CAN EDUCATION ELIMINATE THE ICK-FACTOR?: MEASURING ACCEPTANCE LEVELS OF RECYCLED WATER USE THROUGH EDUCATION

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Introduction

The ongoing drought in California has emphasized the need to develop alternatives to our water sources [1, 2]. One such alternative is increased reuse of treated wastewater to maximize the benefit of resources [1-3]. Despite the clear and present need for new water sources, public acceptance of recycled water remains limited [2, 4-6]. Based on years of research, public surveys and studies, experts within the water reuse community attribute ongoing public resistance to use of recycled water as stemming from two primary sources: the so–called "ick factor," and societal/cultural perceptions of risk related to its use [2, 4-7]. Educating consumers to better understand limited available supply, the water cycle, and the need maximize the benefit of local resources is surely a means to help improve public acceptance levels [4-6]. Research has shown that one of the most effective methods of developing acceptance is to begin at a young age to influence lifelong patterns [8]. This study explores whether a brief educational outreach experience in elementary school, middle school, and high school classrooms can affect students' perceptions about recycled water and reduce the "ick factor" for students involved.

Motivation

This study was developed out of a combined professional, academic, social, and parental interest. In discussions about generally held perceptions of recycled water, purple pipe, and the "toilet to tap" misnomer, we questioned where the "ick factor" comes from. Does consumer reluctance to embrace use of recycled water come from factual information or a *lack* of information? Or perhaps a lack of understanding the water cycle, and the fact that all water is essentially recycled water? These were questions necessary to explore if this general reluctance is to be diminished.

Our discussion then turned to successful educational campaigns that have shown positive and measurable results in shifting generally held perceptions. We noted that educational campaigns such as the school recycling programs and anti-tobacco programs generated community-wide increases in recycling [9] and nation-wide decreases in smoking [10]. We theorized that if educational programs were successful in changing perceptions about recycling and smoking, perhaps educational programs in public schools could produce similar results and increase acceptance levels of recycled water as a viable alternative to fresh water resources.

While researching the topic, we found the WateReuse Foundation's Illustrated Executive Summary for "Downstream: Research to Shift Community Attitudes on Water Reuse" [4] The Foundation's paper showed increased acceptance levels for the of use and consumption of recycled water after respondents were educated about the urban water cycle and were shown a presentation entitled "Downstream." Adults who participated in the research program were more open to use of recycled water after the program than before [4]. We decided to test if similar results could be achieved through a short educational presentation made to elementary through high school students.

Goals of the Study

Ultimately, the goals for this study were to determine the following:

- Do school-aged children have an understanding of the urban water cycle?
- Does education affect acceptance levels for using recycled water in school-age children?
- Does age play a role in the "ick-factor?"

When such acceptance can be fostered in children, it can have a two-fold benefit. First, those children serve as advocates among their families and peer-groups, increasing acceptance levels in the near-term as they share their knowledge [8]. Second, fostering acceptance of recycled water in younger generations leads to life-long acceptance, lasting change, and potentially a paradigm shift in attitudes toward recycled water [8].

We anticipate that the results of this study will be useful for developing appropriate educational opportunities for children and teenagers in an effort to develop increased acceptance of recycled water as an alternative water source.

Hypothesis

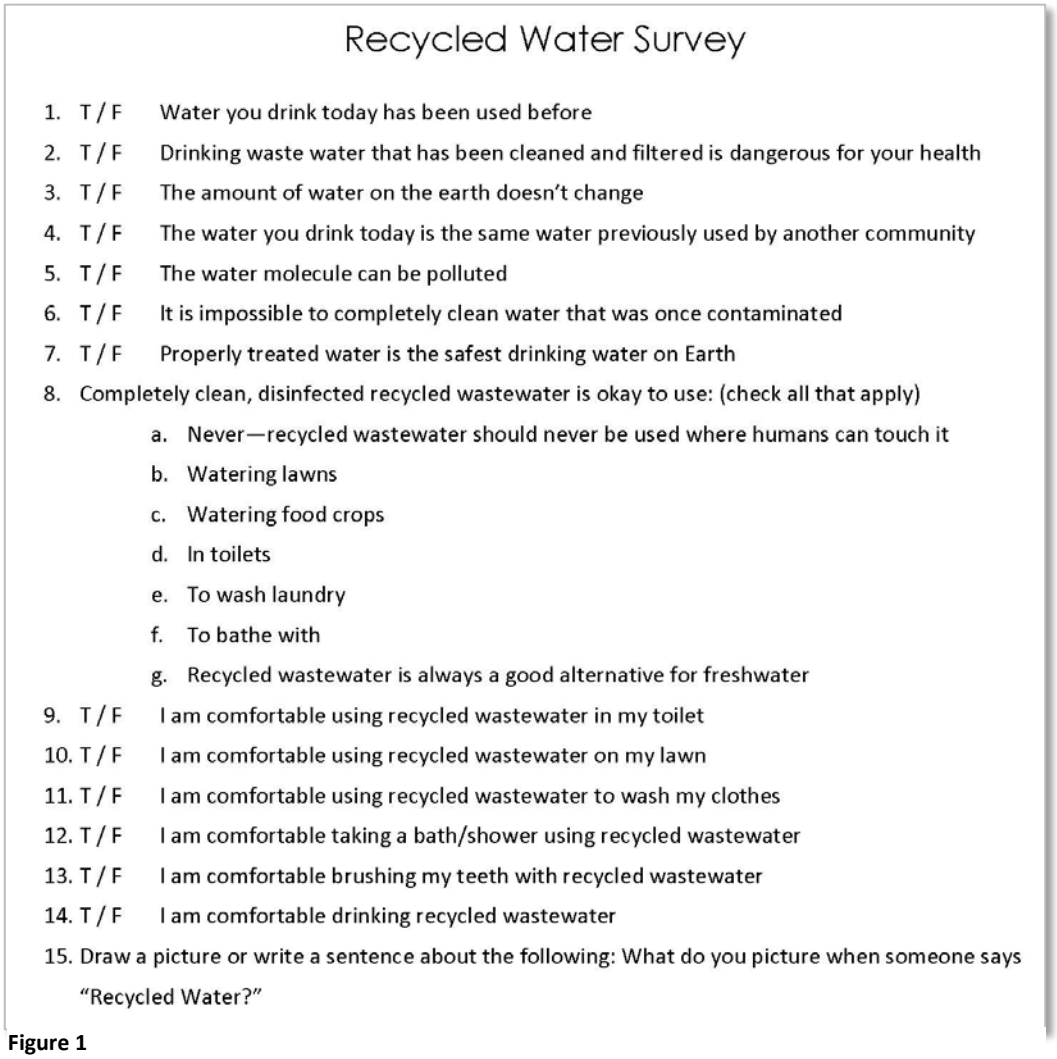
Based on previous studies such the WateReuse Foundation's successful results with a similar study focused on adults' knowledge and behavior [4, 5], we anticipated that our study would also show that acceptance levels for use of recycled water would increase following an explanation of the urban water cycle, water processing techniques, and the growing need for clean, drinkable water. Similarly, we anticipated that the educational experience would lead to a reduction of the "ick factor" throughout all age groups.

Methodology

This study was prepared to explore the perceptions of recycled water held by students in elementary, middle school, and high school, and to learn if and how education can affect those perceptions. To do this, we conducted a series of surveys to identify acceptance levels and specific areas of concern about

water reuse among different ages, both before and after an educational outreach experience. A copy of the survey is shown in Figure 1.

The survey was designed to measure participants' understanding of the urban water cycle, their acceptance levels associated with different types of uses of recycled water, and their comfort levels associated with increasing degrees of personal contact with reclaimed water. The final question in the first survey asks students to respond with a sentence or drawing that represents what they picture when hearing the term "Recycled Water," allowing for a more personalized response. The post-experience survey remains the same with the exception of this final open-ended question which asks students if their perception of recycled water changed after the presentation.



