



ACTIVITY 10

Solutions Through Scientific Optimism

PRESENTATION

ACTIVITY 10

Solutions Through Scientific Optimism

ACTIVITY SUMMARY

Students brainstorm solutions for addressing global needs for clean and accessible water. They then read about some of the most common proposed solutions to global water needs and identify connections to some key ideas of the unit. Students select a community to represent and research specific aspects of its water needs. They propose a plan for addressing these water needs and communicate an aspect of their proposal by creating a public service announcement (PSA). They revisit decisions made in Activity 1 and elsewhere in the unit.

ACTIVITY TYPE
PRESENTATION

NUMBER OF
40-50 MINUTE
CLASS PERIODS
3+

KEY CONCEPTS & PROCESS SKILLS

- 1 New scientific tools and techniques contribute to the advancement of science by providing new methods to gather and interpret data and can lead to new insights and questions. Technology can enhance the collection and analysis of data.
- 2 The development of scientific knowledge is iterative; it occurs through the continual re-evaluation and revision of ideas that are informed by new evidence, improved methods of data collection and experimentation, collaboration with others, and trial and error.
- 3 Scientific optimism enables scientists to solve difficult problems over long periods of time.
- 4 Through science, humans seek to improve their understanding and explanations of the natural world. Individuals and teams from many nations and cultures have contributed to the field of science.

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTION:

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations). (*Science and Engineering Practice: Engaging in Argument from Evidence*)

CONCEPTUAL
TOOLS



VOCABULARY DEVELOPMENT

public service announcement

(assumed prior knowledge)

an educational message created to raise awareness and change people's attitudes or behavior

BACKGROUND INFORMATION

Cryptosporidium Outbreak

The case of Skipton was based on a real outbreak caused by a microscopic parasite known as *Cryptosporidium* that occurred in Milwaukee, Wisconsin, in 1993. Between March and April 1993, approximately 403,000 people experienced symptoms of gastroenteritis including diarrhea, vomiting, and stomach pain. About 4,400 people were admitted to hospitals, and at least 69 people, most of whom were immunocompromised (had impaired immune systems), died. The cause of the outbreak was linked to the inefficiency of one of the two drinking water treatment plants drawing water from nearby Lake Michigan. Immediately before the outbreak, strong spring thunderstorms had increased the lake turbidity, causing an increase in the passage of particulates—including *Cryptosporidium*—through the water-treatment plant. As a result of such outbreaks, treatment plants now test for this and other microscopic parasites.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- LIST OF GLOBAL WATER SOLUTIONS from Activity 8, Procedure Step 4
- VISUAL AID 1.2 "Scoring Guide: Evidence and Trade-Offs (E&T)" (OPTIONAL)
- CLASS CONCEPT MAP FROM ACTIVITIES 1 AND 5 (OPTIONAL)
- ITEM-SPECIFIC SCORING GUIDE: Activity 10, Build Understanding item 3

FOR THE CLASS

- COMPUTERS WITH INTERNET ACCESS

FOR EACH STUDENT

- STUDENT SHEET 10.1 "Water Solutions and Key Concepts"
- STUDENT SHEET 10.2 "Research Notes for a PSA"
- STUDENT SHEET 10.3 "Evaluating Websites" (OPTIONAL)
- VISUAL AID 1.2 "Scoring Guide: Evidence and Trade-Offs (E&T)" (OPTIONAL)
- MATERIALS REQUIRED FOR PSA

