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Environmental Health Education for Teachers: Results of Pre- and Post-surveys from a Pilot Study Addressing Chemical Use Reduction and Integrated Pest Management in Homes

Alesia Ferguson[1*], Ilias Kavouras[1], Robert Ulmer[2], Keith Harris[3], Helm Rebecca[1] and Zoran Bursac[4]

[1]*Department of Occupational and Environmental Health, Fay W Boozman College of Public Health, Little Rock, AR, USA*

[2]*Department of Urban Affairs, College of Professional Studies, University of Nevada, Las Vegas: Maryland Parkway, Las Vegas, USA*

[3]*Science, Technology, Engineering and Mathematics (STEM) Center, College of Education, Little Rock, AR, USA*

[4]*Department of Biostatistics, Fay W Boozman College of Public Health, Little Rock, AR, USA*

[*]**Corresponding author**: Alesia Ferguson, Department of Occupational and Environmental Health, Slot #820 Fay W. Boozman College of Public Health, University of Arkansas for Medical Sciences (UAMS) Little Rock, AR 72205, Tel: 501-526-6662; E-mail: aferguson@uams.edu

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Abstract

Science teachers from multiple K-12 schools (i.e., kindergarten-high school) were engaged in a two-day training addressing the key topics of integrated pest management practices and chemical use reduction. This training was provided to introduce teachers to these essential aspects of promoting a healthier home and a reduction in associated adverse health outcomes. Indoor exposures are of particular importance for the elderly and very young who spend the majority of their time at home. Early childhood education related to the proactive and intimate role humans play in shaping the health of their home is seen as important for sustainable and effective public health and community health actions. Innovatively, the training used newer formats of engagement called Liberating Structures (LS) to engage and excite teachers on these environmental health topics. This paper describes the environmental health knowledge of those thirty-five teachers through pre- and post-surveys delivered during the training to assess their ability and willingness to transfer this knowledge into the classroom. Also explored are curriculum areas for integration of these environmental and public health topics.

Keywords: Environmental Health; Chemical Use Reduction; Integrated Pest Management Practices; Healthy Homes; K-12 Teacher Professional Development

Introduction

There is no more intimate environment that people relate to than their own home environment where they sleep, play, and eat. In this environment, personal actions influence the health of the home. With the significant part that people play in the health and condition of the environment, it becomes imperative to find effective avenues to impart knowledge and produce ownership in environmental health issues. Teachers play a role in developing young minds and creating a science and health literate populace [1]. This pilot training for K-12 teachers focused, as one of its main objectives, on imparting knowledge of the specific environmental health topics of integrated pest management practices (IPM) and chemical use reduction (CR) in the home to promote better indoor air quality, healthier homes, and healthier people. In the United States, K-12 education for children begins, generally, at age 5 and ends at age 18, after which children then enter college for undergraduate studies. General ideas on keeping a healthy home and, in particular, the holistic seven principles of a healthy home, as developed by the United States National Center for Healthy Housing (NCHH), were also introduced. These seven principles include "Keep it Dry," "Keep it Clean," "Keep it Maintained," "Keep it Ventilated," "Keep it Contaminant Free," "Keep it Safe," and "Keep it Pest Free." The project's approach was to not only determine existing knowledge, but also impart knowledge on less common classroom environmental health topics to teachers and encourage them to incorporate these topics into their science or health education coursework. The use of liberating structures (LS) in the trainings and delivery of educational content was a strategy to engage teachers and introduce them to newer teaching methods in the classroom.