Recycled Water Survey

1. T / F Water you drink today has been used before
2. T / F Drinking waste water that has been cleaned and filtered is dangerous for your health
3. T / F The amount of water on the earth doesn't change
4. T / F The water you drink today is the same water previously used by another community
5. T / F The water molecule can be polluted
6. T / F It is impossible to completely clean water that was once contaminated
7. T / F Properly treated water is the safest drinking water on Earth
8. Completely clean, disinfected recycled wastewater is okay to use: (check all that apply)
   a. Never—recycled wastewater should never be used where humans can touch it
   b. Watering lawns
   c. Watering food crops
   d. In toilets
   e. To wash laundry
   f. To bathe with
   g. Recycled wastewater is always a good alternative for freshwater
9. T / F I am comfortable using recycled wastewater in my toilet
10. T / F I am comfortable using recycled wastewater on my lawn
11. T / F I am comfortable using recycled wastewater to wash my clothes
12. T / F I am comfortable taking a bath/shower using recycled wastewater
13. T / F I am comfortable brushing my teeth with recycled wastewater
14. T / F I am comfortable drinking recycled wastewater
15. Draw a picture or write a sentence about the following: What do you picture when someone says "Recycled Water?"

Figure 1

These surveys were distributed to select classrooms in local schools, most of which were located in San Luis Obispo[1] and Santa Maria, California[2]. Students ranged in age from third grade through high school. Responses were grouped according to age range: Elementary (3rd grade through 5th grade); Middle School (6th grade through 8th grade); and High School (9th grade through 12th grade).

Prior to the classroom visit and the educational presentation, teachers facilitated the students taking the first survey. We then visited each classroom and conducted a 30-minute educational presentation.

[1] San Luis Obispo is located approximately 200 miles south of San Francisco and 200 miles north of Los Angeles.
[2] Santa Maria is within northern Santa Barbara County and is about 30 miles south of San Luis Obispo.

The presentation included the following elements:

- "Downstream" slideshow developed by the WateReuse Foundation (https://www.watereuse.org/node/1795)
- A video presentation also produced by the WateReuse foundation called "The Ways of Water." (https://www.watereuse.org/foundation/ways-of-water)
- An in-depth description of the urban water cycle brought to life through a visual graphic. (Figure 2)
- A hands-on experiment involving three glass jars filled with water from three different sources: bottled, tap, and recycled water from the San Luis Obispo WWTP. During this segment, students were asked to make observations and conjectures as to which water was the recycled water.
- A follow-up discussion and question-and-answer session with the students.

At the conclusion of the question-and-answer session, we administered the second survey.

We recorded survey results, both before and after the presentation, in an excel database to enable us to review and determine any correlation between the educational experience and both knowledge and opinions regarding recycled water use.

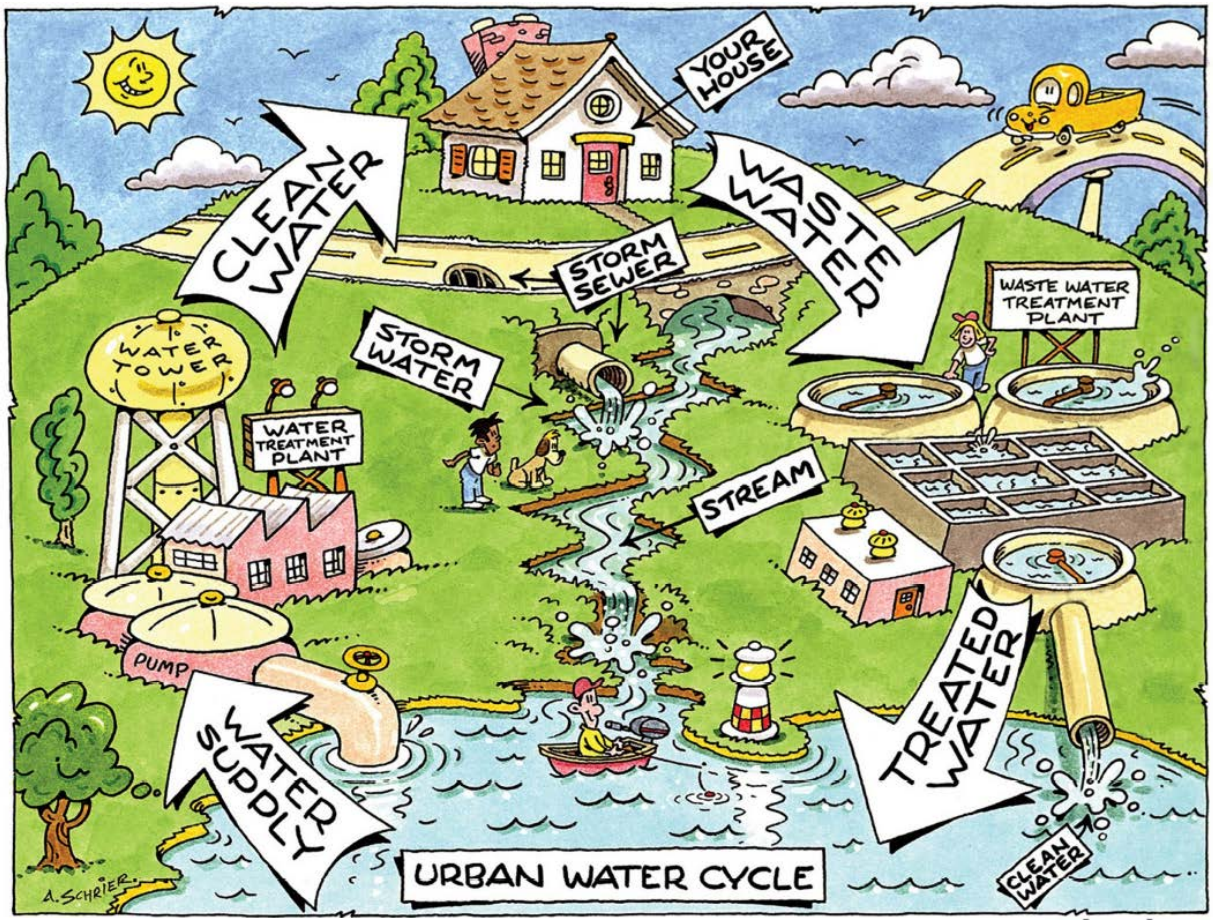


Figure 2

Results and Discussion

Questions were divided into two categories: knowledge-based and opinion-based. Questions 1 through 7 are questions based on facts. The remaining questions assess students' level of comfort about specific activities or levels of personal contact regarding recycled water. The discussion below addresses response to the knowledge-based questions as a group and the opinion-based questions as a second group. A graphic summary of responses to each question on the survey, both overall and broken down by age group, are included as an Appendix to this report.

Knowledge-based Questions

In the knowledge-based questions, the "Before" answers are indicative of students' general level of background knowledge regarding water, water and wastewater treatment, and reuse. This material would typically be covered in science classes or class discussions on environmental sustainability [11].

Figure 3 shows the overall results of correct versus incorrect responses for Questions 1 through 7, as a group. The "After" results support the expectation that the information provided in the educational experience allowed students to more successfully respond to the knowledge-based questions. The rate of correct responses increased from roughly 47% correct before to 70% correct after.

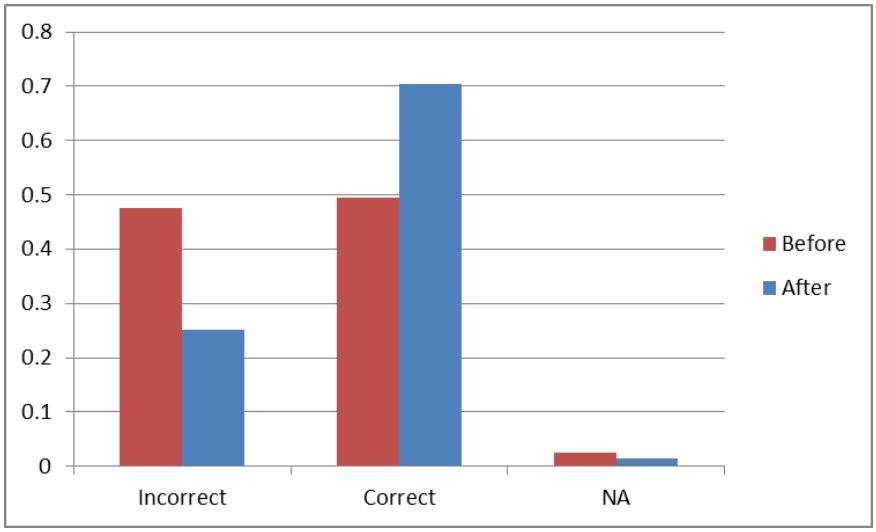


Figure 2

Perhaps more interesting, the "Before" results show a roughly 50%/50% successful response rate. As questions required true/false response, this result is statistically the same response we would expect from guessing. This result suggests that science and environmental sustainability discussions in classrooms are not currently focusing on water and water reuse. While many teachers in public schools feel forced to teach "to the tests" to achieve an acceptable pass rate on standardized tests [12], as Common Core Standards become more prevalent in classrooms, they will require more hands-on and applied outlets for instruction [11]. Our results suggest that the