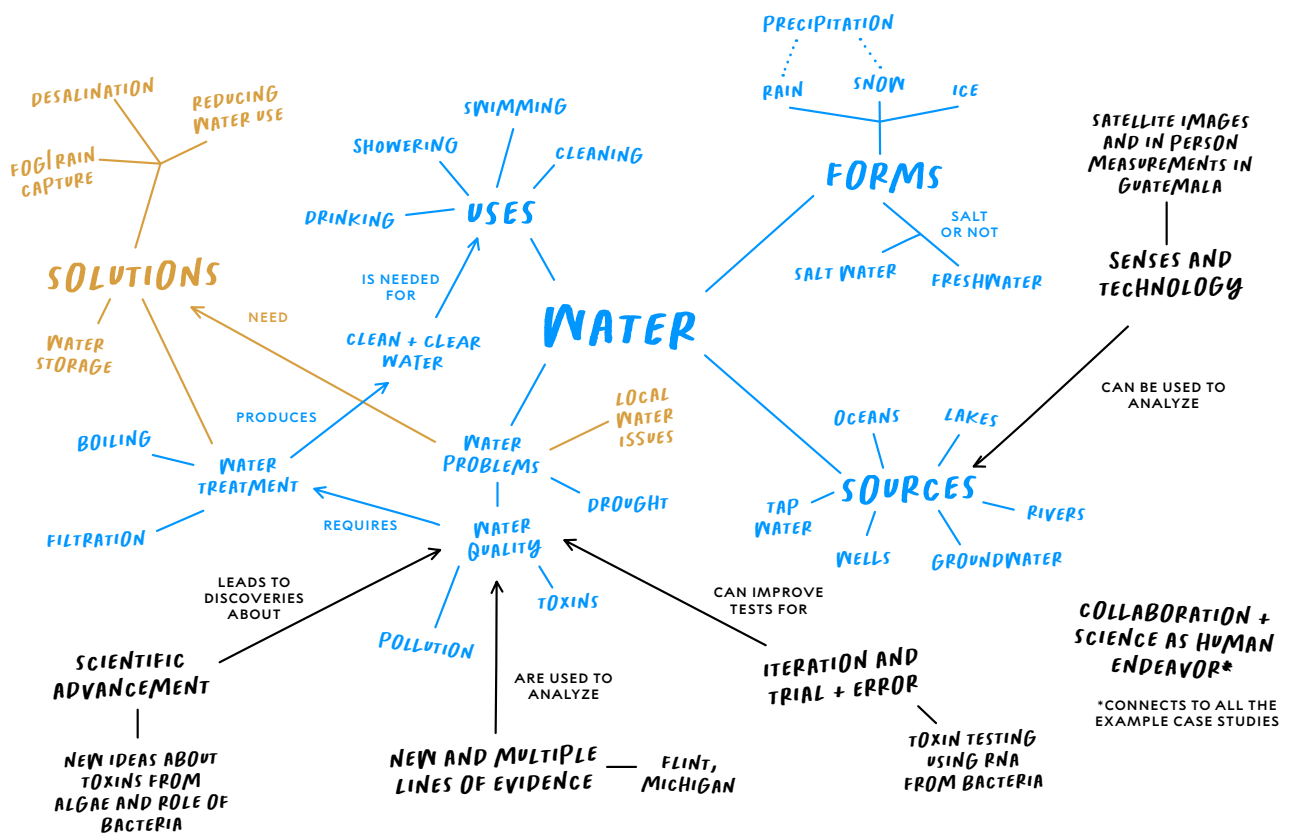
TEACHING NOTES

Suggestions for **discussion questions** are highlighted in gold.
 Strategies for the **equitable inclusion** are highlighted in blue.

GETTING STARTED (10 MIN)

1 Revisit students' list of global water solutions from Activity 8.

- Review the list of global water solutions students suggested in Activity 8, Procedure Step 4. Ask, **Have you thought of any new ideas since you last brainstormed these ideas? Would you revise your ideas in any way?** Inform students that they will have the opportunity to add to or revise their thinking in this activity.
- Either verbally summarize or read the introduction in the Student Book to highlight other recent innovations in the field of water quality and accessibility. You may wish to build on the class concept map created in Activities 1 and 5, either here or at the end of the activity. A sample concept map is provided here:



PROCEDURE SUPPORT (90-120 MIN)

