

5E Integrated STEM Lesson Plan

Unit Title: The United Arab Emirates Needs an Iceberg?

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Topic: The distribution of water on Earth

Targeted Grade Level: 5th Grade

Time Needed: Approximately twelve days

Subject Integration: Science, Math, Literacy, Engineering, and Social Emotional Learning

Justification:

Throughout this unit science, math, literacy, engineering, and social emotional learning are integrated to add depth to the concepts being taught. Rather than have singular lessons for each standard, integrating them together allows the students to think schematically and build connections that enhance the students' understanding of each of the subjects involved. In this particular unit, the science standard concerning the distribution of water is the basis for the lesson, and, in order for students to grasp how incredible it is that we only have 1% of Earth's fresh water readily available to us, students need to have a concept of place value and the ability to read decimals/percentages. This makes the integration of these two subjects a natural one and it sheds light on the fact that there is real-world importance to learning to read decimals and to being able to round them. The ability for students to reason mathematically and to read decimals is also incorporated through the analyzing of data and interpreting of precipitation and temperature amounts. Just as real scientists do, the students need to be able to reason mathematically in order to draw appropriate conclusions. They also need to be able to read informational texts and quote them accurately to make further inferences, which is how literacy skills are integrated in this unit. In terms of the engineering integration, it is incredibly important for students to see that engineering is not something that is separate from science for, without an understanding of science, engineers would not be able to viably solve problems, and students are exposed to this as they use the engineering design process to create water filters to meet the immensely important need the world has for fresh water. The need for fresh water also sheds light on the social

emotional learning integration, as it is important for students to empathize with people from different walks of life who do not have access to the same resources we do. By thinking about the water crisis and placing themselves in the shoes of others, the students are strengthening their social awareness.

Standards:

NGSS Performance Expectations

Students who demonstrate understanding can:

- 5-ESS2-2.** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. *[Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]*
- 5-ESS2-1.** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. *[Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]*
- 3-5-ETS1-2.** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p><u>Using Mathematics and Computational Thinking</u> Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.</p> <ul style="list-style-type: none"> • <u>Describe and graph quantities such as area and volume to address scientific questions.</u> <p><u>Developing and Using Models</u></p>	<p><u>ESS2.C: The Roles of Water in Earth’s Surface Processes</u></p> <ul style="list-style-type: none"> • <u>Nearly all of Earth’s available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.</u> <p><u>ESS2.A: Earth Materials and Systems</u></p> <ul style="list-style-type: none"> • <u>Earth’s major systems are the geosphere (solid and molten rock, soil, and sediments), the</u> 	<p><u>Scale, Proportion, and Quantity</u></p> <ul style="list-style-type: none"> • <u>Standard units are used to measure and describe physical quantities such as weight and volume.</u> <p><u>Systems and System Models</u></p> <ul style="list-style-type: none"> • <u>A system can be described in terms of its components and their interactions.</u> <p><u>Influence of Science, Engineering, and Technology on Society and the Natural World</u></p>

<p><u>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.</u></p> <ul style="list-style-type: none"> • <u>Develop a model using an example to describe a scientific principle.</u> <p><u>Constructing Explanations and Designing Solutions</u> <u>Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.</u></p> <ul style="list-style-type: none"> • <u>Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.</u> 	<p><u>hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.</u></p> <p><u>ETS1.B: Developing Possible Solutions</u></p> <ul style="list-style-type: none"> • <u>Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.</u> • <u>At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.</u> 	<ul style="list-style-type: none"> • <u>Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.</u>
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Common Core State Standards

Math:

MP2

Reason abstractly and quantitatively.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

MP4

Model with mathematics.

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify

important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5.NBT.A.3 Read, write, and compare decimals to thousandths.

- 5.NBT.A.3.A Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$.

-5.NBT.A.3.B Compare two decimals to thousandths based on meanings of the digits in each place, using $>$, $=$, and $<$ symbols to record the results of comparisons.

5.NBT.A.4 Use place value understanding to round decimals to any place.

Literacy:

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.

Other Standards

CASEL Core SEL Competency: *Social Awareness*

The ability to take the perspective of and empathize with others, including those from diverse backgrounds and cultures.