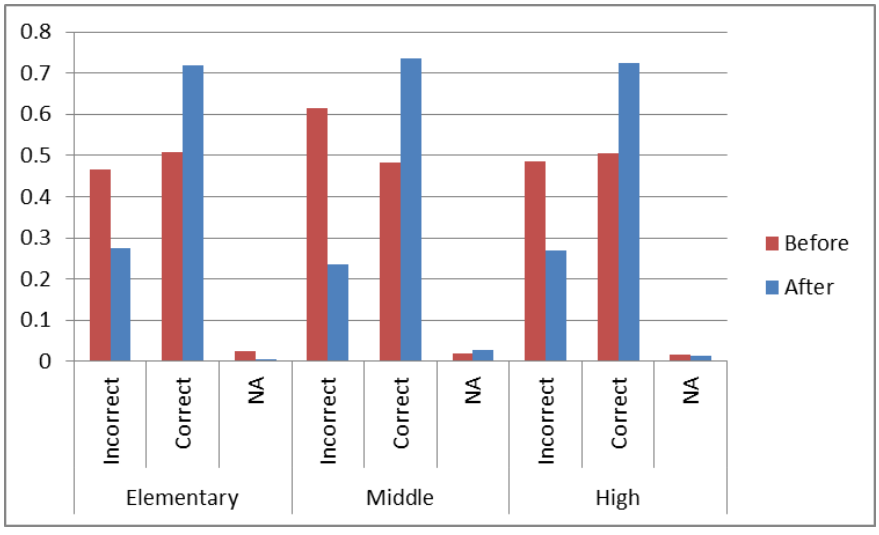


Figure 3

WateReuse Foundation may have an opportunity to develop classroom instruction modules that address scientific application of water and water reuse concepts and comply with Common Core Standards. Such modules would benefit teachers, students, and ultimately water consumers [11].

Figure 4 shows the overall knowledge-based results, broken down by age-group. Again, the "Before" results provide the most interesting insight. We had expected that knowledge about water science would improve as education levels increased. However, results remained approximately the same as guessing, across all age levels. While water science and environmental sustainability classroom education modules can be tailored to fit any age level, they are perhaps especially necessary in the high school level. High school students are making their decisions about whether or not to attend college and what major to pursue once there. Given the anticipated need for increasing numbers of graduates in Science, Technology, Engineering, and Math (STEM) fields in the next decade [13], getting high school students interested and excited about the importance of water reuse and environmental engineering may boost the number of those intending to enter the field. Our results suggest that current science instruction is not adequately addressing this area.

Opinion-based Questions: Understanding the "Ick factor"

Question 8 best summarizes the overall results of the opinion-based questions. Question 8 was designed to determine students' comfort levels with increasing levels of personal contact with recycled water, from watering lawns (Point 1 on the "Degree of Contact" scale) to using recycled water as a universal replacement for fresh water (Point 6). Figure 5 shows the expected result that, as the degree of personal contact increases, students' comfort levels decreased.

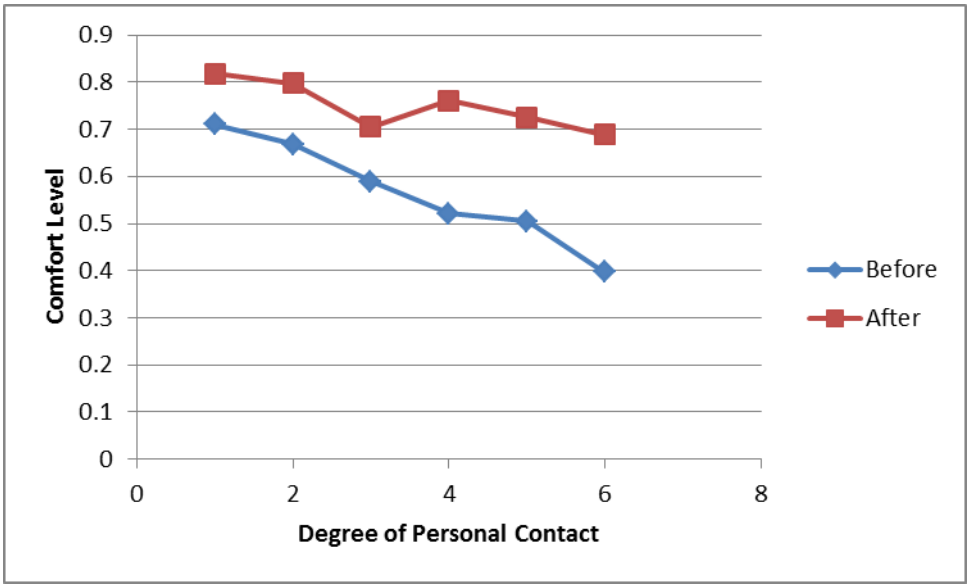


Figure 4

It is encouraging that the "After" results indicate a much-higher level of comfort, across all levels of personal contact, than the "Before" results. These data support our hypothesis that education would reduce the "ick-factor" associated with use of recycled water. Even a brief educational experience with minimal opportunity for interaction yielded this encouraging result. This result suggests that on-going education about water treatment, recycled water, and its importance in sustainable management of our water resources will indeed yield a reduction in the prevalent bias against more wide-spread use of recycled water.

Question 8a is not represented on the above figure, but it did provide an interesting result that merits discussion. Question 8a represented an extreme view: "recycled water should never be used where humans can touch it" and received agreement from less than 10% of the students, both before and after the survey. On a positive note, the vast majority of respondents felt that there is definitely some place for

using recycled water as part of water resource management, even before their educational experience. While the extent of that acceptable use might vary between respondents, there is already openness to the concept. On a less positive note, approximately 10% of respondents agreed with this statement even after the educational experience. It is apparent that some people will require more than a single brief educational experience to change their opinions.