Indoor air, over the last few decades, has been recognized as important to human health based on the increased time spent indoors by populations and improper energy upgrades that result in insufficient filtration that reduces the dilution effects of pollutants generated indoors [2]. Sources of biological, chemical, and physical contaminants are varied and pose a threat to indoor air quality and human health [3]. Shared messages and education on IPM and CR in the home address health problems in the home and are vital to current and future generations. These topics specifically address the environmental priorities of "Protecting Air Quality" and "Assuring the Safety of Chemicals and Preventing Pollution" issued by the United States Environmental Protection Agency (EPA) in their 2011-2014 Strategic Plan [4]. Indoor exposures are of particular importance for the elderly and very young who spend the majority of their time at home. These groups can be compromised, as many have existing health problems (e.g., elderly and respiratory problems) or behaviors that increase their exposures (e.g., the young and increased hand to mouth activities) [5].

Proper management of pests in the home is of particular importance to all residents. Cockroach and dust mite allergens are factors, with enough evidence in the literature to be causally linked to the exacerbation and development of asthma [6]. Asthma alone is estimated to have close to an 8.1% and 9.2% prevalence nationwide for

adults and children in the United States, respectively [7]. It is imperative for all households to understand and control adverse exposures in the home that contribute to asthma and other respiratory illnesses [8-12] and to maintain a clean home free of pests [13,14]. In the 2011 United States Housing Survey, it was estimated that over 13 million housing units across the nation (out of 132 million) had seen signs of cockroaches in the last 12 months. The Southern regions reported three times more incidents of occurrence than the Northeastern region and over five times more incidents of occurrence than the Midwest. Many homes also show problems with mice and other rodents [15]. This means that families in the South must engage in integrated pest management in and around the home. Integrated pest management practices entail maintaining a clean, dry, and sealed home and storing and using pesticides, when necessary, in a safe and appropriate manner [16,17]. In other words, it is a holistic approach to pest management where the least toxic methods are used first. This approach is warranted, because pesticides are linked to a multitude of health problems (e.g., cancer, neurodevelopmental disease) and call for precautionary approaches in their use in around the home [18].

General chemical use reduction is also of critical importance in the home. Individuals use a vast array of chemical products around the home and for personal care [19]. These include harsh pesticides, as described above, cleaning products, burning candles, new building materials that off gas, fragrances, and other cosmetic products [20]. There are some specific chemicals that are of greater concern in the indoor environment and these include naphthalene, formaldehyde, a variety of polycyclic aromatic hydrocarbons (PAHs), and aldehydes [21-25]. These chemicals can be irritants (including triggers for asthma), carcinogens, and endocrine disruptors [20,26]. Naphthalene, for example, is found in pest repellants, deodorant, cigarette smoke, and vehicle emissions from attached garages [23]. Cleaning habits and product usage varies among families and across demographics [19,26] but they call for caution in their use. Limited studies are available on many chemical products used in the home and long-term health effects from their combined usage remains unclear, especially as new products enter the market continually. Chemical use reduction strategies and lessons can be imparted to the general public to reduce chemical concentrations in homes and promote health.

Traditional science education in middle school, grades 5 through 8 (i.e., ages 10-14), is often purely objective, rational, and rigid in it instruction, requiring the teacher to follow specific standards of delivery and separation of biology, chemistry, and physics concepts [27]. Environmental health education, on the other hand, is often a diverse mix of concepts, where current environmental controversies such as global warming and industrial pollution require all four dimensions (i.e., nominal, functional, conceptual, and procedural) of science literacy [1]. Not all science teachers will be comfortable with teaching and discussing these issues with students, allowing them to critically think through these issues, unless given the necessary skills [27]. The uncertainty of chemical exposures and long term health effects requires an introduction to the idea of risk reduction and the precautionary principle, concepts typically included in the discussions of environmental science. The topic areas of chemical use reduction and integrated pest management come with additional consideration of the impact humans have on their immediate environment and individual health. These topics also require the teacher to discuss issues of personal choice, personal behavior, and the development of skills required for personal decision making [1].