Measurable Student Learning Objectives:

- Students will be able to demonstrate understanding of how water is distributed on Earth by modeling it with mathematics, and by determining factors that affect it.

- Students will be able to make accurate scientific inferences by reasoning mathematically and reading, writing, and comparing decimals.
- Students will be able to round decimals to accurately display data interpreted from a graphical display.
- Students will be able to explain the steps of the water cycle and to judge the conditions necessary for it to function.
- Students will be able to evaluate the effectiveness of a solution to a design-problem.

Nature of STEM: Elements of the nature of science consist of instruction that uses a variety of methods to encourage students to ask questions about the natural world and to be able to explain natural phenomena. It also has students recognize that science is not set in stone – that it can change as scientists analyze empirical evidence and make inferences (Appendix H). This unit helps students develop an understanding of the nature of science through the way it encourages students to explain the natural phenomena of water distribution through argumentation and inferencing. Science is not a prescribed set of rules, it is an active process where students are encouraged to inquire about why things are the way they are, and that is what this unit strives to do. The nature of engineering is one that emphasizes the design process and incorporates skills from all of the STEM domains to help instill engineering habits of mind (Katehi, Pearson, & Feder). Since this unit is grounded in a real-life scenario where the students are exposed to the severe need humanity has for clean water, engineering habits of mind are built within students as they are driven to apply the design process to solve the freshwater problem by engineering filters. The grounding of the unit in a real-life connection also helps to highlight the nature of math which encourages the students to see that math goes beyond rote memorization and the applying of rules – that it serves a purpose and can be applied. The nature of math highlights the importance of persevering through problems, and being able to reason abstractly and quantitatively, construct arguments, create models, and use tools appropriately (Standards for M.P.). They are encouraged to think and share their thoughts. In this unit, the students are able to interpret scientific information about the amount of freshwater an area has by reasoning quantitatively. They also create a mathematical model of the distribution of water. Finally, the nature of technology encourages students to build their technical skills while recognizing the relationships that exist between technology and other fields. It also encourages students to recognize the scope technology reaches and how it has advanced over time (ITEA). While students are not directly taught technical skills through this unit, the students do get to apply technical skills as they use interactive simulations and read electronic books. They are also exposed to the scope of technology used to access fresh water from simple filters and wells to advanced processing plants designed to bottle glacial water from icebergs.

Appendix H – Nature of Science in the NGSS. (2013). Retrieved from <https://www.nextgenscience.org/sites/default/files/Appendix%20H%20-%20The%20Nature%20of%20Science%20in%20the%20Next%20Generation%20Science%20Standards%204.15.13.pdf>

English Language Arts Standards " Reading: Informational Text " Grade 5. (n.d.). Retrieved April 25, 2020, from <http://www.corestandards.org/ELA-Literacy/RI/5/>

International Technology Education Association. (2007). *Standards for technological literacy: content for the study of technology*. Reston, VA.

Katehi, L., Pearson, G., & Feder, M. (2007). "Engineering in K-12 Education: Understanding the Status and Improving the Prospects". Retrieved from https://www.nsf.gov/attachments/117803/public/1b--Eng_in_K12_Ed.pdf

Standards for Mathematical Practice. (n.d.). Retrieved April 13, 2020, from <http://www.corestandards.org/Math/Practice/>

Engaging Context/Phenomena: The engaging phenomena I will be using is one from the Wonder of Science that gives a depiction of a massive undertaking the UAE is considering of towing an iceberg from Antarctica to their shoreline as a solution for the water crisis there are enduring.

Data Integration: I will be integrating data from several sources throughout this unit; including, data on the distribution of water on Earth from the United States Geological Survey Science School, data on the precipitation and temperature amounts of different climatic zones from the NSTA e-book, "Investigating Weather and Climate", and data from Our World in Data on the "Renewable internal freshwater resources per capita". Students will be modeling the data from the USGS Science School by measuring out milliliters of water equivalent to the graphically displayed percentages. They will be using the data from the NSTA e-book to infer how much fresh surface water an area is likely to have, and they will be using the Our World in Data figures to assess how dire the need for fresh water is in various places and to compare and contrast the availability of freshwater per capita in different countries.