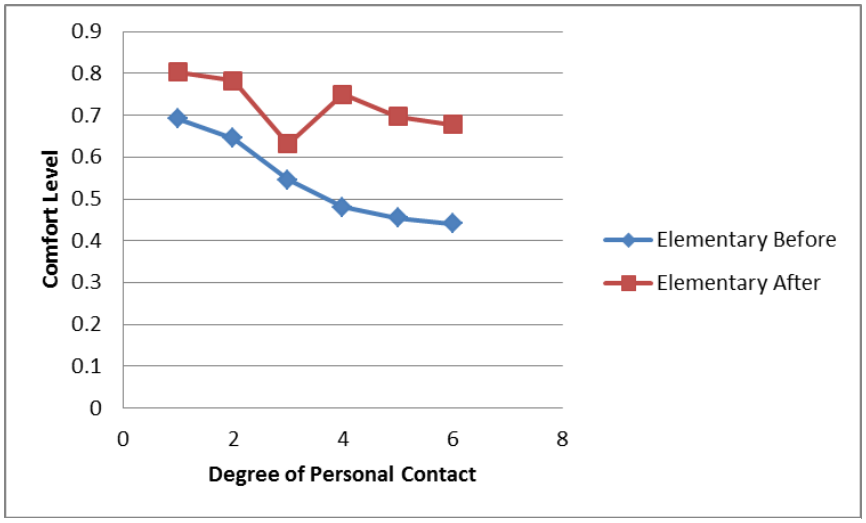


Figure 5

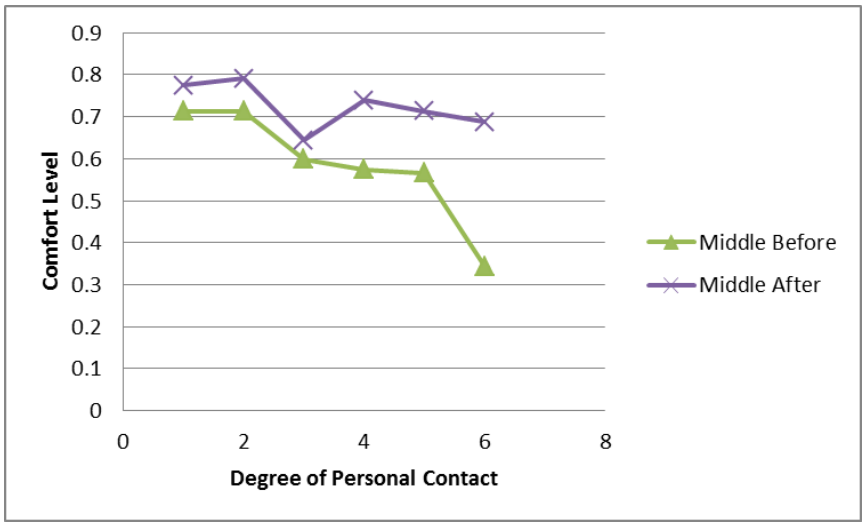


Figure 7

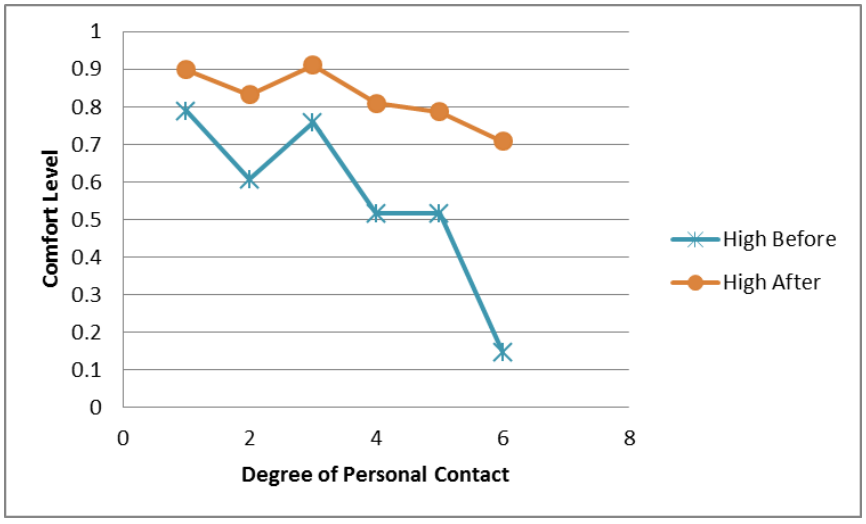


Figure 8

The question remains: is this 10% a highly vocal minority, keeping the alleged "ick-factor" relevant far longer than it is actually a concern for the larger majority? This question poses an opportunity for further study, or perhaps directed inquiry to those 10% who remain uncomfortable with use of recycled water.

Figures 6 through 8 show the breakdown of responses to Question 8 by age group. Elementary and Middle school students showed very similar responses overall, with virtually identical responses seen in the "After" data. High school students show similar trends as their younger peers, though in generally they seem to more strongly opinionated: "Before" responses show a lower comfort level in general than the younger students, and "After" responses show a higher comfort level. This trend probably indicates that (a) older students have a greater reaction to the "ick-factor" (young children being notoriously fascinated rather than repelled by the disgusting). Further, high school students are probably more responsive to

scientific arguments to change their opinion. They may have understood the material better than the younger students or simply have more scientific training at this point in their educations that allows them to more readily understand new information and adapt their pre-conceived opinions.

This result strongly encourages further education. Even at the high school level where "Before" opinions were expressed most strongly, students responded to the educational experience with increased levels of personal comfort – a reduction of "ick-factor" response, if you will. While the results were most dramatic at the high school level, our results clearly indicate that all groups showed a positive response to the educational experience, justifying appropriately-developed education in water reuse and sustainable water management at all levels.

Limitations of the Study

As with any study, limitations are bound to exist. We have defined the following limitations inherent in our study. These limitations present an opportunity to broaden our scope of work in future studies.

Response Continuity

When we developed our strategy, we wanted students to have anonymity. Responses were left anonymous, and responses were simply grouped by age level. It would have provided interesting to data to see how each individual's perspectives changed had we been able to track each student's change in perspective and define the variances. This might have provided insight into what information or aspect of the presentation specifically was effective, or ineffective, in causing students to change their opinions.

Vocabulary

As some of the vocabulary exceeded younger participants' understanding, our data could have been skewed. This is especially a concern for the pre-survey responses, where they did not have an opportunity to ask questions and clarify understanding. Indeed, many of the pre-survey responses show a 50% T/F response rate, which indicates students were likely guessing, possibly because they did not understand the vocabulary used in the question. However, the high school students showed the same response rate for the knowledge-based questions, and it is likely that the words at least were familiar to the high school students, even if not the concepts that the words represented. (That is, they understand the words "water" and "recycle" if not the concept of recycled water). When considering adjustments to vocabulary in future studies, addressing the conceptual level of understanding is the key focus rather than word choices alone.

Limited Demographics

San Luis Obispo is home to California Polytechnic State University and boasts a well-educated, fairly affluent, and mostly white residential base. Santa Maria has a higher Hispanic residential base with many of the students speaking primarily Spanish in the home. While pulling data from the two cities provided a more diverse sampling, most of the data came primarily from students living in San Luis Obispo. Having a wider and more diverse demographic could have provided more significant results.

Figure 9 shows a comparison of "Before" and "After" responses to Question 8 for the Middle school students from Santa Maria (SM) compared to those from San Luis Obispo (SLO). While the San Luis Obispo sample size is considerably smaller than the group of Santa Maria students, the two samples show decidedly similar trends, both before and after the education experience. Though only limited conclusions can be drawn from these results, they suggest that the results from the educational experience are consistent across the diverse range of students represented in these samples.

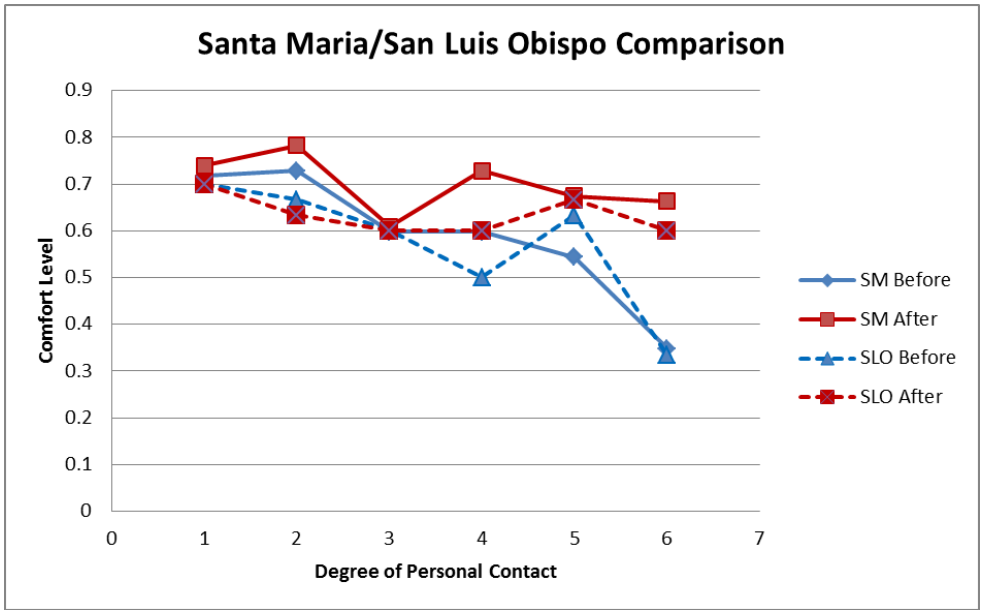


Figure 9

Sample Size

Ultimately, our sample size could have been larger; however, our results show a significant difference between before and after responses. We feel confident in our conclusion that educational programs work in the schools to improve knowledge, reduce the "ick factor" and ultimately improve overall acceptance of recycled water usage.

Conclusions

Through our research, we were able to determine the answers to each of the questions this study intended to address.

Do children have an understanding of the urban water cycle?

The survey questions which tackled the urban water cycle in the first survey resulted in a higher instance of wrong answers which translates that the students were unfamiliar with the urban water cycle. The survey results that followed the educational session yielded an increase in correct answers regarding the urban water cycle. In short, students did not have an understanding of the urban water cycle prior to our educational session, but they showed a greater confidence in response to questions about the urban water cycle after the presentation.

Does education affect acceptance levels for using recycled water in school-age children?

Based on the results outlined above, we have concluded that educational outreach—even a short, 30 minute presentation—produces a measureable reduction of resistance to the use of recycled water. Providing students with scientific information about the urban water cycle, material regarding technological advances in water purification, and the importance of recycled water as part of our larger water management system, does indeed result in an overall reduction of the "ick-factor."