An optional environmental science class at the high school level (i.e., ages 15-18) would seem to be a suitable opportunity to introduce topics such as IPM and CR to young adult minds. However, within the Arkansas academic framework (i.e., curriculum) for middle grades, 5th through 8th, there are a number of classes where these topics and related topics on maintaining a healthy home could be incorporated into the framework as practical applications of science relevant to the demonstration of effects on human health [28]. Physical education can approach the concept from a behavioral aspect, where people reduce the use and overuse of harsh chemicals to protect their health. This fits within the concept of personal care and acceptable behaviors. Science projects also present opportunities to address environmental health topics not typically covered in curriculum materials allowing for creative and independent thinking to further develop [29].

An objective of the pilot program was to look at the effectiveness of the training to impart knowledge on the topics of chemical use reduction and integrated pest management to teachers from diverse science backgrounds. These were newer topics not typically taught in Arkansas schools in the current science or health curriculum. By using Liberating Structures to impart this knowledge, our hope was to get teachers excited about these topics, make the training more enjoyable, create an environment to share ideas, and create lasting memories. Therefore, one further objective of the training was to introduce teachers to new teaching methods transferable to the classroom environment.

Liberating Structures have the potential to promote listening, build relationships, encourage open communication and generate ownership of the environmental issue or interest [30]. A “Liberating Structure” is often referred to as a “destructive methodology” in positive terms, as it destroys prior ways of conducting business (i.e., simple PowerPoint slide presentations only for information transfer). One example of a Liberating Structure used in the training was the “1-2-4-All” structure, where participants used a systematic process (i.e., individually and then in growing group interaction) to discuss ideas and concepts on IPM and CR, which were ultimately refined and shared with the entire class. The use of Liberating Structures has been successfully applied to other scenarios and, in particular, conflict resolution [30]. Below, we report the results of pre- and post-surveys delivered to 35 teachers in the training that occurred Summer-2013.

Methods

The University of Arkansas for Medical Sciences worked through two Science, Technology, Engineering, and Mathematics (STEM) Centers (affiliated with the University of Arkansas at Little Rock [UALR] and the University of Arkansas Pine Bluff [UAPB]) to recruit teachers from multiple schools in diverse communities to the training. STEM centers service the science teachers in their counties and designated regions. To recruit, we used the email lists of these teachers from the STEM centers to invite them to this training. This was a convenience sample. Initially, 47 signed up for the trainings, and 36 attended. One person did not attend on the second day. Ultimately 35 teachers completed pre- and post-surveys before and after the trainings.

Trainings were four hours each day with a 45-minute break for in-class lunch and socializing. Table 1 displays the agenda. Time was given to participants at the beginning and end of the training to complete pre- and post-surveys, respectively. The key topic of Chemical Use Reduction received 1 hour and 15 minutes of specific

instruction on Day 1 and Integrated Pest Management Practices received 45 minutes of specific instruction on Day 2. Group projects using Liberating Structures (LS) were used repeatedly throughout the two-day training to discuss topic areas and solidify main concepts. Teachers were given an overnight assignment on Day 1 to study the Liberating Structures' brochure, visit the Liberating Structures' website, and present the next day on what they thought would be useful formats to adapt to K-12 classrooms when delivering and teaching environmental health topics, such as those covered in the training.

Day/Time	Day 1	Day 2
8:30-9:00	Breakfast/Check in	Breakfast/Check in
9:00-9:30 am	Pre-Survey/Introductions/ Grant Descriptions	Presentations Based on Assignment
9:30 -10:00 am	Liberating Structures	Integrated Pest Management
10:00-10:20 am	Science Curriculums	
10:20 am-10:30 am	Break	Break
10:30-11:00 am	Practical Applications in Science: Science Projects	Group Project: Use of a LS
11:00-11:30 am	Group Project: Use of a LS	Healthier Homes
11:30-12: 15 pm	Lunch	Lunch
12:15-1:00 pm	Chemical Use Reduction	Integrating PMCR into Curriculum and Science Projects
1:00-1:20 pm		Using LS for Communication
1:20-1:50 pm	Group Project: Use of a LS	Group Project: Use of a LS
1:50-2:00 pm	Closing: Instructions: Assignment	Closing/Post-Survey/Sign-Up

Table 1: Teacher's training agenda.

