Lesson 1: Water Resources and Water Footprints

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SUMMARY

This lesson helps students understand why Earth is considered the "water planet." Students analyze how much of Earth's water is available for humans to use for life-sustaining purposes, and they explore the concept of water scarcity in both physical and economic terms. They look at the many ways that humans use water and investigate international trends in agricultural, industrial, and household water consumption. The lesson also sets up the focus of this course: the concept of water footprints. Students explore how water footprints are an invaluable tool for identifying patterns of water use so that individuals, businesses, and even nations can more effectively manage their use of one of the most precious resources on Earth: water. Critical to this exploration is a visit to watercalculator.org, where students calculate their personal water usage, analyze the results, and set a base point for tracking and conserving their water use.

ESTIMATED TIME NEEDED

Two 55-minute sessions

KEY VOCABULARY

scarcity, freshwater, salt water, water conservation, water consumption, drought, climate change, direct water use, virtual water, water footprint, irrigation, water quality, sustainable production, sustainable consumption

OBJECTIVES

Students will be able to …

- ✓ Describe the availability of water on Earth.
- ✓ Describe several ways that people use water.
- ✓ Differentiate between direct and indirect (or virtual) water.
- ✓ Give examples of ways we can conserve water (directly or virtually).
- ✓ Explain how a water footprint can help contribute to the better management of our water resources.
- ✓ Evaluate their water footprint using GRACE Communication Foundation's Water Footprint Calculator located at watercalculator.org.

Lesson 1: Water Resources and Water Footprints

INSTRUCTIONAL EMPHASIS

Instructional methods, key skills, and values/attitudes emphasized in this lesson include the following

VALUES/ATTITUDES

- ☑ Leadership
- ☑ Resilience
- ☑ Mindfulness
- ☑ Optimism
- ☑ Empathy
- ☑ Curiosity
- ☑ Global Citizenry

SKILLS

- ☑ Critical Thinking
- ☑ Creative Problem Solving
- ☑ Collaborating
- ☑ Communicating
- ☑ Information Literacy
- ☑ Systems Thinking
- ☑ Adability

METHODS

- ☑ Problem-Based Learning
- ☑ Real-World Application
- ☐ Modeling
- ☑ Brain-Based Learning
- ☑ Multiple Intelligences
- ☑ Technology Integration
- ☑ Multi-Disciplinary

ATTACHMENTS

- Water Resources and Water Footprints Presentation
- Water Resources and Water Footprints Presentation Teacher's Notes
- My Water Footprint Stats Worksheet
- My Water Footprint Stats Sample Answers
- Basic Rubric
- Participation Checklist

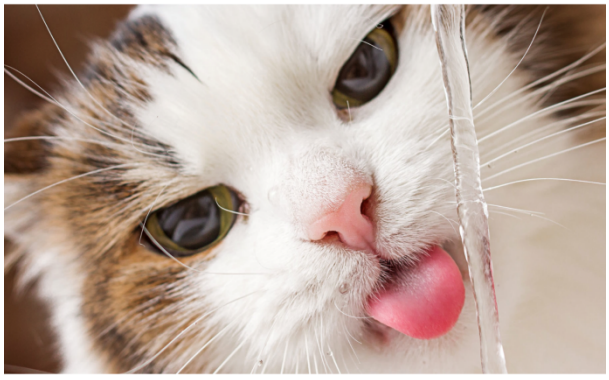
MATERIALS

SESSION 1: HOW DO WE USE WATER?

- ☐ Audiovisual presentation equipment with access to the Internet
- ☐ Student access to computers, smart phones, and/or tablets, and the Internet

SESSION 2: HOW DO I USE WATER?