Does age play a role in the "ick-factor?"

Our research concluded that the older students were, the more likely they were to resist close-contact use of recycled water, prior to the educational experience. Encouragingly, the educational outreach resolved much of the initial existing "ick-factor" held by students and yielded in a higher acceptance level with its use. Further, this acceptance level is fairly consistent across all age levels. This results support the need for greater educational outreach to students of all age levels to develop broad-scale reduction in the resistance to use of recycled water and ultimately, hopefully, eliminate the "ick factor."

References

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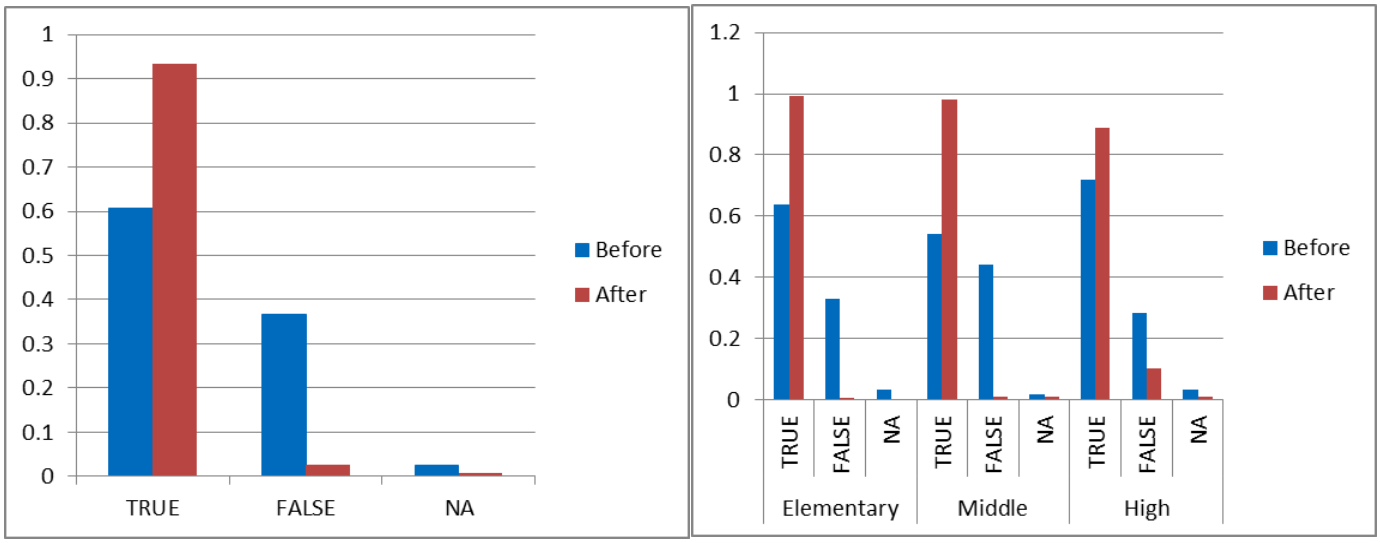
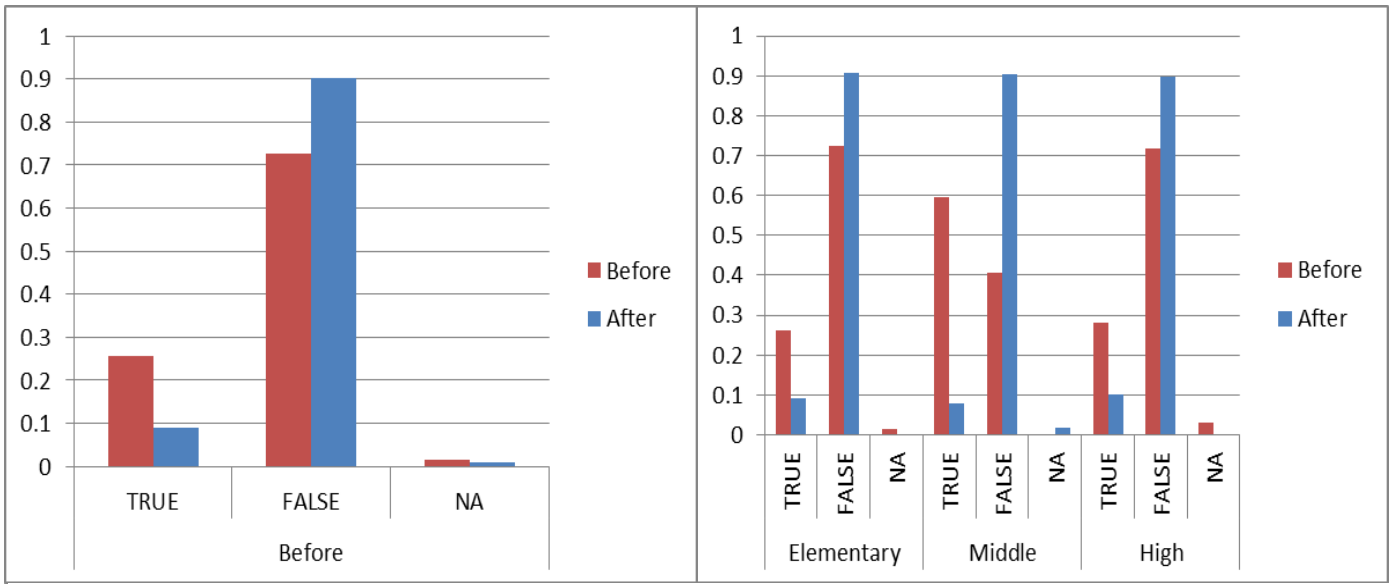
Appendix

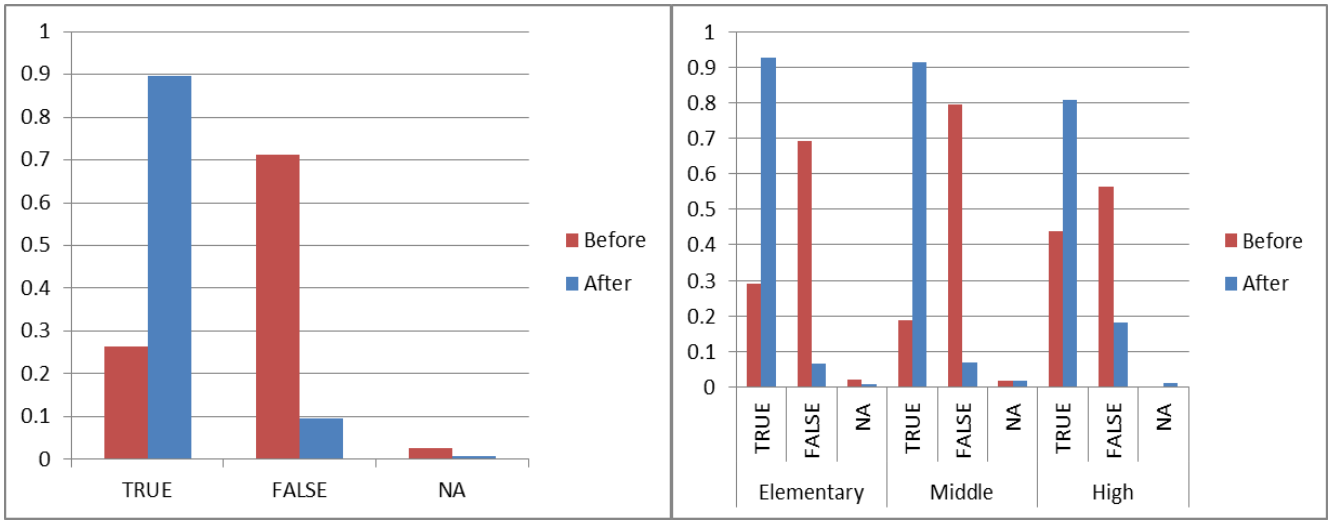
Figures below show the results of each question, both overall and broken down by age group. The text for each question is shown in the figure caption.



