversations about Community-Based Participatory Research and Trust: "We Are Explorers Together". *Prog Community Health Partnersh*, 10(2), 305–309. doi:10.1353/cpr.2016.0039 [PubMed: 27346777]
- Chepesiuk R (2007). Environmental literacy: knowledge for a healthier public. *Environ Health Perspect*, 115(10), A494–499. [PubMed: 17938718]
- Christopher S, Watts V, McCormick AK, & Young S (2008). Building and maintaining trust in a community-based participatory research partnership. *Am J Public Health*, 98(8), 1398–1406. doi: 10.2105/AJPH.2007.125757 [PubMed: 18556605]
- Cummins C, Doyle J, Kindness L, Lefthand MJ, Bear Dont Walk UJ, Bends AL, . . . Eggers MJ (2010). Community-based participatory research in Indian country: improving health through water quality research and awareness. *Fam Community Health*, 33(3), 166–174. doi:10.1097/FCH.0b013e3181e4bcd8 [PubMed: 20531097]

- Doyle JT, Redsteer MH, & Eggers MJ (2013). "Exploring Effects of Climate Change on Northern Plains American Indian Health". *Clim Change*, 120(3). doi:10.1007/s10584-013-0799-z
- Duerden MD, & Witt PA (2010). The impact of direct and indirect experiences on the development of environmental knowledge, attitudes, and behavior. *Journal of Environmental Psychology*, 30, 379–392.
- Eggers MJ, Doyle JT, Lefthand MJ, Young SL, Moore-Nall AL, Kindness L, . . . Camper AK (2018). Community Engaged Cumulative Risk Assessment of Exposure to Inorganic Well Water Contaminants, Crow Reservation, Montana. *Int J Environ Res Public Health*, 15(1). doi:10.3390/ijerph15010076
- Erdogan M (2011). The effects of ecology-based summer nature education program on primary school students' environmental knowledge, environmental affect and responsible environmental behavior. *Educational Sciences: Theory & Practice*, 11(4), 2233–2237.
- Erdogan M (2015). The effect of summer environmental education program (SEEP) on elementary school students' environmental literacy. *International Journal of Environmental & Science Education*, 10(2), 165–181.
- Fitzgerald EF, Hwang SA, Lambert G, Gomez M, & Tarbell A (2005). PCB exposure and in vivo CYP1A2 activity among Native Americans. *Environ Health Perspect*, 113(3), 272–277. [PubMed: 15743714]
- Freire P (2000). *Pedagogy of the Oppressed* (30th Anniversary Edition) (Ramos MB, Trans.). New York, NY: The Continuum International Publishing Group Inc.
- Gadhoke P, Christiansen K, Swartz J, & Gittelsohn J (2015). "Cause it's family talking to you": Children acting as change agents for adult food and physical activity behaviors in American Indian households in the Upper Midwestern United States. *Childhood*, 22(3), 345–361.
- Hoover E, Cook K, Plain R, Sanchez K, Waghiyi V, Miller P, . . . Carpenter DO (2012). Indigenous peoples of North America: environmental exposures and reproductive justice. *Environ Health Perspect*, 120(12), 1645–1649. doi:10.1289/ehp.1205422 [PubMed: 22899635]
- Kamo N, Carlson M, Brennan RT, & Earls F (2008). Young citizens as health agents: use of drama in promoting community efficacy for HIV/AIDS. *Am J Public Health*, 98(2), 201–204. doi:10.2105/AJPH.2007.113704 [PubMed: 18172136]
- Leeming FC, O'Dwyer W, & Bracken BA (1995). *Children's Environmental Attitude and Knowledge Scale*. CHEAKS.
- Mittelstaedt R, Sanker L, & VanderVeer B (1999). Impact of a week-long experiential education program on environmental attitude and awareness. *The Journal of Experiential Education*, 22(3), 138–148.
- Nutbeam D (2008). The evolving concept of health literacy. *Soc Sci Med*, 67(12), 2072–2078. doi: 10.1016/j.socscimed.2008.09.050 [PubMed: 18952344]
- Office of Enforcement and Compliance Assurance. (2013). *Providing Safe Drinking Water in America: 2013 National Public Water Systems Compliance Report*. Retrieved from Washington, DC <https://www.epa.gov/sites/production/files/2015-06/documents/sdwacom2013.pdf>
- Onyango-Ouma W, Aagaard-Hansen J, & Jensen BB (2005). The potential of schoolchildren as health change agents in rural western Kenya. *Soc Sci Med*, 61(8), 1711–1722. doi:10.1016/j.socscimed.2005.03.041 [PubMed: 15967559]
- Patton MQ (2002). *Qualitative Research & Evaluation Methods*. Thousand Oaks, CA: Sage Publications, Inc.
- R Core Team. (2017). *R: A language and environment for statistical computing*. Vienna, Austria.
- Schwarzenbach RP, Egli T, Hofstetter TB, von Gunten U, & Wehrli B (2010). Global Water Pollution and Human Health. *Annual Review of Environment and Resources*, 35, 109–136.
- Smith SE (2009). *Growing Up Green: A Study Focusing on Environmental Attitudes, Knowledge, and Focusing on Environmental Attitudes, KNowledge and Behaviors of Elementary Children*. *University of Tennessee* (Masters Thesis).
- Sparks SMA, Tiger LL, & Tiger AA (2016). Developing a Model American Indian Intergenerational Youth Health Messenger Program to Promote Breast Cancer Screening. *American Indian Culture and Research Journal*, 40(4), 101–122.