Training materials

Powerpoint slides: PowerPoint presentations and the agenda were divided into 4 parts shared by various instructors. Day 1 of training covered liberating structures, science curriculums, and chemical use reduction. Day 2 covered integrated pest management, healthier homes, integrating program concepts into the curriculum, using liberating structures in the classroom, and relationships and communication. The training of the teachers was led and directed by 5 instructors from three Arkansas institutions and three departments of various backgrounds: environmental science, K-12 education, and communication and speech.

Brochures: Four brochures were prepared and given to the teachers for the training. Brochures addressed the specific topics of the program: "Chemical Use Reduction," "Integrated Pest Management for Homes," "Liberating Structures for Environmental Education," and "Developing a Science Project." Brochures were developed to refine messages in the format we felt ideal for this project. In particular, the use of Liberating Structures for these environmental education topics and for their use in the K-12 classroom was a new topic area. Chemical use reduction for the home was also a newer concept developed for this program.

Teacher folders, teacher kits, and display items: Folders were prepared for the teachers with a cover sheet about the program and the objective of the training. Included in the folders were the agenda, copies of presentation slides, brochures, and many additional materials such as supportive materials from EPA and other agencies on the topics of integrated pest management, chemical use reduction, and healthy homes. These included, for example, "Citizen's Guide to Pest Control and Pesticide Safety" [16], "Safe Use of Pesticides around the Home" [31], "Science Frameworks for Arkansas," [28] and more. Display items relevant to the training were purchased and displayed on both days of training. A sample of each of these items was included in kits for the teacher to take to their classrooms to share with students. The teacher kits were organized in plastic bins and included a variety of safer cleaning products for the home (e.g., vinegar, hydrogen peroxide) and items considered to be the first approach for integrated pest management in the home (e.g., rats traps, copper coils for plugging holes, dust mite covers to protect pillow cases, washable cloths for wiping floors). To accompany the kits, teachers were also provided with a list of possible uses for these milder cleaning products around the home, including mixing quantity (e.g., window cleaning, washing clothes). The display items shown on the day of training had more items and, for example, included recommended filters for Heating, Ventilation, and Air Conditioning Units (HVACs) and smoke alarms/carbon monoxide monitors for a general discussion of maintaining a healthy and safe home as related to the seven principles of keeping a healthy home.

Statistical methods: In Section 1, there were 15 pre- and post-survey "skills proficiency" questions based on a 4-point Likert scale to rate their skill level using the categories of "none," "aware," "skilled," or "proficient" regarding chemical use reduction, integrated pest management, use of liberating structures, and K-12 science projects. The second section used response options of "Yes/True," "No/False," or "Don't Know" to test participants on specific content covered in the training. Pre-and post-survey questions also asked about what they considered safe products in the home and post-survey questions attempted to determine their willingness to convert to safer products. Some program evaluation and satisfaction questions with "Yes" or "No" responses were asked on the post-survey only, and participants were also allowed to write any comments or suggestions concerning the training.

Excel was used to enter and compile surveys for statistical analysis in SASv9.4 software. Changes in correlated proportions and paired differences in means were tested via paired t-test and McNemar's test. Specifically, skills proficiency responses in Section 1 were coded on a "0-3" ordinal scale (41) and compared between pre- and post-survey via paired t-test to look at significant differences in scale means. Percent shifts in proficiency categories are also reported, where a non-response is grouped with Not-Aware. In Section 2, knowledge responses were examined for a change in the number of correct answer responses on pre- versus post-survey where "Don't know" and incorrect responses are assigned "0" and correct responses are assigned "1" in the binary analysis. Overall correct to incorrect responses pre/post-survey were examined with McNemar's test to assess the significance of paired proportion changes from pre- to post-test. Results were considered significant at the alpha level of 0.05 with the exception of paired proficiency questions where we use alpha of 0.003 to adjust for over inflation.