2 The class brainstorms a list of the water issues raised in the unit.

- Since this activity both provides an opportunity for students to express their own open-ended ideas and describes current work in the field, consider conducting the first part of the Procedure without the use of the Student Book.
- Work together to summarize a list of the water issues raised in the unit, such as :
 - water contamination by chemicals and organisms that live in water and can make people sick (*Cryptosporidium*, cholera, algae blooms)
 - increasing global water scarcity
 - uneven distribution of freshwater resources
 - any locally relevant water issues that have been raised over the course of the unit such as issues related to water contamination, disrupted water lines, drought, pollution of local lakes and rivers, and wastewater treatment
- Compare this list to the concept map created in Activity 1. Add new ideas from this list to the concept map.
- Discuss how student ideas have changed over the course of the unit and any new ideas and questions they may have about global water needs.
- Read the introduction in the Student Book. Students may be interested in knowing that some elements of the Skipton scenario are based on an actual outbreak of *Cryptosporidium* that occurred in the drinking water of Milwaukee, Wisconsin, in 1993. Prior to that outbreak, drinking water was not routinely tested for the presence of the *Cryptosporidium* parasite. As students have learned, drinking water is now tested for *Cryptosporidium*, and water quality standards have set a limit of 0.

3 Student groups work together to brainstorm solutions to a specific water issue.

- Student groups should select one of the water issues that were identified by the class and brainstorm solutions to addressing that specific issue. Encourage students to be as innovative as possible and not to be constrained by issues of cost, etc. Students can record their ideas in their science notebooks.
- Student groups should discuss the role of scientific tools and scientific optimism in their proposed solutions.

- You may wish to have students share their ideas with the class and to compare their ideas with their previously brainstormed list. For example, in Activity 8, one sample student idea was:

I would like to make something that could turn shower water into drinking water or water for plants. It is a waste for shower water to just go down the drain. It would need to be filtered to get all the soap and dirt out first.

- Have students describe in what ways they revised their initial ideas. Ask, **What solutions were particularly strong and were proposed both times?** Have students share their thinking. Students may propose the same ideas and have suggestions for improvement, such as using a filter for cleaning the water.

4 Students learn about eight current approaches to addressing global water needs.

- The Student Book describes eight current approaches to addressing global water needs: water conservation, water storage, water transportation, water recycling, desalination, nature-based solutions, rainwater capture, and geological “paleo valleys.”
- Assign each paragraph to one student group, give them 5–10 minutes to work, and have them create a quick summary of the information for the class, in their own words.
- Hand out Student Sheet 10.1, “Water Solutions and Key Concepts,” which lists four of the key concepts from the unit. While listening to group summaries, have students mark which of these ideas are represented in each approach. While a sample student response is provided, there is not one correct response. Engage students in explaining their ideas.
- Students may note the obvious benefit of these solutions. They may also have questions or concerns about potential disadvantages or other impacts. Ask, **What do you think are the disadvantages of any of these solutions? How do you think they could be overcome?** For example, one disadvantage of water conservation is that it relies on individuals to change their behavior, which is not easy to do. Many local governments provide financial incentives and disincentives to push people to make changes more quickly.

5 Students research global water issues for a particular region.

- Students are asked to research water issues for a particular region. Hand out Student Sheet 10.2, “Research Notes for a PSA,” as a place for students to record their research. A sample student response can be found at the end of this activity. Point out that students are expected to record their source of information as well as their notes. You may want to provide Student Sheet 10.3, “Evaluating Websites,” as a guide to determining the reliability of websites, which is related to the conceptual tool of determining credible sources.
- **Depending on your student population and available resources, this research task can be as open-ended or as constrained as you wish to make it. It is relatively easy to find out general information about drinking water sources and water issues for various countries and regions around**

the world by simply performing an Internet search. If your students are having trouble choosing a location or you would like to make sure to have a variety of water issues and solutions represented in the research, consider making a list of locations, along with a couple suggested websites to start with, for students to choose from. The regions of the Middle East and North Africa are currently the worst off globally in terms of water stress, and solutions are not limited to increasing water quality or access. For example, the United Arab Emirates (UAE) imports nearly all its food as a way to bypass the need to use large amounts of water for local agriculture. Another suggestion is to have students focus on different water issues and solutions in your own region or country. For example, in the United States, different regions of the country experience different water challenges: The Southwestern United States is experiencing an extreme drought; parts of the Midwestern and Southern United States often experience flooding; and other regions, such as Newark, New Jersey, have aging drinking water infrastructure that affects clean water access.