- Villanueva CM, Kogevinas M, Cordier S, Templeton MR, Vermeulen R, Nuckols JR, . . . Levallois P (2014). Assessing exposure and health consequences of chemicals in drinking water: current state of knowledge and research needs. *Environ Health Perspect*, 122(3), 213–221. doi:10.1289/ehp.1206229 [PubMed: 24380896]
- Zelezny LC (1999). Educational interventions that improve environmental behaviors: A meta-analysis. *The Journal of Environmental Education*, 31(1), 5–24.
- Zimmerman LK (2010). Environmental Values Short Form.

Impact Statement

This study provides evidence that program development, implementation, and evaluation can benefit from long-term community-academic partnerships, application of a health literacy framework and integration cultural values, to improve environmental-related knowledge, attitudes and behavior, and further suggests that knowledge and skills may be passed on to parents and family members.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Functional Literacy including Cultural Components Addressed in all Programs: <ul style="list-style-type: none"> • Water cycle • Water chemical properties • Water and life • Hydration and the human body • Water quality • Formation of springs • Water conservation • Roles and responsibilities of Guardians • Visits to culturally important water sources • Community members sharing stories about importance of water • Discussions on integrating Western and Indigenous science • Crow names for local water sources 				
Interactive Literacy Addressed in all Programs: Newsletter take-home activities.				
Interactive/Critical Literacy: Children created posters to share what they learned with parents on last day.	Interactive/Critical Literacy: Children discussed what they had learned in a video shown to their parents.	Enhanced Interactive Literacy: Discuss with a parent: • Share the activity we did today with your parent. [Bring signed slip back] Enhanced Critical Literacy: Children developed their own videos to teach their parents something they had learned about water.	Enhanced Functional Literacy: Photography basics Research ethics Enhanced Interactive Literacy: Photovoice exhibit Enhanced Critical Literacy: Action plan • Decorating and setting out garbage cans • Making rain barrels to recycle water	Enhanced Functional Literacy: Research literacy Enhanced Interactive Literacy: Newsletter take-home activities Discuss with parent: • Story about a local spring. [Share story with group next day] Enhanced Critical Literacy: Choosing and testing their own water sources, presenting results
Pre Pilot Summer 2015 5-days	Afterschool 2015-16 12-2hour sessions	Summer 2016 5-days	Afterschool 2016-17 14-2hour sessions	Summer 2017 4-days

Figure 1.

Listing of topics by year and their fit within the three-level health literacy framework

Attendance data and participant characteristic (sex) for years 2 and 3 of the Guardians of Living Water project.

Table 1.

	Attendance			Sex		
	Total # Sessions	Mean # Sessions Attended	Mean % of Sessions Attended	Total # Female Students	% Female Students	Total # Male Students
Afterschool						
2015-2016	12	6.79	56.58	13	54.17	11
2016-2017	14	9	64.29	4	36.36	5
Summer						
2016	5	3.93	78.57	8	57.14	5
2017	4	3.53	88.16	12	63.16	7

Table 2.

Knowledge Pre-Posttest scores from summers 2016 and 2017.

	Topic	Question	mean	N	variance	df	t-statistic	p-value (one-tailed)
<i>Summer 2016</i>								
Total score for Crow natural resources questions								
			0.82	11	0.11	10	0.43	0.34
			0.77	11	0.17			
		What mountains are represented on the logo?	0.73	11	0.22	10	0	0.5
			0.73	11	0.22			
		Which river is represented on the logo?	0.91	11	0.09	10	1	0.17
			0.82	11	0.16			
Total score for healthy practices questions								
			0.75	10	0.08	9	-1.5	0.08
			0.85	10	0.03			
		Which of these hand-washing methods will kill bacteria?	0.9	10	0.1	9	-1	0.17
			1	10	0			
		How long should you wash your hands with soap and water?	0.9	10	0.1	9	-1	0.17
			1	10	1			
		Germes are spread from one person to another through...	0.5	10	0.28	9	0	0.5
			0.5	10	0.28			
		A healthy habit I can practice is...	0.7	10	0.23	9	-1.5	0.08
			0.9	10	0.1			
Total Score for Water and the Body								
			0.7	10	0.067	9	-0.557	0.29
			0.75	10	0.069			
		Approximately what % of your body is water?	0.6	10	0.27	9	-1.96	0.04*
			0.9	10	0.1			
		Water is important to my body because...	0.7	10	0.23	9	0.56	0.3
			0.6	10	0.27			
		Urban water cycle: What is not part of the urban water cycle?	0.2	10	0.18	9	-2.45	0.018*
			0.6	10	0.27			
<i>Summer 2017</i>								
Total score for spring formation								
			0.47	15	0.12	14	-1.57	0.069
			0.67	15	0.1			