- ☐ Student access to computers, smart phones, and/or tablets, and the Internet



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STANDARDS CORRELATIONS

This lesson, with all components included, is linked to the following standards:

COMMON CORE STATE STANDARDS (CCSS)

English Language Arts: RI.6.1–4, 7, 10; RI.7.1, 3–4, 10; RI.8.3–4, 10; W.6.1.A–C, 2.B–D, 4, 10; W.7.1.B–C, 2.A–C, 4, 10; W.8.1.B–C, 2.B–D, 4, 10; SL.6.1.A–D, 2–6; SL.7.1.A–D, 2–6; SL.8.1.A–D, 2–6; L.6.6; L.7.6; L.8.6; RH.6-8.1–8, 10; RST.6-8.2–10; WHST.6-8.2.A–B, D, 4, 7, 9

Mathematics: 6.NS.A.1, C.5; 6.SP.A.1, B.4, B.5.; 7.RP.2A–D; 7.SP.B.3–4; HSN.Q.A.1–3

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Earth's Systems: MS-ESS2-5; MS-ESS3-3–5

Engineering Design: MS-ETS1-1

TEXAS ESSENTIAL KNOWLEDGE AND SKILLS (TEKS)

Science:

Grade 6: §112.18.2A–E; 3A–D

Grade 7: §112.19.2A–E; 3A–D; 8A

Grade 8: §112.20.2A–E; 3A–D; 10B; 11C

CLOUD EDUCATION FOR SUSTAINABILITY (EFS) STANDARDS & PERFORMANCE INDICATORS

Grades 3–12: A5; B4–5, B7–9; C1, C3–8, C13–14, C20, C22, C28–30, C34–35, C46, C48–52; D1–2, D5, D7; E2–4, E6–7; F1, F3, F5A–C, F6; G2, G4, G10, G22, G26, G34; H7–12; I28–30

Lesson 1: Water Resources and Water Footprints

BACKGROUND INFORMATION

Water conservation encourages students to become more mindful of their daily direct water use, encouraging them not to waste water when brushing their teeth, washing dishes, showering, etc. These lessons go beyond those activities to encourage a greater perspective and to cultivate students' awareness and understanding of indirect (virtual) water use. The lessons promote conversation about how food choices and shopping habits have a larger impact on water consumption than students may realize. They do this by introducing the concept of water footprints and helping students understand how they use water beyond the tap.

The goal of **Lesson 1** is to provide students with an in-depth understanding of key water issues. Students learn key facts about water resources and water footprints and then use a water calculator to identify and analyze their personal direct and virtual water consumption. The lesson gives students a foundation of knowledge and helps them understand why they should care about protecting water resources. Once students understand why the issue is important, it is easier for them to make a fundamental shift in attitude about their water use.

In **Lesson 2**, students learn how to articulate and share the concept of a water footprint. Then they investigate in greater detail the impact of their food consumption habits on their virtual water use and begin thinking about how their diet is influenced by systems outside of themselves, such as social groups, advertising, and structures in place at home and at school.

Lesson 3 empowers students to take action. First, they investigate how the products they buy impact their virtual water footprint. Then they devise a plan to reduce their personal water footprint. Next, they work together to evaluate the water footprint of their school campus. Finally, they create a Strategic Action Plan to reduce the school's water footprint and work in groups to get the necessary permissions to enact a water-saving plan for the campus.

The 5E Instructional Model

All three lesson plans are designed using the 5E instructional model, which leads students to Engage, Explore, Explain, Elaborate, and Evaluate the topic. The article Lesson Planning: 5E Model + Technology is one resource for learning more about the 5E model and 21st century learning.