- Students can begin by typing the country/region they are investigating, along with the phrases “primary source of drinking water” or “water issues” to find out where most people get their water and what the most pressing concerns are in that region.
- Students are likely to have the greatest challenge in identifying currently utilized solutions in each area. Students may want to use the phrase “water problems and solutions in . . .” to begin their research.
- Guide students to gather more detailed research on one currently utilized solution rather than creating a comprehensive list. This will be more useful in developing a PSA. Point out that students should focus on a solution they are interested in since they will be using their research to develop a PSA.
- If your students need more guidance, consider limiting the regions that they can research or selecting a local city or state to focus on. For countries with lots of available online data or geographically varied concerns, such as the United States or Brazil, it can be easier to focus on a particular region than the country as a whole.

6 Students create a PSA for their country or region.

- Review the concept of a PSA. Students may have observed billboards that warn young people about the risks of smoking, seen magazine ads that recommend drinking milk, or watched short TV segments encouraging reading.
- Ask, **What PSAs have you seen? What made that particular PSA memorable? Did it influence your behavior? Why or why not?** Encourage students to reflect on the best elements of the PSAs they are familiar with in order to incorporate those elements into their own work.
- PSAs can take different forms, such as a print ad, an infographic, a TikTok video, a Twitter feed, an Instagram post, a YouTube video, a billboard, etc. Have students brainstorm different forms of a PSA. Decide which ones you would consider acceptable for the purposes of this assignment. If you do not want students to use a particular social media platform, consider having them design their PSA as a storyboard proposal for possible consideration by one of the platforms.

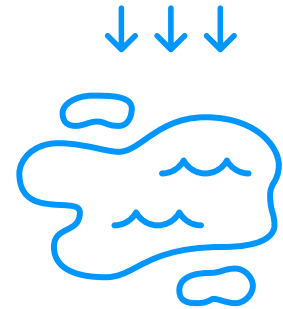


DROUGHT AFFECTS US ALL

WHAT'S THE PROBLEM?

Water levels in Lake Arid have decreased by over 50% over the last 30 years.

- 60% of our region's water supply comes from Lake Arid and the remainder relies on private ground wells.
- 10 of the last 16 years have had record levels of low rainfall.
- Over half of our local economy depends on water for agriculture and livestock capacity.
- Our region is in a state of "severe drought" (level D2) according to government agencies.



If drought conditions continue...

current usage levels will raise water rates and we may need a new source for water.



WHAT CAN WE DO?

Our city is currently investigating alternative water sources and water-saving initiatives:

- *Damming the nearby Rolling River*
- *A water reclamation project to use recycled water for crop irrigation*
- *Water restrictions for lawns and other non-essential usage*

GET INVOLVED!

Join city board meetings
 Contract and join the local water council
 Volunteer with others:
www.sourcewatercollaborative.org



HOW CAN I HELP?

Conservation of water

- Check for leaks in toilets, faucets, and pipes
- Plant drought resistant plants
- Water lawns only when they need it
- Take short showers
- Don't leave water running
- Install low-flow high-efficiency toilets, Energy Star rated appliances for saving water



The average washing machine uses...
41 gallons of water

TIPS

- Always run a full load
- Use newer water-saving front-loaded machines

SYNTHESIS OF IDEAS (30-40 MIN)

7 Students present their PSAs to the class.

- Review students' PSAs for accuracy and appropriateness before having them present to the class.
- Provide each student with a sticky note for each PSA being presented. Have them write one positive feedback comment to the presenting person or group. Distribute the notes to each presenter after first reviewing the notes.