Results

Attendance at trainings

The thirty-five teachers that attended represented twenty-two different schools and taught a spectrum of grades, kindergarten (i.e., age 5 to 6) through 12th (i.e., age 17 to 18), with 57% of the teachers from grades 6 through 8 (considered middle school for most districts in Arkansas). Although some teachers taught all subjects, most teachers that attended taught science. Most of the teachers were females (86%), with the majority over fifty years of age (49%). This coincided with many participants having many years of service as a teacher. The average number of years of service was 16 for teachers trained.

Prior training and feelings on training

None of the thirty-five teachers reported ever having received training on the topics of chemical use reduction and integrated pest management on the pre-survey. In addition, all teachers on the post-survey agreed or reported satisfaction that the training was informative and would be helpful in the classroom, that instructors were knowledgeable, that the level of instruction was appropriate with their skill level, and that they would recommend the training to other teachers in the K-12 educational system.

Section 1: Skills proficiency questions

The results of the Proficiency questions are reported in Table 2. On average, across all fifteen questions teachers said they were "Not Aware" of the topics 35.24% of the time on the pre-survey. By the post-survey, the average response for "Not Aware" for these 15 questions dropped to 2.67%. All teachers had awareness, on some level, on the question of "Types of pesticides used around the home" (Question 3). Other questions for which most teachers felt they had some level of awareness before the training were "Safety regulations for pesticides" (Question 4), only 3 teachers responded "Not aware," and "Use of Clickers in the classroom" (Question 9), only 2 teachers responded "Not Aware." Across all 15 questions, the biggest gains were in the category of "Skilled," with an average 42.86% increase. Proficient increased across all questions by 9.52%, and "Aware" decreased by 19.81%. The question that had the largest percent increase in "Proficient" was "Health Effects of Pesticides" (Question 7), a 17.14% increase. The two questions having the largest shift in response from "Not Aware" to other increased knowledge categories were "Format of Liberating Structures" (Question 1), 88.57%, and "Application of Liberating Structures" (Question 2), 85.71%. A paired t-test was performed to determine significant differences in mean summed scores between pre- and post-test, where "Not Aware" is assigned 0, "Aware" is assigned 1, "Skilled" is assigned 2, and "Proficient" is assigned 3 (Table 2). All questions showed a showed a significant change based on all p-values less than 0.05. The largest difference in means were for Questions 1 and 2 on the topics of liberating structures and Question 15 on student topics for integrated pest management practices and chemical use reduction projects (Table 2).

Questions	Difference in Means (post-pre)	Std. dev.	t-test-P value	% change in "Aware"	% change "skilled"	% change "Proficient"
1. Format of Liberating Structures	1.714	0.667	<0.0001	17.14	60.00	11.43
2. Application of Liberating Structures	1.618	0.697	<0.0001	17.14	57.14	8.57
3. Types of pesticides used around the home	0.657	0.684	<0.0001	-54.29	42.86	11.43
4. Safety regulations for pesticides	0.600	0.695	<0.0001	-40.00	45.71	2.86
5. Classes/types of chemicals used around the home	0.857	0.601	<0.0001	-31.43	45.71	8.57
6. Health effects of chemicals	0.743	0.657	<0.0001	-45.71	51.53	5.71
7. Health effects of pesticides	0.771	0.647	<0.0001	-48.57	54.29	5.71
8. Format of student science projects	0.441	0.786	<0.0025	0.00	5.71	8.57
9. Use of clickers in the classroom	0.412	0.892	<0.0001	-31.43	8.57	17.14
10. Use of Phone polls in the classroom	0.758	0.867	<0.0110	-14.29	28.57	8,57
11. Biological strategies for pest control	1.000	0.804	<0.0001	-8.57	45.71	5.71
12. Physical strategies for pest control	1.177	0.904	<0.0001	-11.43	42.86	14.29
13. Safer or milder chemical choices for cleaning	0.829	0.923	<0.0001	-37.14	42.86	11.43