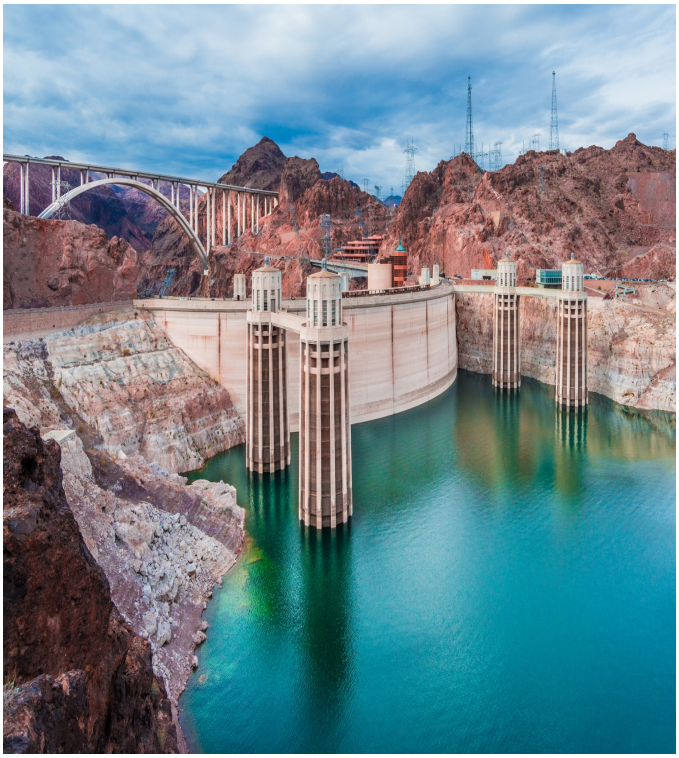
A Cautionary Word …

Be careful to avoid using words like "good" and "bad" when discussing the use of water and other products. Such words could leave students feeling shamed, which is not an effective motivator for change. For example, some students may be sensitive to the notion that a water habit they have, such as taking an occasional long shower, is "bad." In addition, be careful to discuss the merits of sustainably produced foods and consumer goods (e.g., organic produce from a farmers' market) without heavily disparaging less sustainably produced items. Encourage students to come to their own conclusions and to gently help their families shift to more sustainable habits and purchasing practices. Farmers' market produce, for example, is sometimes more expensive than supermarket produce. You may want to encourage students to do research on inexpensive alternatives to current habits and purchasing practices that they can present to their families, rather than assuming families have the means to change all their habits and practices and replace them with new "good" ones.

Lesson 1: Water Resources and Water Footprints

IN ADVANCE

Review the lesson materials in advance. Note that pp. 8, 16, and 19 of the presentation/corresponding Teacher's Notes recommend links for students to follow. You may wish to have students connect to the Internet to access these links or project the websites to review the information together as a class; alternately, you could review the websites in advance and share details during class. (You can also skip these suggestions.) Plan to set up and test your audiovisual presentation equipment in advance and make a copy of the My Water Footprint Stats Worksheet for every student.



Adobe Stock: superjoseph: drought at the Hoover Dam

PROBLEM-BASED LEARNING TIPS

This program contains three lessons on water conservation; each can stand alone, or all three can be completed together as a series. Consider conducting these three lessons together as a problem-based learning (PBL) experience for students. You could begin with this first lesson by encouraging students to come up with a central question they can explore together throughout the module. Effective PBL is student-led, so encourage students to come up with their own question. If students get stuck, you might share a few questions such as the following to get them thinking:

- Could global climate change impact our water consumption habits for the better?
- How could we rethink our water consumption habits to create a more sustainable future?
- How can we inspire members of our school community to adopt more sustainable water consumption habits??
- Why might our community need to be more open to the practice of water conservation?

After students have come up with a central question, write it on the board and refer back to it frequently. Also encourage students to keep it in mind as they move through the lessons. You may wish to suggest that they each create a Water Footprint Portfolio, which could be a folder, a notebook, or even an electronic portfolio to which they can add helpful links, completed worksheets, and other products, ideas, etc. This Common Sense Education article shares a few examples and descriptions of electronic portfolio tools.

ACTIVITY BREAKDOWN

SESSION 1: HOW DO WE USE WATER?

Time	Exercise	Description
5 min.	Engage	Students respond to a writing prompt and then view a short video.
40 min.	Explore	Share the Water Resources and Water Footprints Presentation with students and use the corresponding Teacher's Notes to generate discussion.
10 min.	Explain	Students revisit their answer to the earlier writing prompt, discuss it with a peer, and then share their thoughts with the class.
Homework		Suggest that students use the Water Footprint Calculator at watercalculator.org to assess their personal water footprint at home before working through it in class. The calculator will prompt them to answer questions for everyone who lives in their household, so reflecting with members of their households on some of the questions can help them arrive at more precise estimates.