Differentiation of Instruction: I can modify my instruction to meet the needs of all learners in many ways. One way is by varying the type of instruction I use to incorporate small group, whole-group, partner, and individual work. Another way is by incorporating a variety of activities that meet different learning styles, such as having kinesthetic activities and visuals.

Reviewing vocabulary terms and concepts students may have forgotten or be unfamiliar with is yet another way instruction can be modified. Offering the students choices is also a way to differentiate instruction to give students ownership of their learning.

Real-life Connection: There are many real-life connections throughout this unit. During the engage phase, for example, students are asked to think about their connections to water. This sets the stage for the mission and enables all students to connect to the topic since everyone interacts with water on a daily basis. Then, in the explore phase students are able to physically visualize how little water is available on Earth by modeling it themselves. Later in the unit, the students are given the chance to reflect on the stark reality of the water crisis and to place themselves in someone else's shoes. This real-life connection transforms a simple statistic into living, breathing people. Finally, and most importantly, the entire unit is based on the real-life connection to the United Arab Emirates and their proposal to drag an iceberg to their shores. By having the whole unit rooted in a real-life context, the students are able to see the meaning behind what they are learning and to develop associations to it.

Possible Misconceptions: One possible misconception the students might have is not understanding that water is not as available everywhere else as it is here. Another misconception the students could have is that water is not recyclable and that once it has been drunk or used it is gone. The students could also not understand that there is a difference between weather and climate.

Lesson Procedure:

5E Model	5E Objectives
<u>Engage</u>	<p>Procedure:</p> <p>Day 1) To orient the students and to get them thinking about the topic of this lesson, have them create a topic web based on the word “water”. After they have had ample time to get their thoughts flowing, have student volunteers share words from their webs while you record them on a piece of chart paper. Once the web is complete, encourage the students to observe the vast number of items they came up with ranging from where water is found on Earth to all the ways we use it. Take a moment to pause here and ask the students to imagine what the world would be like without water. Then, have them consider if the Earth could ever run out of water. Have the students argue this last question and make sure they explain their reasoning as they share their thoughts. (Use these questions to assess what students know about the distribution of water and the water cycle).</p> <p>Now that their minds are ripe with thoughts about water, direct their attention to a screen and share the anchoring phenomena for which this lesson is named, “Towing an Iceberg to the United Arab Emirates” [A description of the video can be found below under “Resources”] (Andersen, P.); forewarn the students that it is in Arabic so you will be reading the subtitles aloud. When the clip has ended, ask the students to “Turn-and-Talk” to share their initial thoughts about the video and what the United Arab Emirates is planning. Call on a few students to share out, clarify any misunderstandings, and then inform the students that you are going to play the video clip again, and, as they watch, you want them to think about wonderings they have. After the clip has ended the second time, have the students share any wonderings the video clip led them to think of and record their questions on chart paper. If the following question (or one similar to it) does not come up naturally, share with the students that a wondering you have is, “Why do some places not have enough water?”, as this is an important concept you will be exploring later on. Then, tell the</p>

students that these wonderings are all going to be things we explore as we learn about water and where it is on Earth.

Modifications: By beginning the lesson with a topic web I am ensuring that all students have equal access to the lesson topic because it allows the students to make connections and it activates their prior knowledge. Having a class topic web also gives students the benefit of seeing other students' thoughts and it will become a resource the students can refer back to as they progress through the unit. I have also included a "Turn-and-Talk" in the procedure above to give students who are less likely to share their thoughts with the whole class an opportunity to talk.

Standards Addressed: This phase sets the stage for what the students will learn relative to the science standards 5-ESS2-2 and 5-ESS2-1.

Formative/Summative Assessments: Formative assessments during this phase include the topic web to garner students' thoughts, and questioning to assess students' prior-knowledge relative to water.

Resources: The materials necessary for this phase include: paper for the students to record their topic webs, chart paper, and the following link:

Link to the Phenomena video: <https://thewonderofscience.com/phenomenon/2018/5/13/towing-an-iceberg-to-the-united-arab-emirates>

(This video gives an overview of the daring enterprise the United Arab Emirates will soon undertake to move an iceberg from Antarctica to their shore line to serve as a fresh water source for their people and land.)