14. Concepts behind the precautionary principle	1.343	0.725	<0.0001	-2.86	51.53	11.43
15. PMCR topics that could be used for science projects	1.471	0.615	<0.0001	-5.71	60.00	1.43

Table 2: Proficiency questions results (i.e, Self-Rated Skills). Note: Self-rated proficiency questions showed great improvement following the day's training, with the largest positive percent change occurring in the "skilled category" for most questions. The two questions having the largest shift in response from "Not Aware" to other increased knowledge categories were "Format of Liberating Structures" (Question 1), total of 88.57%, and "Application of Liberating Structures" (Question 2), total of 85.71%.

Section 2: Knowledge questions

To look at significant changes in response for questions 16 through 31, right answers were assigned a 1 and wrong answers and "Don't Know" were assigned 0's in the McNemar's test of significance. Five of the seventeen questions did not show a significant change after training (Table 3). For example, Question 19 tested knowledge on whether cockroaches and dust mite allergens increased the severity of asthma attacks, and Question 20 tested knowledge on whether formaldehyde is one of the chemicals of concern in the indoor environment. These questions seemed to be well understood by teachers before training and were answered correctly by most prior to training. Most teachers already also knew that critical thinking on science projects is a focus before the high school level (i.e., starting in Middle school and at least by ages 13-14) and that air ducts need to be cleaned regularly (Questions 31 and 25). Very few teachers knew that there were 15 main leadership principles of Liberating Structures. The 15 leadership principles of liberating structures were not covered in the class and could only be found on the liberating website and in the prepared brochure on the topics. Possibly, not all teachers encountered this during the overnight assignment. This is an area that could be better emphasized during future trainings.

Questions	Pre-Right Answer	Post-Right	P-value	Missing Values	Right answer
16. Cleaning substances are listed by the Arkansas Poison Control Center as one of the most common poisons.	19	31	0.0005	2	True
17. The precautionary principle requires weighing cost and benefit of an action.	13	31	<0.0001	0	True
18. The Consumer Product Safety Commission does not have a database to search for chemical and physical properties of chemicals.	19	29	0.0016	1	False
19. The timing of exposure does not affect toxicity and health effects on the body.	25	30	0.0588	2	False
20. Formaldehyde is one of the chemicals of concern in the indoor environment.	27	32	0.0588	0	True
21. Professional applicators of pesticides around the home receive training and certification.	20	29	0.0201	1	True
22. Pests do not become resistant to pesticides over time.	29	31	0.0414	0	False
23. There are 5 principles to maintain a healthy home.	10	21	0.0116	1	False
24. Cockroaches and dust mites can increase asthma attack severity.	33	33	1.0000	0	True
25. Air ducts should be cleaned regularly.	33	34	na	1	True
26. Chemical Burns should not be rinsed with water immediately.	17	22	0.2513	2	False
27. The most common source of carbon monoxide poisoning is combustion appliances such as furnaces or gas stoves.	28	32	0.1025	1	True
28. The "9 whys" are one of the liberating structures used for communication.	4	32	<0.0001	1	True
29. There are 15 main leadership principles of Liberating Structures.	2	8	0.0339	0	True
30. The Physical Education and Health Framework contains strands related to PMCR.	9	28	<0.0001	0	True
31. Student projects are not focused on critical thinking until High-School.	27	30	0.2568	1	False
32. EPA has a safer product label for consumer products.	10	29	<0.0001	2	True

Table 3: Results for knowledge questions. Note: Pre and post-knowledge questions indicated that teachers made some improvements in their knowledge based on the day's training in the environmental areas of chemical use reduction and integrated pest management, and in the use of liberating structures (i.e., for questions with P-values less than 0.05). In a few areas, most teachers already had prior knowledge (e.g., Ques. 31. Critical thinking in the process of student science projects begins before high school).