SESSION 2: HOW DO I USE WATER?

Time	Exercise	Description
10 min.	Elaborate	Working in small groups, students brainstorm a list of habits they have, products they buy, or foods they eat that they think may require a lot of water and then rank those items according to which likely require the most water.
45 min.	Evaluate	Working independently, students use the Water Footprint Calculator at watercalculator.org to estimate their personal water footprint. Then they take the data gathered from the calculator to complete the My Water Footprint Stats Worksheet. Students participate in a final discussion and question/answer session.

Notes

IMPLEMENTATION INSTRUCTIONS

SESSION 1: HOW DO WE USE WATER?

Engage

1. Instruct students to take out a blank sheet of paper and respond in writing to the following prompt: What do you think the phrase "eat water" means? In what ways do you think you "eat" water every day? Allow students 2–3 minutes to record their thoughts.

2. Show students a short video, Freshwater scarcity: An introduction to the problem, as a quick introduction and to jump-start their thinking.

WaterCalculator.org

Explore

3. Delve into the topic in greater detail with the Water Resources and Water Footprints Presentation. Use the discussion topics, activities, and technology links in the corresponding Teacher's Notes to actively engage students and encourage thoughtful reflection.

Explain

4. Have students revisit their earlier response to the question: "How do you 'eat' water every day?" Give them a minute or two to record their thoughts.

5. Have students find a partner to discuss their updated responses to the writing prompt.

6. Conclude the session with a whole-class discussion, inviting volunteers to share how their thoughts have changed since before the presentation regarding the amount of water they "eat" every day. Give students the opportunity to ask questions or share insights on anything they have learned.

Homework

Tell students that in the next session, they will be analyzing their water footprint via watercalculator.org. Explain that it may be helpful for them to work through the calculator with a family member at home before completing it in class. The Water Footprint Calculator will prompt them to answer questions for everyone who lives in their household, so reflecting with members of their households on some of the questions, such as "where does your electricity come from" and "how many miles do you drive each week" can help them arrive at more precise estimates. Advise students to write down any details they may forget so they can easily recall the information when using the calculator again in the next session.

WATER FOOTPRINT® CALCULATOR

IMPLEMENTATION INSTRUCTIONS, continued

SESSION 2: HOW DO I USE WATER?

Elaborate

1. Divide the class into groups of 3–4 students and have each group brainstorm a list of habits they have, products they buy, or foods they eat that they think may require a lot of water.

2. After five minutes or so, have groups rank the items, with 1 indicating the habit or product they think requires the greatest amount of water.

3. Encourage volunteers to share with the class the habits or products they think require the most water. Alternately, you could have them reflect on their lists in a journal entry.

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Evaluate

4. Then tell students that you are going to give them an opportunity to evaluate their personal water footprint using the Water Footprint Calculator at watercalculator.org. Give each student a copy of the My Water Footprint Stats Worksheet.

5. Go over the instructions at the top of the worksheet together as a class and make sure students understand that to fill out the worksheet, they will need the final summary that appears below their final water footprint calculation, so caution them not to close out of the calculator too soon.

6. Tell students they will explore their results and learn more about water footprints in the next couple of classes. In the meantime, give them an opportunity to ask questions and/or share any immediate thoughts they have about what they learned in this lesson.

7. Use the Reflection Questions, which begin on the next page, to conduct a final, synthesizing discussion. Alternatively, you could assign the questions to students to complete as homework and then discuss their answers at the beginning of the next class period.

ADDITIONAL TEACHING TIP

If you have students whose native language is Spanish, they might prefer using the Spanish version of the Water Footprint Calculator and website.