Andersen, P. (2018, May 13). Towing An Iceberg To The United Arab Emirates. Retrieved April 11, 2020, from <https://thewonderofscience.com/phenomenon/2018/5/13/towing-an-iceberg-to-the-united-arab-emirates>

Explore

Procedure:

Day 2) During this phase, the students will be exploring the essential question, “Where is water on Earth?” Begin by having the students look at a map or a globe and having them share what percentage of Earth they think is covered with water (about 71%). Then, have them think about all the places on Earth where water can be found. (Refer to the topic web they created the day before, and ask the students if they can think of any other places water might be).

Next, divide the students into groups and distribute copies of the paper, “Where is Water on Earth?”, and ask the students to estimate the percentage of Earth’s water that they think can be found in each of the listed areas. Pause here, and review what it means to estimate and review that a percentage is a part of a whole, so the percentages that they estimate need to total 100%. After the groups have had time to finish, discuss their estimations as a class. [These steps were inspired by steps 1-5 of the class activity “Where’s the Water” by Streamside Science, an extension of Utah State University.]

Then, have the students complete a hands-on activity. Each group will need a 1-liter bottle of water, a graduated cylinder, three cups, and four sticky notes with the labels “Salt Water”, “Water Frozen in Ice Caps & Glaciers”, “Ground Water”, and “Fresh Surface Water”. Inform the students that the 1-liter bottle of water represents all of Earth’s water. Then, follow the steps below:

1. Instruct the students to remove 30 milliliters (2 tablespoons) of water from the bottle and place it in a cup. Explain that this water represents all the freshwater on Earth, while the remaining water represents the saltwater found in oceans. Have them apply the “Salt Water” sticky note to the bottle.
2. Next, have them remove 10 milliliters (2 teaspoons) of water from the cup and place it into a second cup. Explain that this represents the freshwater on Earth that isn’t frozen. Apply the “Water Frozen in Ice Caps & Glaciers” sticky note to the cup with 20 ml. of water.
3. Now, have the students remove a teaspoon of water from the second cup and carefully tip it into the remaining cup. Inform them that that one teaspoon of water is all the freshwater that is readily available to us, while the other 10 milliliters of freshwater are trapped underground. Have

the students apply the “Ground Water” sticky note to the cup with 10 ml. of water and the “Fresh Surface Water” sticky note to the cup with the single teaspoon of water.

[The above activity is based on steps 4-6 of the Scholastic activity entitled, “A Drop in the Bucket”.]

After completing the activity, display a graph of the actual percentages of the distribution of Earth’s water from the USGS webpage, “Where is Earth’s Water?”, and ask students to share what they notice and what they learned from the activity. Then, have the students recall what they know about rounding percentages to the nearest whole number (review this concept with students if they are unfamiliar with it), and instruct them to round the percentages on the graph and record them on their paper. Check their understanding of place value by asking them questions that require them to compare the values. Finally, to assess their take-aways, have the students complete the Exit Slip at the bottom of the page explaining what they used to think and what they think now.

Modifications: Modifications in this phase include taking time to reinforce students understanding of estimates and percentages, and completing the hands-on activity in small groups. Rather than conduct a whole class demonstration I wanted to give the students the opportunity to measure the amounts themselves to give them ownership of the activity. Also, by having the reflection at the end be a written reflection rather than a class discussion I can garner a response from all students to see how their thinking changed throughout the lesson, and it enables them to be metacognizant.

Standards Addressed: The standards that are being addressed here are the Common Core Math Standards MP4, 5.NBT.A.3, and 5.NBT.A.4, and the NGSS 5-ESS2-2, including disciplinary core idea ESS2.C. The cross-cutting concept of scale, proportion, and quantity can also be seen here, as can the science and engineering practice of using mathematics and computational thinking.

Formative/Summative Assessments: During this phase I am assessing the students formatively via the “Where is Water on Earth?” worksheet and the “Exit Slip” there in. The worksheet allows me to see how their thinking has changed about water from their estimates at the beginning of the lesson to the exit slip question at the end. It also allows me to assess their understanding of rounding percentages and their ability to interpret data.

Resources: To conduct this phase of the lesson the following materials are needed: one “Where is Water on Earth?” worksheet per student, a 1-liter bottle of water per group, a graduated cylinder

per group, three cups per group, and four labeled sticky notes per group. You will also need access to the following USGS webpage to display the graph.