Topic	Question		mean	N	variance	df	t-statistic	p-value (one-tailed)
What is the location called where ground water flows from the Earth's surface in an amount large enough to form a pool or stream-like flow?	What is permeability?	pre-test	0.47	15	0.27	14	-0.37	0.36
		post-test	0.53	15	0.27			
		pre-test	0.47	15	0.27	14	-1.78	0.048*
		post-test	0.8	15	0.17			

Note: Only students who completed both the pretest and posttest were only included in this table.

Table 3.

Interactive literacy: Take-home activities returned by participants each day

Program	Session (n = attendance)	Activity Shared with Caregiver	Count (n)	Percent (%)
Summer 2016	Monday (n=9)	What is a Guardian?	9	100
	Tuesday (n=11)	Have you ever had to haul water?	10	90.90
	Wednesday (n=11)	Share about the bugs collected from the river.	3	27.27
	Thursday (n=10)	Share your plume diagram.	3	30.00
Summer 2017	Monday (n=15)	Water Intake Surveys *	14	93.33
	Tuesday (n=17)	Water Samples	15	100
	Wednesday (n=19) **	Spring Story	6	35.29
		Well Survey *	4	21.05

* Note: count only is of the number of students who brought surveys back, not the total number of surveys

** 3 students did not return for Wednesday's session

Table 4.

Environmental Health Interactive and Critical Literacy Pre-and Posttest scores.

	Summer 2016 (n=9)				Summer 2017 (n=16)			
	Pre	%	Post	%	Pre	%	Post	%
John went swimming with his family. He noticed a lot of trash along the river edge. What should John do?								
A: Nothing, it's not his job	1	11.11	1	12.5	1	6.25	1	6.25
B: Tell his parents	0	0	0	0	0	0	1	6.25
C: Ask everyone to help pick up the trash and take it away	7	77.78	6	75	14	87.5	13	81.25
D: Something else	0	0	1	12.5	1	6.25	1	6.25
No response	0	0	0	0	0	0	0	0
Invalid	1	11.11	0	0	0	0	0	0
Sam noticed the water in the bathroom sink was left running. What should Sam do?								
A: Nothing	1	11.11	2	22.22	1	6.25	1	6.25
B: Tell a teacher	1	11.11	0	0	1	6.25	0	0
C: Turn the water off	6	66.67	7	77.78	13	81.25	15	93.75
D: Something else	0	0	0	0	0	0	0	0
No response	0	0	0	0	1	6.25	0	0
Invalid	1	11.11	0	0	0	0	0	0
Water pollution affects my health								
Agree	7	77.78	5	55.56	6	37.5	6	37.5
Disagree	2	22.22	3	33.33	5	31.25	4	25
Not Sure	0	0	0	0	5	31.25	6	37.5
Invalid	0	0	1	11.11	0	0	0	0
I want to learn more about what I can do to protect rivers (and ground water--summer 2017).								
Agree	9	100	9	100	9	56.25	11	68.75
Disagree	0	0	0	0	3	18.75	2	12.5
Not sure	0	0	0	0	3	18.75	3	18.75
No response	0	0	0	0	1	6.25	0	0
I can tell someone at home what I learned about protecting water								

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

	Summer 2016 (n=9)				Summer 2017 (n=16)			
	Pre	%	Post	%	Pre	%	Post	%
Agree	9	100	9	100	11	68.75	13	81.25
Disagree	0	0	0	0	3	18.75	0	0
Not sure	0	0	0	0	2	12.5	3	18.75

Table 5.