REFLECTION QUESTIONS

Use the following questions to prompt critical thinking and guide students to reflect on the lesson:

- Are you surprised at how much or how little water you use compared to people in other parts of the world? *(Sample answer: I am not surprised that people in the United States consume so much water. I am surprised by how little water people in some other parts of the world consume.)*

- How do the foods you eat and the products you buy affect freshwater resources in a way you never considered before? *(Sample answer: I guess I thought I had no responsibility for the water needed to produce the food I eat and the stuff I buy—that responsibility belongs to the farmers and the manufacturers. It never occurred to me that I can actually make a difference by cutting back or rethinking what I eat and what I buy.)*

- What actions can you take to help conserve freshwater resources directly? *(Sample answer: I can turn off the water when I brush my teeth and I can take shorter showers.)*

- What actions can you take to help conserve freshwater resources virtually? *(Sample answer: I'm not sure yet. Maybe I could do research to find out how much water my favorite foods require. I think eating less meat would be a good way for me to conserve freshwater resources virtually.)*

- How might your attitude toward freshwater resources affect people in other countries? *(Sample answer: I think, as someone who lives in an industrialized nation, I take freshwater resources for granted. If I continue to use so much water directly and virtually, it may have a real impact on people in my community or even in other countries who already have very little to spare.)*

- Are you concerned about water scarcity now or for the future? *(Sample answer: Yes. It seems like more and more places around the country are facing droughts, and people are being asked to make big sacrifices to conserve water. I think it is a real issue for all of us today, not just for people in other countries.)*

- What do you think are the best ways to prepare for or cope with water scarcity? *(Sample answer: I think spreading awareness is the best way. I learned things today that I honestly had never, ever thought about. I think it would be helpful if everyone had the opportunity to think carefully about the issue and educate themselves.)*

ASSESSMENT OPPORTUNITIES

Allow students to choose a way to share what they've learned from this lesson, either by selecting one of the ideas listed on the pages that follow or via a method of their own choosing. Then use the Basic Rubric or create a tailored rubric to assess how well students understood the information in the lesson and how well they were able to express their understanding. Share the rubric with students in advance so they have a clear understanding of expectations. The Reflection Questions above also provide an excellent opportunity for checking students' understanding of key topics. In addition, see the Additional Activities and Extensions section, beginning on the next page, to further check student comprehension as well as to reteach and extend key ideas from the lesson.

DIFFERENTIATION

- For students whose native language is Spanish, you could suggest that they use the Spanish version of the Water Footprint Calculator: calculadoradeagua.org. Also point out that the Water Footprint Calculator site includes water saving tips in Spanish.

- Give students who may struggle with the content of this lesson an overview of the material in advance so they can mentally prepare for the tasks ahead.

- The video Where Is Water? – The Water Rooms #2 (also referenced in the Using Technology section) is another great option for preparing students for the content in advance or reinforcing content after the lesson.

watercalculator.org

CULTURAL ADAPTATION NOTE

As mentioned in the Background Information, it is important to avoid using words like good and bad when discussing the use of water and other products. Such words could leave students feeling shamed, which is not an effective motivator for change. For example, some students may be sensitive to the notion that a water habit they have, such as taking an occasional long shower, is "bad." In addition, be careful to discuss the merits of sustainably produced foods and consumer goods, such as organic produce from a farmers' market, without heavily disparaging less sustainably produced items. Encourage students to come to their own conclusions and to gently help their families shift to more sustainable habits and purchasing practices. Farmers' market produce, for example, is sometimes more expensive than supermarket produce. You may want to encourage students to do research on inexpensive alternatives to current habits and purchasing practices that they can present to their families, rather than assuming families have the means to change all their habits and practices and replace them with new "good" ones.

ADDITIONAL ACTIVITIES AND EXTENSIONS

COMMUNITY CONNECTIONS

- Suggest that students look into efforts in the community to save water. For example, local restaurants might be serving water only on request. They can also look for models of large businesses trying to save water, such as campaigns that are promoted in local stores and other businesses or attached to specific products. Encourage students to share examples they find with the class.

- Fresh, green lawns are popular across the United States in many different forms, from small apartment courtyard lawns, to large front and back yards at single homes, to expansive parks and golf courses. Lawns are wonderful for many purposes, but they usually require a great deal of water for proper growth. Encourage students to pay attention as they are moving through their community to the various types of grass lawns as well as to lawn alternatives, and to take photos of different options. Then encourage them to learn about xeriscaping and other alternatives to grass lawns, such as by reading The Seven Principles of Xeriscape. Then they could summarize their findings by writing their own "Get Along with Less Lawn" article to share with the school community.