Link to “Where is Water on Earth” worksheet: <https://drive.google.com/file/d/1oz6j45x5w88dwVh-Cojq-pEEye0GJdEq/view?usp=sharing>

Link to Graph: https://www.usgs.gov/special-topic/water-science-school/science/where-earths-water?qt-science_center_objects=0#qt-science_center_objects

Lesson 1: A Drop in the Bucket. (n.d.). Retrieved April 11, 2020, from <http://www.scholastic.com/snp/waterworld-levi.htm>

Stream Side Science. (n.d.). Retrieved April 11, 2020, from <https://streamsidescience.usu.edu/lessons/5-12/wheres-the-water/index>

Where is Earth's Water. (n.d.). Retrieved April 11, 2020, from https://www.usgs.gov/special-topic/water-science-school/science/where-earths-water?qt-science_center_objects=0#qt-science_center_objects

Explain

Procedure:

Over the next several days the students will learn about and be able to explain two factors that contribute to the distribution of water on Earth: the water cycle and climate. They will also analyze data and use it to infer information.

Day 3) Begin by stating, “Yesterday we saw how water is distributed on Earth, and we saw how little fresh surface water there is, so today we are going to think about WHY water is where it is and HOW it gets there.” Show the NASA video clip, “Water, Water, Everywhere”. Then, tell the students they are going to see the water cycle in action through a demonstration. For this demonstration, you will need the following: a vase, hot water, a plate, and ice. [This is based on a video posted by Hoopla Kidz Lab on YouTube]. Follow the steps below.

1. Have the students hypothesize what they think will happen when you place a plate of ice over hot water.

2. Pour the hot water in the vase and place the plate on top. Let it sit for a minute. Then, ask the students to share their observations.
3. Add the ice to the top of the plate. Let it sit for a minute. Then, ask the students to share their observations.
4. Discuss how each phase of the water cycle was represented.

After the demonstration, have the students find a partner. Together, they will explore an interactive water cycle diagram to learn more about each step. (The students will need a computer to access “The Water Cycle for Schools and Kids” webpage from USGS.gov). Then, to assess their understanding have the students write a reflection to explain whether or not the demonstration would work if cold water was used instead of hot water.

Day 4) To begin, display page 25 of the NSTA e-book, “Investigating Weather and Climate”. (The page is an interactive view of Earth’s surface that allows students to click on different magnifying glasses to see different climate zones and the amount of water/vegetation that is present). Call on various students to click on the different magnifying glasses to reveal the pictures below. Ask the students what they notice about the different images and ask questions such as, “Do you see any patterns?” and, “What do the different colors mean?”. Then ask, “Why do you think some of these places have more water than others?”. Have the students turn to the person sitting next to them to share their thoughts. After they have had time to share with their partner, call on a few students to share their thoughts with the class. (If the water cycle does not come up in the discussion, facilitate questions to guide the students there to remind them about what they learned yesterday.) Then, as a class, finish reading Chapter 4: Exploring Weather Patterns Across Earth. Prior to moving on to the activity, take time to begin a vocabulary list of important terms the students learned and to clarify the difference between weather and climate.

Next, tell the students that they will be investigating the five major climate zones. There will be five groups. Each group will be assigned either Tropical, Dry, Temperate, Cold, or Polar. As a group they are to do the following:

1. Read the pages from Chapter 5: Comparing Climates Around the World that correlate with your assigned climate zone.

2. Follow the on-screen directions to compare the precipitation and temperature data for the example locations. (Remind them to read the decimals closely and to pay attention to their place values.)
3. As a group, create a presentation in the format of your choice (For example, a poster, a slideshow, a newspaper article, etcetera...) to share the information below:
 - a. Your Climate Zone
 - b. What the Precipitation and Temperature are like
 - c. An explanation as to whether or not there is a lot of freshwater available to the people in countries with your assigned climate.

The students should be given the rest of the class time to meet with their group and begin the assignment.