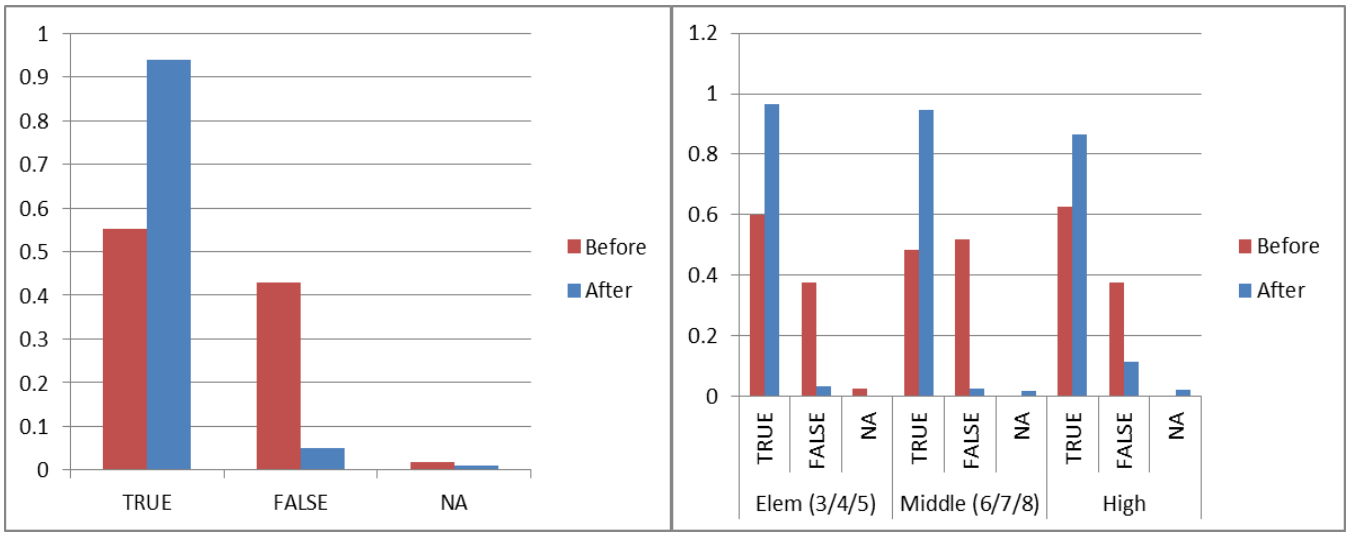
Question 1: Water you drink today has been used before.



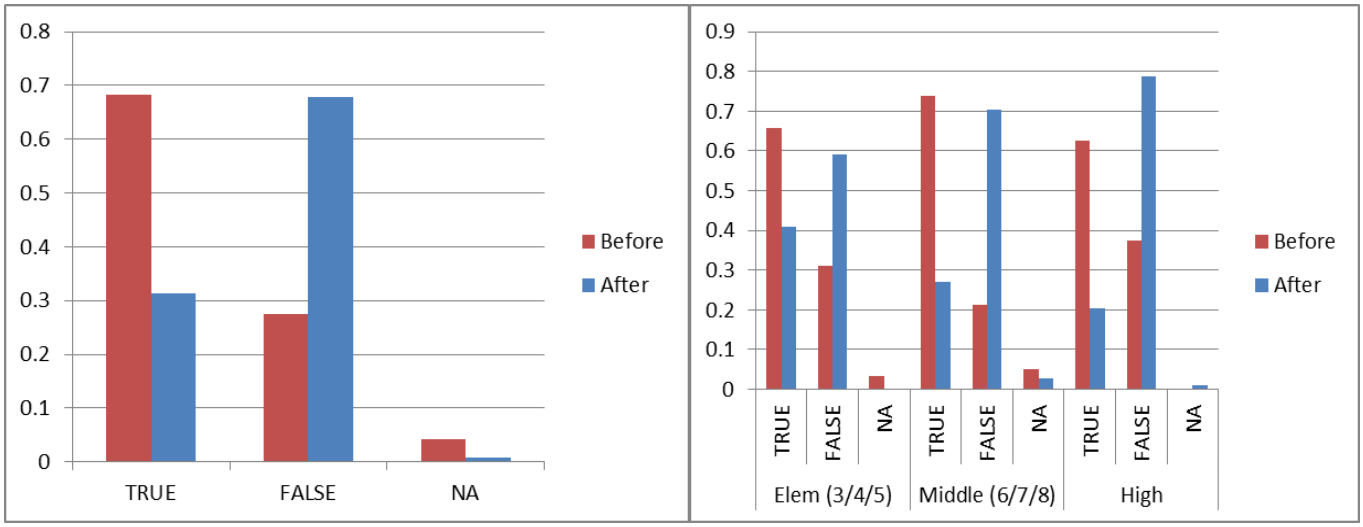
Question 2: Drinking waste water that has been cleaned and filtered is dangerous for your health.



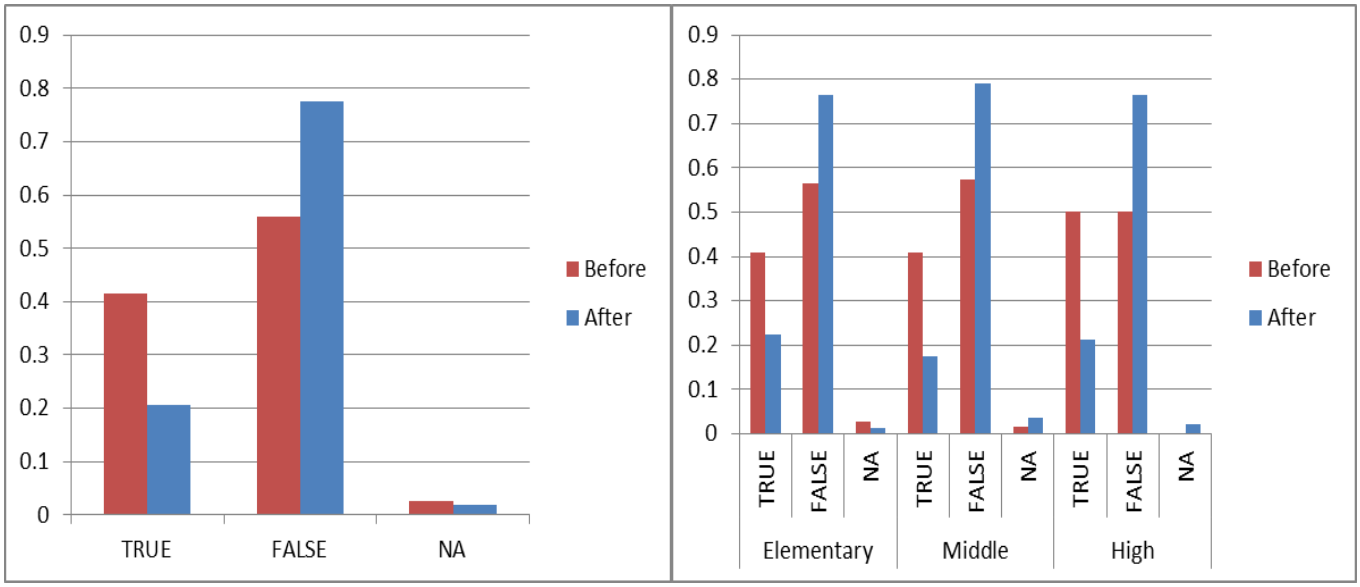
Question 3: The amount of water on earth doesn't change.



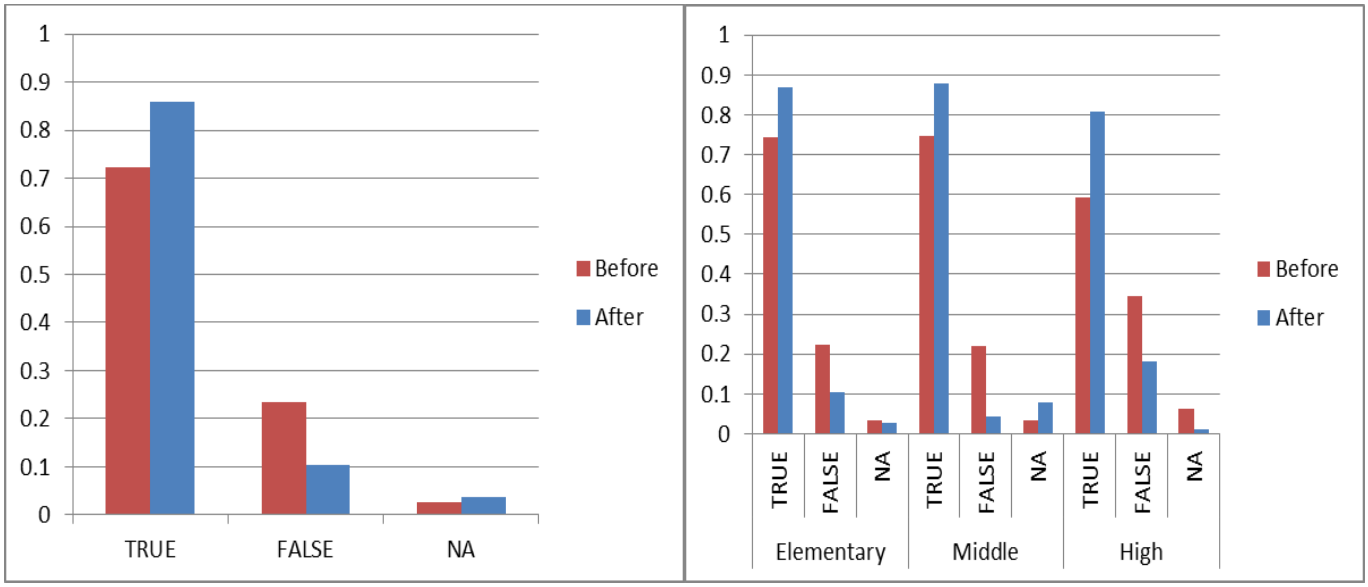
Question 4: The water you drink today is the same water previously used by another community.