ADDITIONAL ACTIVITIES AND EXTENSIONS, continued

CROSS-DISCIPLINARY CONNECTION: LANGUAGE ARTS

Write the following quotation on the board to share with the class:

> "Water, water everywhere, nor any drop to drink."
> —The Rime of the Ancient Mariner,
> by Samuel Taylor Coleridge

Use the quote to stimulate discussion. Begin by asking students what "nor" means in this context. *(not)* Then encourage them to explain in what context a person might feel there is water everywhere but nothing to drink. *(He or she could be floating on a boat in the ocean without any freshwater to drink. Or he could be at the side of a contaminated river or lake, feeling the water source is not safe to drink.)* Interested students may wish to do more research on Coleridge or read the entire poem and then explain to the class why Coleridge might have been expressing this sentiment.

Gustave Doré, *Der alte Matrose*, 1877, from The British Library

CROSS-DISCIPLINARY CONNECTION: MATH

Students interested in math could track precipitation data for their area. A good source for this data is the NOAA National Centers for Environmental Information Climate at a Glance website. From this site, students can find and plot the appropriate data by selecting Precipitation in the Parameter dropdown bar and Annual in the Time Scale dropdown bar. Then they can select the appropriate Start Year, End Year, and State from the dropdown bars. Finally, students can click Plot to view a line graph and corresponding data table with relevant information. If possible, encourage students to also gather predictive data for the area. Students could also use a graph to show droughts that have occurred in your area over a period of time. If you are in an area that is not prone to droughts, students could pick another area to analyze, such as one your community draws resources from that is more prone to droughts. The United States Drought Monitor is a great resource for checking to see if your region is currently experiencing a drought.

CROSS-DISCIPLINARY CONNECTION: SOCIAL STUDIES

Share with students that when a community is experiencing a drought, residents are often asked to limit how often they water their lawn, avoid washing their car, and other activities to conserve water. Ask: When a community then receives abundant rainfall, do you think residents should be allowed to stop conserving water? Share this multimedia article from a community in California to further explore the issue as a class: With the drought over, will cities loosen their strings on watering? Then encourage students to suppose they have a friend who lives in such an area and write them a letter explaining why continuing to conserve water is a good idea.

ADDITIONAL ACTIVITIES AND EXTENSIONS, continued

USING TECHNOLOGY

- An excellent video to help give students perspective is Where Is Water? – The Water Rooms #2 from UNESCO WWAP (United Nations Educational, Scientific and Cultural Organization's World Water Assessment Programme). You may wish to assign this video for all students to view at home before class or for students who seem to struggle to understand key points during class to view as a recap or reinforcement of key ideas covered in this lesson.

- Encourage students to work alone or in pairs to explore the interactive article: 476 gallons of water were used to make this plate. Then regroup as a class and ask students to share what they learned about their preferred foods and whether this sort of technology is useful.

CAREER INSPIRATION

Have students review the article Get to Work! Jobs in Water Protection from the Water Footprint Calculator site. Instruct them to pick one career, find out more about it, and then write a brief synopsis of the career—including educational background requirements, universities offering relevant programs, and local or regional employers offering relevant opportunities—on a large index card. Then have students post their cards around the classroom and host a Water Protection Careers Gallery Walk where they can take a look at each card.

North Atlantic Division – U.S. Army Corps of Engineers. Students from the New York Harbor School, Rocking the Boat, and other partners in the New York and New Jersey Harbor community place oysters in an artificially created reef off Soundview Park in the Bronx, New York.