Days 5 and 6) Over the next two days the students are to complete their assignment and present their work to the class. Hang the students' work up in the classroom so it can become a resource for the students to refer to. (If their work is digital try to print it so it can be displayed as well). On Day 6, after all of the students have presented, point out on the climate map from the e-book where Alabama is and have them determine, based on what they have learned, what type of climate we have here and how much freshwater they think is available to us. Then, in table groups have the students take turns reading the first four paragraphs of the entry in the Encyclopedia of Alabama entitled, "Water Resources in Alabama" aloud. (*Alabama has an estimated 10% of all freshwater resources in the United States!*) Prior to them reading, review how to read informational texts going over its structure and features. As they finish reading, instruct them to select a quote that most stood out to them from the article and write it on a sticky note. Then, they will place it on a piece of chart paper entitled, "Water Resources in Alabama". Discuss their thoughts. *This will be an important conversation as it will be referred to later for the students to compare their local freshwater resources to global resources.* [Educators teaching this lesson elsewhere should use their local information.]

Modifications Some modifications incorporated in these lessons include beginning a vocabulary list for students to refer to and clarifying the difference between commonly misunderstood terms –

weather and climate. Another modification is having the students work in groups to prepare presentations so they can bounce ideas off of each other as they explore the concepts. The students have also been given the opportunity to choose which method they would like to use to present their information.

Standards Addressed: The standards that are being addressed here include NGSS 5-ESS2-1 as well as the underlying disciplinary core idea ESS2.A, the cross-cutting concept of system and system models, and the science and engineering practice of developing and using models. The CCSS for Math MP2 and 5.NBT.A.3 are also addressed, as are the CCSS for Literacy RI.5.1 and RI.5.4.

Formative/Summative Assessments: The students are being formatively assessed during this phase through their reflection on the water cycle and through their group presentations on the climate zones and the impact climate has on the distribution of water. Rather than just reporting facts, the students are using higher thinking skills of comparing and inferring. The students ability to quote informational text accurately is also being assessed formatively through the class discussion.

Resources: The resources needed during this phase include the NASA video “Water, Water Everywhere”, water cycle demonstration materials (a vase, hot water, a plate, and ice), paper, computers, the NSTA e-book, “Investigating Weather and Climate”, materials for students to create posters if they so choose, copies of the article “Water Resources in Alabama”, sticky notes, and chart paper.

Link to NASA video: <https://gpm.nasa.gov/education/videos/water-water-everywhere>

Link to Hoopla Kidz Lab for reference: <https://youtu.be/3v98madaW1M>

Link to Water Cycle Interactive: https://www.usgs.gov/special-topic/water-science-school/science/water-cycle-schools-and-kids?qt-science_center_objects=0#qt-science_center_objects

Link to NSTA e-book: <https://my.nsta.org/ebook/109161/investigating-weather-and-climate/25>

Hairston, J. E., Rodekohr, D., Brantley, E., & Kensler, M. (2008, August 16). Water Resources in Alabama. Retrieved April 25, 2020, from <http://www.encyclopediaofalabama.org/article/h-1645>

hooplakidzlab. (n.d.). LAB 360. Retrieved April 12, 2020, from <https://www.youtube.com/user/hooplakidzlab/featured>

Investigating Weather and Climate E-Book: National Science Teaching Association. (n.d.). Retrieved April 11, 2020, from <https://my.nsta.org/ebook/109161/investigating-weather-and-climate/>

The Water Cycle for Schools and Kids. (n.d.). Retrieved April 12, 2020, from https://www.usgs.gov/special-topic/water-science-school/science/water-cycle-schools-and-kids?qt-science_center_objects=0#qt-science_center_objects

Water, Water, Everywhere! (n.d.). Retrieved April 11, 2020, from <https://gpm.nasa.gov/education/videos/water-water-everywhere>

Elaborate

Procedure:

Now that the students have learned all about the distribution of water on Earth, how it moves through the water cycle, and the amount of water present in different climate zones, the students will elaborate on their learning by examining data that demonstrates the water crisis and how people in drier climates are suffering from a lack of freshwater.