Selected Quotes from Parent and Student Interviews

EHL Categories	Codes and Example Quotes
<u>Functional Literacy</u>	
Child's Perspective	<p>What they learned [sample of codes related to program activities]</p> <ul style="list-style-type: none"> • Water is sacred -I learned about... water is sacred...how to keep it clean...not to make fun of water. • Water quality -If there's dragonflies and those kinds of bugs it's okay, but if there's leeches and worms in there it's bad. • Water conservation -I would use less water because you can save water and our water bill won't be bigger and higher.
Parent's Perspective	<p>What children learned [also evidence of interactive literacy]</p> <ul style="list-style-type: none"> • Water is sacred -I liked it because it taught about how vital water is to the Crow Reservation. • Water quality -She told us about how she got to test the water and it came back yellow. She told us about the story of the boy who threw a rock at the white buffalo. • Water conservation [trip to water treatment plant] -He goes, you know the water from the toilet? they recycle it all.
<u>Interactive Literacy</u>	
Child's Perspective	<ul style="list-style-type: none"> • Sharing with others: Program activities -I'll tell my mom that I got to be in Chief Plenty Coups' house and in his room and that I got to make some springs. And that we were looking for each other's contamination in the sand [and] that we went to a spring and are going to look at the water to see if it's healthy to drink. -What I would say about pollution if I talk to the chairman is that people are disrespecting it, like kicking it or just putting trash and kicking it all around, and some people just dump their trash into it, and like manure and stuff. -I would tell the tribal leaders] to clean the water and have the rivers checked every month. • Sharing with others: Ways be environmentally responsible -[I would tell them] not to throw trash in the river and to treat it good -Tell them not to leave the water sink on, tell them not to leave the water hose on. • Increased sharing skills -[Guest Speaker] showed us that you shouldn't be afraid to be funny. You can be funny and yourself in front of everybody. • Barriers to sharing -It was difficult... because... my mom's always on her phone and then my brother's playing his game and then my grandma and grandpa are always watching TV and he's always on his newspaper. -It would be difficult because some of them might think that we're just little kids and we don't know anything.
Parent's Perspective	<ul style="list-style-type: none"> • Sharing with others: Program activities -He told me and her (pointing to participant's sister) about stuff. So she knows some stories about what he told her. He paid attention.
<u>Critical Literacy</u>	
Child's Perspective	<ul style="list-style-type: none"> • Environmental Responsibility -And it's important to like respect water. And take care of it. -I pick up trash at the river when I have time, when I'm not in a rush and it will be easy because I like to keep the environment clean. • Collaborative Action -We can have an assembly [to teach younger kids about protecting rivers]. -Also, we could make a movie or talk at an assembly to teach them about protecting rivers -Ask what farmers are doing with pollution and the cows.
Parent's Perspective	<ul style="list-style-type: none"> • Collaborative action -If the children can convince their families and their friends, and then they'll convince the community and we all need to take initiative to help clean our water. It could carry on into other things in the community not just the water.

EHL Categories	Codes and Example Quotes
<p><u>Program Evaluation</u></p> <p>Child's Perspective</p>	<ul style="list-style-type: none"> • Enhancing Skills <ul style="list-style-type: none"> -She started to look at the posters in my office and she could understand some of them. She started to ask me questions about what they meant and she could understand what I was telling her. It was really neat. I think before the camp she did not know much about water issues but after the camp she was more aware of them. -You know she just values those packets that were given to her and she was really going through that testing thing. • Activities they liked <ul style="list-style-type: none"> -I liked camp today because we got to go on a field trip to Pryor and hear a story... I liked it because I got to learn history and...I never heard history before from someone. -We had to use teamwork to get across the river so none of our teammates would get eaten. • Activities they did not like <ul style="list-style-type: none"> -I didn't like...coming on the bus. -The least fun activity was the springs. -I really didn't like that one [pucker effect]. • Pretests <ul style="list-style-type: none"> -Some of them are easy, some of them I couldn't answer. -They were confusing and hard to read (Pre-pilot summer camp used pencil/paper test). -They were pretty good, and, like test your mind before you wake up. • Acceptability of Change Agent Framework <ul style="list-style-type: none"> -You guys are on the right track about having children share information with parents and others because our belief, the Crow belief is that children are sacred to us. They come to us pure. They don't have any biases; they don't have any prejudices that they bring with them. The Crow belief is that because children come to us without, they're still innocent, and so they have a lot of power. • Positive Assessment <ul style="list-style-type: none"> -I think it's a good idea. I know when my kids come home from school I ask them what they learned in school and they share all sorts of things with me. This would be accepted by others. I think it'll be beneficial for both the parents and the community to have the children tell their family about issues going on. -This was a camp that he really liked so he was up and ready to go and didn't want to miss. And every day he talked about tomorrow we're going to do this. • Barriers to participation <ul style="list-style-type: none"> -It's transportation, living out in the country, transportation is a little bit difficult. -The third day I think you guys went to Pryor, and he didn't want to go. He said it was too far and so he stayed... you know if it was in Crow he would have stayed. But the one in Pryor was too long.

Note. EHL=environmental health literacy.