8 The class discusses decisions made in Activity 1 and elsewhere in the unit.

- Ask, **What questions do you still have about global water use?** Students may be curious about specific technologies such as how saltwater can be treated to become freshwater, how changes in global climate patterns will affect water quality and availability in other parts of the world, and so on.
- Use Build Understanding items 2 and 3 to review some of the work done in the unit.
- Build Understanding item 5 provides an opportunity for metacognitive thinking. Point out this opportunity for student self-reflection.
- Ask, **Has your understanding of science changed over the course of this unit? If so, how?** If not, explain. Create a list of student responses. Students may identify the interaction of human senses and scientific tools and technology to gather evidence, the importance of evidence in informative scientific explanations, and the role that people play in the development of scientific ideas. Encourage students to identify new understandings that have been developed over the course of the unit.
- Discuss the Unit Guiding Question found at the beginning of the unit: **How do people use evidence and iteration of ideas to construct scientific explanations that are relevant to everyday issues, such as water quality?** Have students share their thinking about the relationship between scientific ideas—such as evidence, iteration, and explanation—to everyday life. Over the course of the unit, students have encountered many examples of the use of evidence and iteration in the development of explanations of water quality, such as with the fictional town of Skipton and the real-world case of Flint, Michigan.

EXTENSION (10 MIN)

9 Use the Extension as an opportunity for advanced learning.

The development of new scientific ideas and innovations is ongoing. Students can do online research to find out the latest discoveries and inventions that address global water use. Alternatively, you may choose to do some additional research and present recent news to the class. Or print/link to a single recent news article or video that you would like students to read or watch.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

- ① Consider which characteristics of your region informed your choice of water solutions.
- a What is one characteristic in this region that may change in the future due to climate or economic changes?
Rainfall in this area may change over time.
 - b If this change occurs, how would it affect your proposed solution?
There would be less water conservation from water storage because less water could be collected from rainfall.
 - c How could you modify your proposal to be prepared for this change?
I could suggest increasing other water-conservation methods, such as reduced home water use, to balance the loss of water from rainfall.
- ② You began this unit by making decisions about Skipton's water supply.
- a Based on what you know now, would you change your decision? Why or why not?
Originally, I recommended that Skipton use water from Lake Timtim. I would change my decision to first try to reduce water use in the town. This reduction in water use could make it easier to meet the town's water needs.
 - b Are there other decisions you made during this unit that you would change? Explain.
I would keep my other decisions the same because they were informed by evidence, and I haven't found out anything else that would change my thinking.

③ E&T Scoring Guide

How do you think global water issues, such as water quality and water availability, should be addressed? Support your answer with multiple lines of evidence from this unit and identify the trade-offs of your decision.

Level 4 response

I think global water issues should be addressed in multiple ways. Water conservation, water storage, and water recycling, combined with thorough water quality testing, could help address water quality and water availability. Water quality tests such as pH and turbidity can help ensure that water is safe to drink. Reducing water use, storing rainwater, and recycling wastewater can increase the water available to a community. The trade-offs are that people will have to be more aware of their water use and change their water habits. This will take time, so change may be slow. People who disagree with my decision might say that this approach is too slow and other methods should be used.

Level 3 response

I think the global water issue of water availability should be addressed by using several methods. I think some of the best ways to do this are to reduce water use and to recycle wastewater. There are many easy ways to reduce water use, such as turning off the water when you brush your teeth and making sure leaks get fixed. Communities could also help with programs to teach people how to recycle wastewater in easy ways, like keeping a bucket in the shower to catch the water when you're waiting for it to warm up and using that water in the garden. The trade-off is that it is hard for people to change their habits so it might not be an easy or quick way to address water availability.

Level 2 response

I think the global water issue of water quality should be addressed by more water testing. Communities should test for things like pH and turbidity to make sure water is safe to drink. The trade-off is that these tests cost money.

Level 1 response

I think the global water issue of water quality should be addressed by more water testing because sometimes the water might not be good to drink.

CONNECTIONS TO EVERYDAY LIFE

- ④ Many people think that advances in science and technology will eventually result in solutions to most global problems. Do you agree or disagree? Explain your ideas.

I agree that advances in science and technology will be able to help address many global problems, but not all. For example, science and technology may help find new solutions but cannot prevent the problem itself. Some parts of the world will have less water and may not be able to gather enough clean water for its entire population.

- ⑤ How can the concepts you learned in this unit be applied to your own life?

I am more aware of possible water quality issues in my own drinking water and my own water-use habits. I will probably waste less water and pay more attention to water availability and water quality in my community.