Day 7) To begin, have the graph entitled, “Renewable internal freshwater resources per capita” from Our World in Data.org on display. (Since it is intended for an older audience explain that what it is demonstrating is the amount of renewable freshwater that is available based on the country’s population.) Ask students to share what patterns they notice. (They should see that the amount of available water in Brazil is much higher than other countries with drier climates, and that the available fresh water supply has drastically decreased over the last forty years.) On a map, point out some of the countries. Show the students where the United Arab Emirates is, and inform them that, similar to Pakistan (which is listed on the graph), their freshwater sources are also drastically decreasing. In small groups, have the students speculate as to why this might be. Then, have a speaker for each group share some of the reasons their group came up with. Record the student responses on chart paper. Share with the students that the reasons they came up with are all plausible, and that the trend this graph shows is something that, unfortunately, is happening in

many countries all over the world. This is called the water crisis. (In case some students are unfamiliar with the word crisis, take time to discuss its definition.) Then, share the water crisis video from Wonderopolis.org with the students. Afterwards, if a board is available, draw a ripple spreading out from a pond and ask the class to share all the things that not having clean water affected. Explain how it is like a ripple effect, with one thing affecting another.

To focus on the students' social emotional learning, have the students think back to our discussion the day before about the abundance of water we have here (refer to the chart paper they created) and imagine if all our water were to dry up and disappear. Have them imagine they were in the shoes of someone experiencing the water crisis first hand, and instruct them to write a brief written reflection about how their lives would be affected if they did not have access to clean water. If there's time have a few people share.

Day 8) Orient the children by reminding them about the water crisis they discussed yesterday. And remind them that the video ended on a note of hope – that there are ways to help people in need and to help protect our water in general. Ask students to brainstorm some of the ways that were mentioned in the video (may need to explain desalinization for students), and then have them brainstorm ideas of their own.

Next, inform the students that scientists and engineers are working together to find solutions - from desalinating ocean water to lugging icebergs from Antarctica! What is important is providing fresh water that is free of disease and pollution to people in need. To elaborate on the importance of this the students will be conducting an engineering design challenge. The design challenge they will be completing is entitled, "Water Filtration Project: Make Your Own Water Filter", from TeachEngineering.org. Read the "Engineering Connection" and the "Introduction/Motivation" from the website to the students. Then follow the design challenge step by step.

Days 9 & 10) The next two days will be spent completing the design challenge, and having the students rate their water filters based on the specified criteria in the lesson outline on the TeachEngineering.org website.

Modifications: One necessary modification is assisting students by explicitly explaining what the data from “Our World in Data” represents since it is intended for adults. Another modification is drawing the visual on the board of literal ripples to assist visual learners.

Standards Addressed: The standards that are being addressed here include the NGSS engineering design disciplinary core idea ETS1.B, the cross-cutting concept “Influence of Science, Engineering, and Technology on Society and the Natural World”, and the science and engineering practice of constructing explanations and designing solutions. The S.E.L. competency of social awareness is also addressed here.

Formative/Summative Assessments: The students are being formatively assessed in this phase through the class discussion and the written reflection. They are also being formatively assessed on the effectiveness of their design solution through the engineering design challenge. (The rubric for this is included on the TeachEngineering.org website).

Resources: The resources needed during this phase include the Renewable Freshwater Resources graph, a map, chart paper, the Water Crisis video, and the engineering design challenge materials (1 liter of water prepared in advance with soil and sand in it until it is thin but relatively opaque, 3 test tubes prepared with the water standards "A," "B" and "C" (C is filtered through some grass, B is filtered through a coffee filter, and A is filtered through 2 coffee filters with a paper towel in the middle), cotton balls, gauze squares, tulle/netting, tissue, paper towels, coffee filters, gravel (aquarium gravel works great), sand, 3 test tubes per student, test tube racks, graduated cylinders, and the Design Components Worksheet located on the website), as well as the links below:

Link to Renewable Freshwater Resources Graph: <https://ourworldindata.org/water-use-stress>

Link to Water Crisis video: <https://www.wonderopolis.org/wonder/how-much-water-do-you-need-to-survive>

Link to Engineering Design Lesson: https://www.teachengineering.org/activities/view/water_filtration

How Long Can People Go Without Drinking Water? (n.d.). Retrieved April 12, 2020, from <https://www.wonderopolis.org/wonder/how-much-water-do-you-need-to-survive>

Ritchie, H., & Roser, M. (2017, November 20). Water Use and Stress. Retrieved April 11, 2020, from <https://ourworldindata.org/water-use-stress>