Percent usage questions

The pre- and post-survey looked at what teachers believed to be the percent they used safe chemicals and pesticides around their own

home. Table 4 shows the results. Before training, teachers believed that, on average, 45.3% of the products they used around their homes were safe. That percent dropped to 35.9% after training. Prior to training, teachers believed that 36.8% of the pesticides they used around the home were safe. Following training, that percent increased to 41.6%. Teachers also showed some indication that they would be willing to replace some of the chemicals (44.7%) and pesticides (38.2%) with safer products following the training.

Questions	Pre-Avg (NS).	Std. dev.	Post-Avg (NS).	Std. dev.
I currently believe that of the cleaning products I use in my home _____% are healthy and safe.	45.3 (n=33)	27.4	35.9 (n=34)	26.9
I intend to replace _____% of the cleaning products in my home with safer and healthier alternatives.	na		44.7 (n=32)	25.3
I currently believe that of the pest control products I use in the home _____% are healthy and safe.	36.8 (n=29)	34.8	41.6 (n=31)	31.1
I intend to replace _____% of the pest control products in my home with safer and healthier alternatives.	na		38.2 (n=30)	26.1

Table 4: Results for usage questions. Note: The training served to educated teachers about chemical use reduction and integrated pest management around the home (i.e., two environmental health topics) to encourage them to incorporate these topics in their science curriculums for younger children. Following the training many teachers indicated they were willing, based on new knowledge from the training, to replace many of the products in their own home with safer products. Reported averages were however not significant (NS).

Discussion

This was a mature group of teachers, with 10 of the teachers age 40 and under and 25 over the age of 40. Based on the results of the pre- and post-surveys, for most of these teachers, this appeared to be a first introduction to the use of Liberating Structures for conflict resolution and their potential use in classrooms for the discussion of hard or conflicting science concepts. Pre- and post-results showed the most change in this area. We expected this, and, to our knowledge, this is the first training program introducing this topic to K-12 educators. We see it as a potential tool to help children understand more difficult topics and to voice their opinions on potential solutions to environmental health issues. Some similarity exists between Kagan structures, i.e., cooperative learning structures developed in the 1970's and used routinely in the classroom (e.g., Pair and Share), and the liberating structures presented here [32]. Kagan structures revolve around methods to promote equal involvement and concurrent interaction in the classroom with children, not unlike the intent of Liberating Structure originally developed for adults to resolve conflict and move towards solutions [33], in looking at scientific argumentation in a classroom, found that traditional classroom practices limited student interaction and opportunities of working collaboratively and understanding varying perspectives. Therefore, Liberating and Kagan structures, if used more routinely, may offer improved opportunities for critical thinking in the classroom setting.

There were some areas where teachers seemed to have a lot of pre-knowledge, for example, in the area of asthma triggers and sources of carbon monoxide poisoning. However, many teachers seemed to be unfamiliar with the concept of the precautionary principle. This is a foundational aspect of environmental education. For the environmental topics of IPM and CR, much uncertainty exists concerning long-term chronic health effects, and the precautionary principle is highly applicable. There also seemed to be more awareness of the health risks of pesticides than with chemicals used in the home and their potential health effects. This was expected, as many citizens, especially science teachers, have routinely heard in the news about concerns and regulations for pesticides. Concerns about chemicals we routinely use on our bodies and in our homes are of more recent concern and are now only just emerging in the mainstream news, along with concepts on aggregate exposures (i.e., exposure to chemicals that enter our body through the multiple routes of the skin, mouth and nose) and cumulative exposures (i.e., exposures to more than one chemical having the same biological adverse health effect). Teachers did, however, demonstrate previous knowledge about formaldehyde as a chemical of concern in the home environment, as this chemical is commonly understood as a chemical used as a disinfectant and preservative.