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SOME KEY CONCEPTS FROM UNIT 1

	A	B	C	D	E	F	G	H
	water conservation	water storage	water transportation	water recycling	desalination	nature based	rainwater capture	paleo valleys
1 New scientific tools and techniques contribute to the advancement of science.								
2 Individuals and teams from many nations and cultures have contributed to the field of science.								
3 Scientific optimism enables scientists and others to solve difficult problems over time.								
4 The development of scientific knowledge is iterative; it occurs through the continual re-evaluation and revision of ideas that are informed by new evidence, improved methods of data collection and experimentation, collaboration with others, and trial and error.								

SOME KEY CONCEPTS FROM UNIT 1

	A	B	C	D	E	F	G	H
	water conservation	water storage	water transportation	water recycling	desalination	nature based	rainwater capture	paleo valleys
1 New scientific tools and techniques contribute to the advancement of science.	X	X		X	X	X	X	X
2 Individuals and teams from many nations and cultures have contributed to the field of science.		X	X	X	X	X	X	X
3 Scientific optimism enables scientists and others to solve difficult problems over time.				X	X	X	X	X
4 The development of scientific knowledge is iterative; it occurs through the continual re-evaluation and revision of ideas that are informed by new evidence, improved methods of data collection and experimentation, collaboration with others, and trial and error.		X	X		X			X

	RESEARCH NOTES	DATA SOURCE
Country (or geographic location)		
Primary source of drinking water		
Most pressing water issues facing this area		
Currently utilized solutions to water issues facing this area		

	RESEARCH NOTES	DATA SOURCE
Country (or geographic location)	<i>United States</i>	
Primary source of drinking water	<i>85% of the population uses a municipal water supplier that sources surface water from rivers, lakes, reservoirs, or groundwater. Other 15% relies on private groundwater wells.</i>	USGS
Most pressing water issues facing this area	<ul style="list-style-type: none"> • <i>tap water is not reliably clean due to contamination, aging infrastructure, and less government oversight</i> • <i>water scarcity particularly in Southwestern U.S.</i> 	Pulitzer Center The Water Project
Currently utilized solutions to water issues facing this area	<ul style="list-style-type: none"> • <i>water conservation</i> • <i>financial incentives for agricultural uses to decrease contamination from runoff</i> • <i>consolidation of small water systems</i> • <i>educating the public and elected officials</i> • <i>water reuse and reclamation for agricultural and industrial use</i> • <i>collecting data about water contamination of public water supplies</i> 	Consumer Reports USDA

Website URL _____

Name of site/title _____

Who is the author? _____

What type of website is it (.gov, .edu, .com, .org)? _____

What date was the page published/last updated? _____

Who is the intended audience? _____

Purpose of the site (to inform, entertain, persuade) _____

Does the site provide facts, opinions, or both? _____

Evaluate the site for evidence of credibility

(Is there a conflict of interest? Is it free of ideological bias? Is it politically neutral? Are sources acknowledged? Are the sources credible? This often requires looking for other sources that describe the site or its institutional context.)

Evaluate the site for evidence of expertise

(Does the author have appropriate credentials or relevant expertise? A track record of integrity? A strong reputation among peers? A reliable institutional context? Evaluating this may require looking at other sites.)

Evaluate the site for the accuracy and reliability of its information

(Check if you can find other credible sites that agree. Is there consensus among relevant scientific experts about this information? If not, what is agreed upon vs. what is the nature of the disagreement? What range of findings are scientifically plausible?)

Is there any indication of bias? If so, what is the bias?

Website URL <https://thewaterproject.org/community/2021/07/16/facing-the-future-without-fear>

Name of site/title *The Water Project: Facing the future without fear*

Who is the author? *Tom Murphy*

What type of website is it (.gov, .edu, .com, .org)? *.org*

What date was the page published/last updated? *July 16th, 2021*

Who is the intended audience? *People who might donate to their nonprofit organization*

Purpose of the site (to inform, entertain, persuade) *To inform and persuade*

Does the site provide facts, opinions, or both? *Facts*

Evaluate the site for evidence of credibility

(Is there a conflict of interest? Is it free of ideological bias? Is it politically neutral? Are sources acknowledged? Are the sources credible? This often requires looking for other sources that describe the site or its institutional context.)