Santini, E., & Rushton, E. (2019, October 24). Water Filtration Project: Make Your Own Water Filters - Activity. Retrieved April 11, 2020, from https://www.teachengineering.org/activities/view/water_filtration

Procedure:

Day 11) Inform the class that the goal of today is to piece together all of the information they have learned throughout this unit. To do so, replay the initial anchoring phenomena for the students. Then, share an article that was written by Gulf News explaining it in more depth. Next, revisit the questions they asked at the beginning of the unit and see if they can answer any of their questions. (If any of the students disagree on an answer, encourage argumentation between the students and make sure they support their claims). Allow the remainder of class to be a time for students to think back over all they have learned throughout this unit and to ask any lingering questions they might have. (Optional: have students share what they have learned and record their responses on chart paper.)

Day 12) Today the students are going to act as water experts to provide feedback to the United Arab Emirates Council about the UAE's ambitious quest to transport an iceberg to their shoreline. This authentic, summative assessment task will allow the students to demonstrate their understanding of the concepts covered in this unit. See "Help! We Need a Water Expert" to view the assessment. (Note that some students may need assistance with reading and processing the questions while other students may perform better by answering the questions orally so it is important to take these things into consideration when administering the assessment.)

Modifications: To make the learning accessible to all students during this phase one included modification is taking the time to incorporate a question and answer time so students can clear up any misconceptions they might have, as well as a period of self-reflection. While giving the written assessment being available to read the questions aloud to students and/or allowing students to answer orally are important things to consider to make the task accessible to all students.

Evaluate

Standards Addressed: The standards being addressed here are the two NGSS Earth's Systems standards, ESS2.C and ESS2.A,

Formative/Summative Assessments: The "Help! We Need a Water Expert!" is a summative assessment task to see if students can apply what they have learned to a real-life scenario.

Resources: The resources needed during this phase include chart paper (*optional*), the "Help! We Need a Water Expert" Assessment, and the following links:

Link to the Phenomena video: <https://thewonderofscience.com/phenomenon/2018/5/13/towing-an-iceberg-to-the-united-arab-emirates>

Link to Gulf News Article: <https://gulfnnews.com/uae/environment/trial-run-for-uae-iceberg-project-in-2019-1.2244996>

Link to "Help! We Need a Water Expert" Assessment:
<https://drive.google.com/file/d/1AtkOgQ9C8jluTh5kiVFZcU3zWfeeJDSI/view?usp=sharing>

Andersen, P. (2018, May 13). Towing An Iceberg To The United Arab Emirates. Retrieved April 11, 2020, from <https://thewonderofscience.com/phenomenon/2018/5/13/towing-an-iceberg-to-the-united-arab-emirates>

Baldwin, D. (2018, November 7). Trial run for UAE iceberg project in 2019. Retrieved April 11, 2020, from <https://gulfnnews.com/uae/environment/trial-run-for-uae-iceberg-project-in-2019-1.2244996>

Teacher Background: To effectively teach this unit the teacher needs to understand that though there is a lot of water on Earth very little water is actually readily available to people to drink as much of Earth's fresh water is frozen in the poles or deep underground. While the students explore the water cycle and climate as factors that affect the distribution of water on Earth it is important for the teacher to recognize that there are many other factors, such as pollution and ground water contamination that can affect the amount of water that is available to people in different areas. Teachers should also know

that, while weather and climate both describe the conditions of the atmosphere, weather is what is happening in the atmosphere minute by minute, while climate describes the typical weather conditions in a certain area over time. Other background knowledge teachers should have prior to teaching this unit is knowledge about their local water resources, knowledge of where the United Arab Emirates is (near Saudi Arabia), as well as knowledge about the different types of engineers who work with distributing water to people, such as civil and mechanical engineers. The following resources have links to valuable knowledge for the teacher:

TeachEngineering. (n.d.). Retrieved April 13, 2020, from <https://www.teachengineering.org/k12engineering/types-of-engineering>

Weather & Climate. (n.d.). Retrieved April 12, 2020, from <https://gpm.nasa.gov/education/weather-climate>

Where is Earth's Water. (n.d.). Retrieved April 11, 2020, from https://www.usgs.gov/special-topic/water-science-school/science/where-earths-water?qt-science_center_objects=0#qt-science_center_objects