Question 5: The water molecule can be polluted

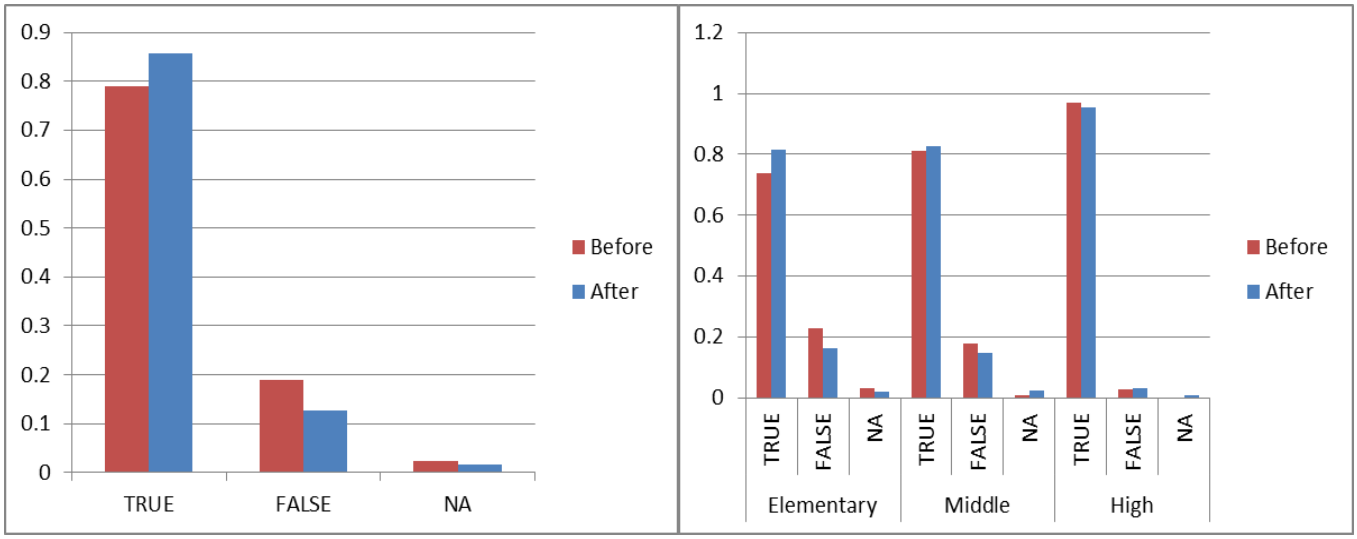


Question 6: It is impossible to completely clean water that was once contaminated.

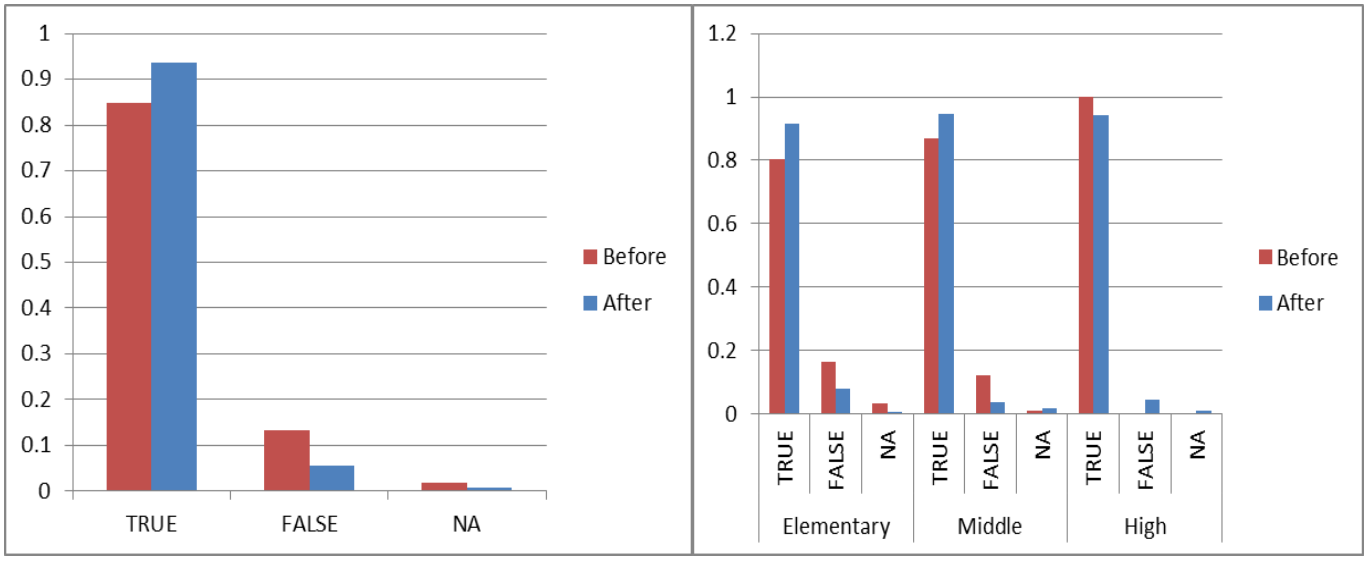


Question 7: Properly treated water is the safest drinking water on earth.

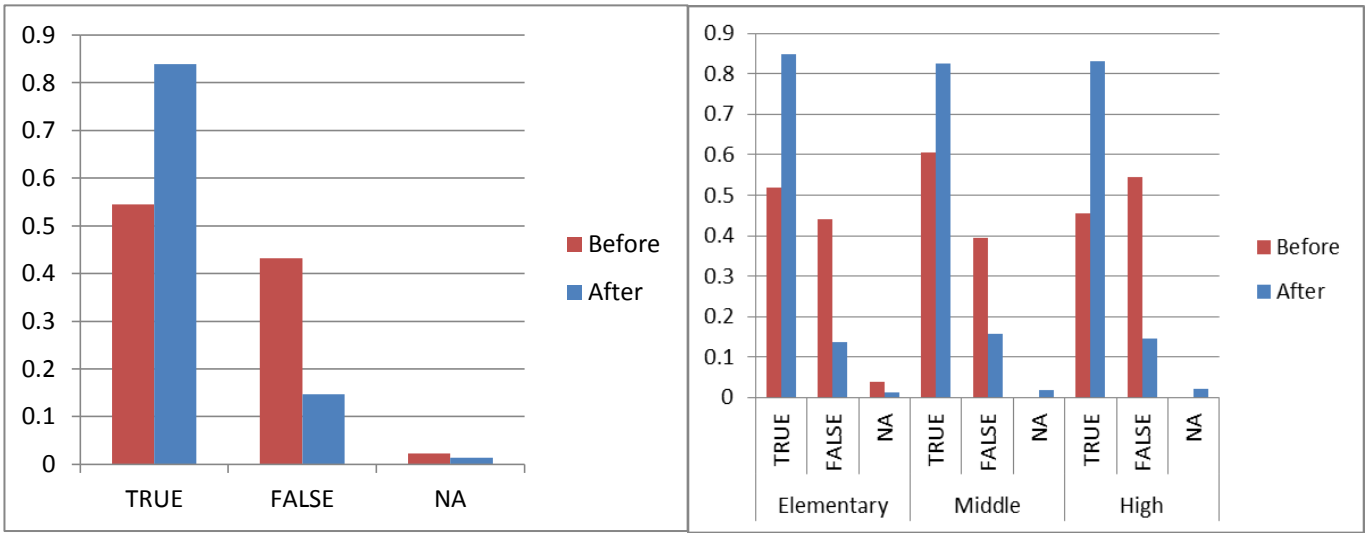
Question 8 results are shown in the main text.