ADDITIONAL ACTIVITIES AND EXTENSIONS, continued

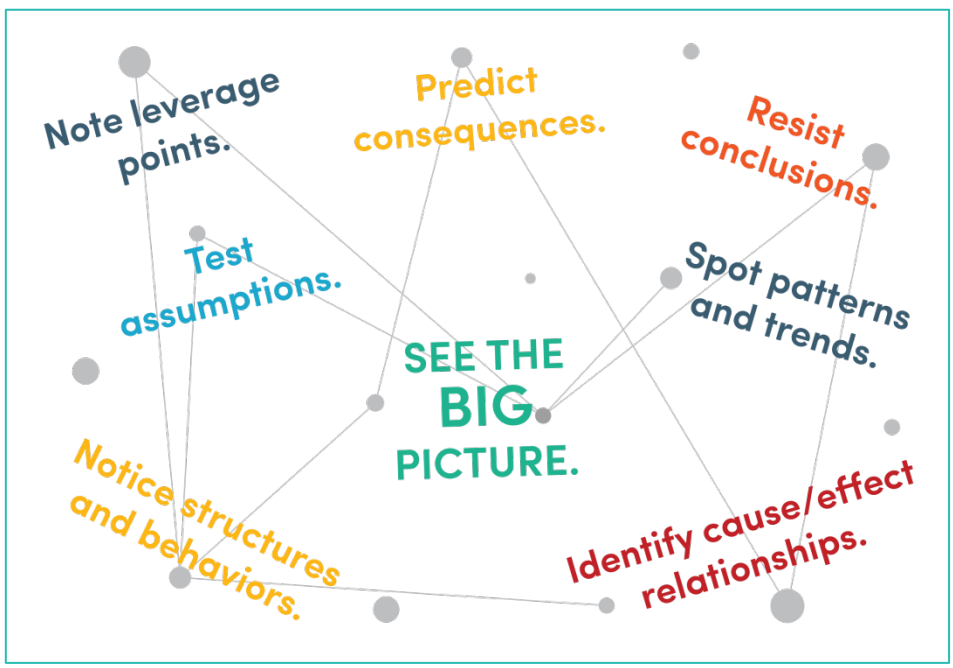
SYSTEMS THINKING

Share with students that systems thinking is a way to examine complex problems and come up with creative solutions. Tell students: Suppose you aren't doing so well in a class. If you are *not* a systems thinker, you might ask your teacher to cut you some slack so you can get back on track. If you *are* a systems thinker, you might:

- List all the factors that have caused you to fall behind in the class.
- Group similar factors.
- Identify cause-and-effect relationships among the factors.
- Brainstorm actions you can take to get caught up.
- Meet with your teacher to share your ideas and come up with a plan together.

You could ask: What are some patterns of behavior that a systems thinker has that a non-systems thinker does not have? He or she:

- Looks at the big picture.
- Searches for patterns and trends.
- Analyzes how a system's structure influences behavior.
- Identifies cause-and-effect relationships.
- Lists and tests assumptions.
- Identifies potential consequences.
- Finds leverage points to improve the system.
- Resists jumping to conclusions.



ecorise.org

Also encourage students to talk about possible results for the two different scenarios. Both approaches could result in the same thing (for example, the teacher cuts the student slack), but the second scenario has broader application (for example, the student has a better understanding of the problem, which leads to less likelihood of repeating the original problem behavior in this and other classes; planning together with the teacher leads to more respect from the teacher, etc.). In other words, instead of making an isolated change, the student has actually made a systemic change.

Now apply that to water use. Discuss how public policies related to water can drive water consumption up or down. For example, in the American West, the "use it or lose it" laws can encourage landowners to overuse water. Explain that water footprints are designed to lead people to make systemic changes. Encourage students to discuss how that might be true. *(Sample answer: Water footprints encourage us to see the big picture, spot patterns and trends, and identify cause and effect relationships that can lead us to make truly impactful progress in water conservation.)* Encourage students to further reflect on the topic by writing a short paragraph about how their work in this lesson is an example of systems thinking. You could then extend the topic by having students read the What Is the Water-Energy-Food Nexus? article and then discuss the article as a class.

RESOURCES/LINKS FOR THIS LESSON

The following resources were cited in this lesson or relate specifically to this lesson:

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RESOURCES/LINKS FOR THIS LESSON, continued

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