We believe that citizens, on becoming aware of potential concerns with the volumes and variety of chemicals used residentially and for personal care, will make choices to reduce usage. The training's intent was to create awareness but not offer definitive answers on health effects for all chemicals used in the home where the evidence did not exist. These teachers did indicate a desire to switch to healthier products (e.g., less volatile products like vinegar) or reduce usage. There was great variability among teachers on the extent to which they would replace the products in their home with healthier products. This may be based on current use of relatively safe products and the extent to which they thought replacement and reduction was needed or feasible in their home. This is, however, the kind of consciousness and thought process we hope teachers can pass on to students in their classroom.

Ultimately, for a more sustained transfer of knowledge of these and other environmental health topics from teachers to students, framework strands for student education could be specifically developed, and/or teachers would need to be introduced to these healthy homes concepts in their early training to promote knowledge transfer to students. Integrated pest management and chemical use reduction are concepts that touch close to home and pertain to every individual's health. They should be valued as important environmental topics to be encountered at an early and impressionable age. The importance of learning environmental risk is valuable at a young age, having the potential to create conscious citizens that work towards safer solutions for the environment and public health [34]. Noted some challenges in teaching environmental risk education to children, including supporting teachers through resources and trainings. Those challenges continue to exist today. Trainings, such as these presented

here, offer opportunities to teachers to enhance their knowledge of various and current environmental health and environmental risks topics; however, more consistent and systematic trainings for teachers across the nation is warranted. In a study of the educational needs of K-12 teachers to be able teach air quality in the classroom, authors found that teachers have little knowledge of how science works, including the scientific process, and how to develop innovative, inquiry based, active learning materials for the classroom [35].

Although, teachers in our program seemed more familiar with concepts encountered in the media (i.e., pesticide harms and harm of formaldehyde exposures), none had received formal trainings on healthy home topics including a more scientific and risk understanding of integrated pest management and chemical exposures. The United States National Science Teachers Association (NSTA) offers many partnerships and training opportunities for teachers nationwide [36]. Newer, challenging learning modules and training opportunities focused on environmental health can be promoted across the nation for science teachers through this Association. Additionally, with the presence of STEM centers in multiple states and regions, the opportunity exists to share this training experience through STEM networks (e.g., ASCE 2012).

New science curriculum standards for the United States have been recently developed with the active participation of 24 of the 50 states within the United States [37]. They are called "Next Generation Science Standards" and are mapped for possible full implementation by 2018 in the State of Arkansas. Other States, potentially, have varying timelines for adoption. The three dimensions of the new standards are: 1) "Practices," meant to promote inquiry and a range of cognitive practices, 2) "Crosscutting Concepts," meant to link different domains of science and promote a more realistic view of world, and 3) "Disciplinary Core Ideas," meant to focus the learning on issues of broad importance and be related to interests and concerns of students [37]. There is great opportunity for topics such as "Healthy Homes," "Integrated Pest Management in the Home," and "Chemical Use Reduction" to be introduced as a lesson plan in this new, more open, and dynamic science curriculum. In particular, once teachers receive proper support and training, the dimension of "Crosscutting Concepts" offers the prospect to demonstrate the aspects of the biology and chemistry curriculum that influence the justification and importance of chemical use reduction in the home, for example.

Study limitations: This study had some limitations. The small convenient sample size of 35 teachers and the training application in a State with its own specific K-12 curriculum may offer some bias in pre-existing experience on these environmental health topics. In addition, proficiency questions are subjective questions and measure the responder's own impression of knowledge growth on a topic. Therefore growth in knowledge may not be consistent across subjects. Despite these limitations, we believe this pilot study offered some insight into level of knowledge and areas for improved information sharing and training on key environmental health topics for K-12 educators.

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