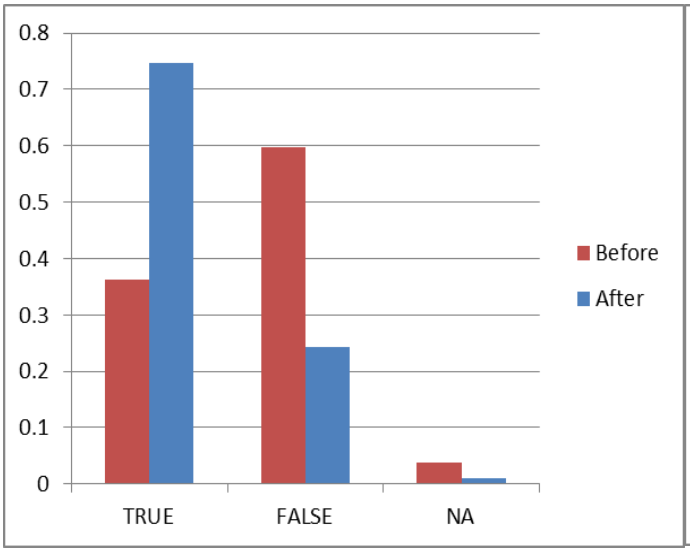
Question 9: I am comfortable using recycled water in my toilet.

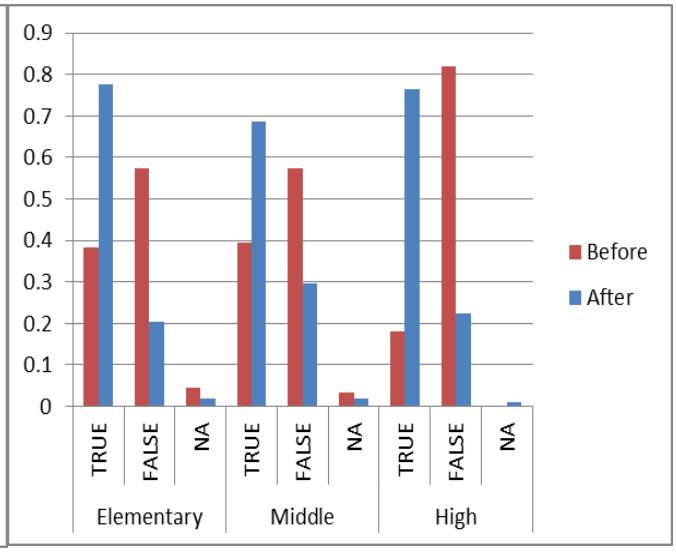


Question 10: I am comfortable using recycled water on my lawn.

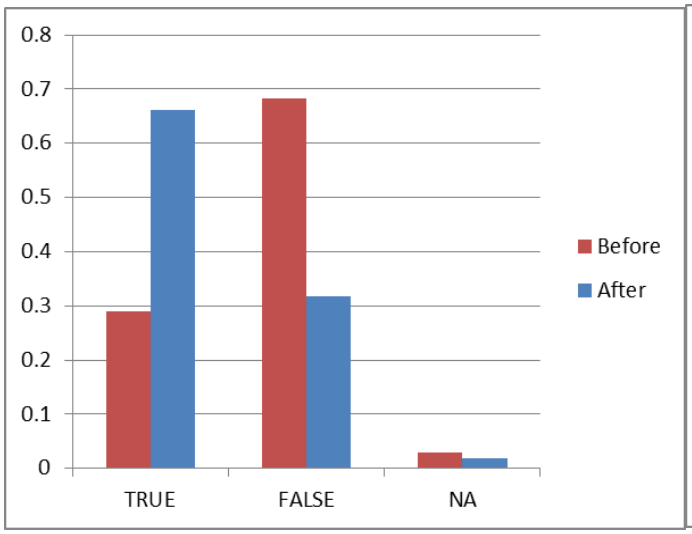


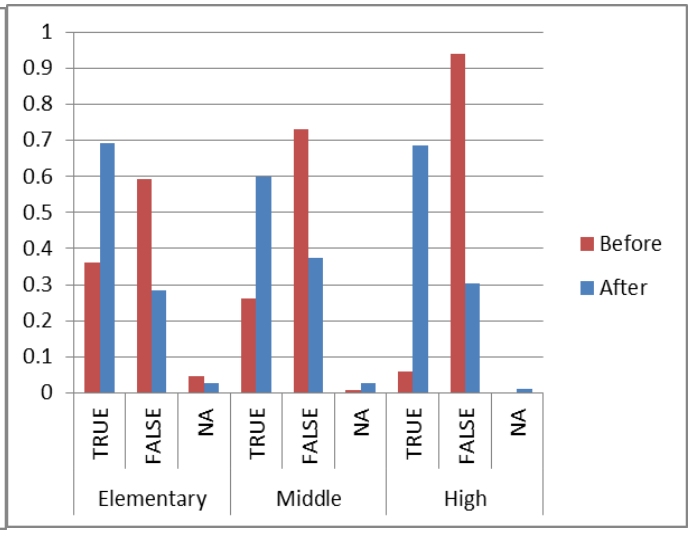
Question 11: I am comfortable using recycled water to wash my clothes.



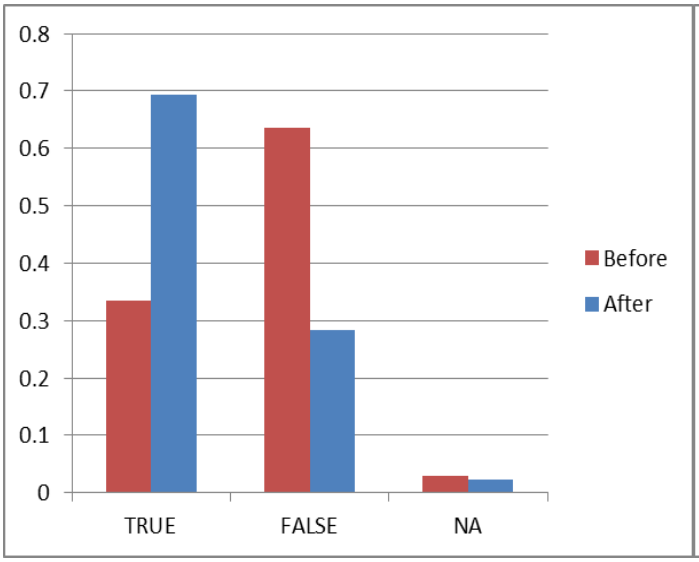


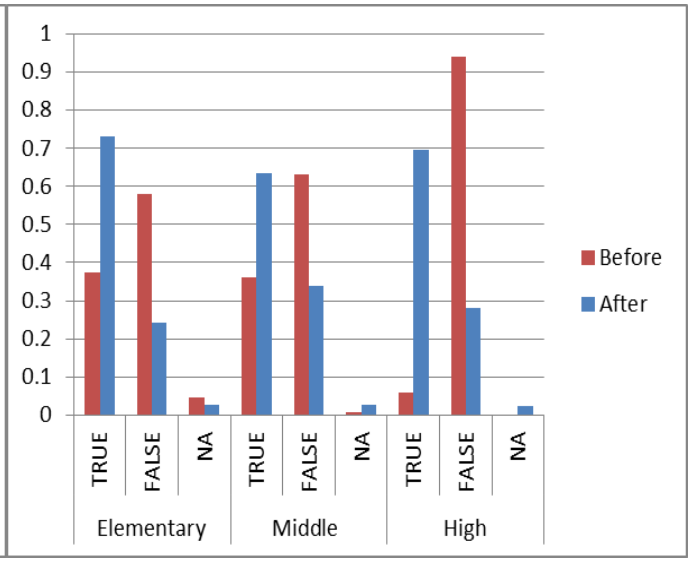
Question 12: I am comfortable taking a bath/shower using recycled water.





Question 13: I am comfortable brushing my teeth with recycled water.





Question 14: I am comfortable drinking recycled water.