There is a small conflict of interest because the site describes a successful project they completed to encourage more people to donate to their charity. The source seems credible because it is a non-profit organization and other sources describe it as having a good charity rating. The site also includes photos documenting the project and links to more information about the project.

Evaluate the site for evidence of expertise

(Does the author have appropriate credentials or relevant expertise? A track record of integrity? A strong reputation among peers? A reliable institutional context? Evaluating this may require looking at other sites.)

According to other websites, the author works for this organization, and designs and manages other similar projects in Kenya, Uganda, and Sierra Leone. He has first-hand experience. The site is an established non-profit, so it should be reliable.

Evaluate the site for the accuracy and reliability of its information

(Check if you can find other credible sites that agree. Is there consensus among relevant scientific experts about this information? If not, what is agreed upon vs. what is the nature of the disagreement? What range of findings are scientifically plausible?)

Other sites support information in the story: typhoid can be common in Kenya, water capture tanks can be more reliable than shallow wells, and they can save time and resources for people who need water. But captured rainwater is not always safe to drink.

Is there any indication of bias? If so, what is the bias?

Yes, because though they are a nonprofit, they want you to donate to their charity. They might be showing only the most successful projects to demonstrate how well they are addressing global water issues.

WHEN TO USE THIS SCORING GUIDE:

This [Scoring Guide](#) is used when students are making a choice or developing an argument about a socioscientific issue when arguments may include judgments based on nonscientific factors.

WHAT TO LOOK FOR:

- Response uses relevant evidence, concepts, and process skills to compare multiple options in order to make a choice.
- Response takes a position supported by evidence and describes what is given up (traded off) for the chosen option.

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
<p>Level 4 Complete and correct</p>	<p>The student provides a clear and relevant choice with appropriate and sufficient evidence, including BOTH of the following:</p> <ul style="list-style-type: none"> • a thorough description of the trade-offs of the decision • reasons why an alternative choice was rejected (if applicable) 	<p>The student's response includes:</p> <ul style="list-style-type: none"> • a clear description of their recommendation for addressing global water issues, including water quality and availability. • a clear, thorough description of at least three distinct lines of evidence that are relevant to and support their position. • a clear, thorough description of at least one appropriate trade-off.
<p>Level 3 Almost there</p>	<p>The student provides a clear and relevant choice with appropriate and sufficient evidence, BUT one or both of the following are insufficient:</p> <ul style="list-style-type: none"> • the description of the trade-offs • reasons why an alternate choice was rejected (if applicable) 	<p>The student's response includes:</p> <ul style="list-style-type: none"> • a clear description of their recommendation for addressing global water issues, including water quality and/or availability. • a clear, thorough description of at least two distinct lines of evidence that are relevant to and support their position. • at least one appropriate trade-off. • descriptions of evidence and trade-offs may be unclear or insufficient.

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
<p>Level 2 On the way</p>	<p>The student provides a clear and relevant choice, BUT the evidence is incomplete.</p>	<p>The student's response includes:</p> <ul style="list-style-type: none"> • a clear description of their recommendation for addressing global water issues, including water quality and/or availability. • a clear, thorough description of at least one line of evidence that is relevant to and supports their position <p>And may include:</p> <ul style="list-style-type: none"> • at least one trade-off <p>However, evidence is less than three pieces and/or trade-off is missing or unclear.</p>
<p>Level 1 Getting started</p>	<p>The student provides a clear and relevant choice BUT provides evidence that is subjective, inaccurate, or irrelevant.</p>	<p>The student's response includes:</p> <ul style="list-style-type: none"> • a clear description of their recommendation for addressing global water issues, including water quality and/or availability. <p>However, evidence is subjective, inaccurate, or irrelevant and/or trade-off is missing or unclear.</p>
<p>Level 0</p>	<p>The student's response is missing, illegible, or irrelevant.</p>	
<p>X</p>	<p>The student had no opportunity to respond.</p>	