

Lesson 15: Using water efficiently

Goals

- Apply reasoning developed in this unit to determine whether a proportional relationship models a situation about water usage.
- Make simplifying assumptions and determine what information is needed to solve a problem about water usage.
- Use proportional relationships to analyse (orally and in writing) a problem about water usage.

Learning Targets

- I can answer a question by representing a situation using proportional relationships.

Lesson Narrative

In this lesson, students use their understanding of proportional relationships to explore whether baths or showers use more water. The warm-up gives students a chance to think about what they would need to know in order to answer this open-ended question and to share their ideas with classmates. In the main activity, students seek out resources to help them answer the question and they create a display to report their findings.

If possible, allow students the chance to work on their own to find values to aid in their solutions. For example, sizes of typical bath tubs are usually listed on websites for hardware stores that carry baths for installation. If these resources are unavailable, some typical ranges are provided or reasonable estimates can be used.

Alignments

Addressing

- Recognise and represent proportional relationships between quantities.

Instructional Routines

- Group Presentations
- Stronger and Clearer Each Time
- Compare and Connect

Required Materials

Internet-enabled device

Tools for creating a visual display

Any way for students to create work that can be easily displayed to the class. Examples: chart paper and markers, whiteboard space and markers, shared online drawing tool, access to a document camera.

Required Preparation

Internet enabled devices are only needed if students will conduct their own research. Tools for creating a visual display are only needed if students are making posters of their methods and results in the second activity.

Student Learning Goals

Let's investigate saving water.

15.1 Comparing Baths and Showers

Warm Up: 5 minutes

This warm-up sets the stage for this lesson. Students are presented with the basic question of whether baths or showers use more water and they brainstorm information that might help them investigate the question.

Launch

"Some people take showers, some people take baths. There is disagreement over which one uses more water. What do you think?" Ask students to think for just a minute about whether they think a shower or a bath uses more water. (This is just to record their first instinct—they should not spend any time researching or calculating right now.) Poll the class and record the total for each category for all to see: "think a bath takes more water" and "think a shower takes more water."

Student Task Statement

Some people say that it uses more water to take a bath than a shower. Others disagree.

1. What information would you collect in order to answer the question?
2. Estimate some reasonable values for the things you suggest.

Student Response

Answers vary. Sample responses:

- Length of the shower: 10 minutes.
- Size of the bath tub: 40 gallons.
- How fast water comes out of the shower head: 2 gallons per minute
- How much of the bath tub is filled with water: 50%

Activity Synthesis

Invite students to share their responses. Record and display their responses for all to see. If these quantities do not come up in conversation, ask students to discuss the ideas and provide reasonable estimates:

- Time spent in the shower
- Volume of the bath tub
- Rate of water coming out of the shower head

15.2 Saving Water: Bath or Shower?

20 minutes

When students are finding values to aid in their method, consider allowing them to research typical values online at hardware websites or search for values that would be useful. If these tools are not available, some values are provided here.

Values that may be useful for students:

- Typical (modern) shower heads have a flow rate of 1.9 to 2.5 gallons per minute. Older shower heads (pre-1992) could have flow rates up to 5.5 gallons per minute.
- Bath tubs hold approximately 120 to 180 gallons of water when completely filled to the top.
- The interior of a typical bath tub has an approximate width of 30 to 32 inches, length of 55 to 60 inches, and depth of 18 to 24 inches.
- There are approximately 230 cubic inches in 1 gallon of water.
- 1 litre of water is 1,000 cubic centimetres.
- 1 litre is approximately 0.26 gallons
- 1 inch is 2.54 centimetres.
- Typical showers last approximately 11 minutes although during a drought, it is recommended to reduce the time to about 5 minutes. During normal circumstances, some people appreciate much longer showers.

After students have made good progress in the activity, tell them to make a display (e.g. poster) to share their method and results.

This activity can take the rest of the lesson, if desired.

Instructional Routines

- Group Presentations
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- Compare and Connect

Launch

Arrange students in groups of 2–4. Tell them either that they should research relative information and provide access to internet enabled devices or tell them that they can ask for the information they need.

Action and Expression: Internalise Executive Functions. To support development of organisational skills, check in with students within the first 2–3 minutes of work time. Check to make sure students have a valid method for comparing the water usage for a bath and a shower prior to allowing them to research typical values of measurements.

Supports accessibility for: Memory; Organisation

Student Task Statement

1. Describe a method for comparing the water usage for a bath and a shower.
2. Find out values for the measurements needed to use the method you described. You may ask your teacher or research them yourself.
3. Under what conditions does a bath use more water? Under what conditions does a shower use more water?

Student Response

Answers vary. Sample responses:

- For a bath filled with 40 gallons of water and a shower head that uses 2 gallons per minute, any showers less than 20 minutes long will use less water than a bath. Longer showers will use more water than a bath.
- For a bath filled with 30 gallons of water and a shower head that uses 4 gallons per minute, any showers less than 7.5 minutes long will use less water than a bath. Longer showers will use more water than a bath.
- A 10 minute shower with a 3.5 gallon per minute shower head will use 35 gallons of water. Filling the bath with less water than that will use less water than the shower. A bath that is filled more than that 35 gallons will use more than the shower.

Activity Synthesis

Allow students to share their displays possibly through a gallery walk or ask them to present to the class. After students have had a chance to explore their work, ask them to share ideas they saw that were interesting and any methods they considered but did not use.

Writing, Representing: Compare and Connect. Use this routine when students present their visual displays. Ask students to consider how comparisons were made between water usage of baths and showers. Draw students' attention to the relationships between

quantities in each situation (e.g., How does the rate of water flow from the shower affect water usage? How does tub size affect the comparison?). Emphasise language used to make sense of strategies used to calculate and compare water usage.

Design Principle(s): Maximise meta-awareness; Support sense-making

15.3 Representing Water Usage

Optional: 10 minutes

This optional activity gives additional review for the material from the unit in the context of this lesson. Students build on the work they did in the previous activity and see that water used in the shower is proportional to time spent in the shower, with constant of proportionality equal to the flow rate of the shower head.

Instructional Routines

- Stronger and Clearer Each Time

Launch

Keep students in the same groups.

Fine Motor Skills: Peer Tutors. Pair students with their previously identified peer tutors and allow students who struggle with fine motor skills to dictate graphing as needed.

Action and Expression: Provide Access for Physical Action. Provide access to tools and assistive technologies such as a graphing calculator or graphing software. Some students may benefit from a checklist or list of steps to be able to use the calculator or software.

Supports accessibility for: Organisation; Conceptual processing; Attention Writing, Conversing: Stronger and Clearer Each Time. Use this routine to help students improve their writing, by providing them with multiple opportunities to clarify their explanations through conversation. Give students time to meet with 2–3 partners to share their response to the first question. Students should first check to see if they agree with each other on whether the two quantities they identified represent a proportional relationship. Provide listeners with prompts for feedback that will help their partner add detail to strengthen and clarify their ideas. For example, students can ask their partner, “How do you know they are proportional?” or “What do you mean . . . ?” Then provide students with 3–4 minutes to revise their initial draft based on feedback from their peers. This will help students understand quantities that do and do not represent proportional relationships through communicating their reasoning with a partner.

Design Principle(s): Optimise output (for explanation); Maximise meta-awareness

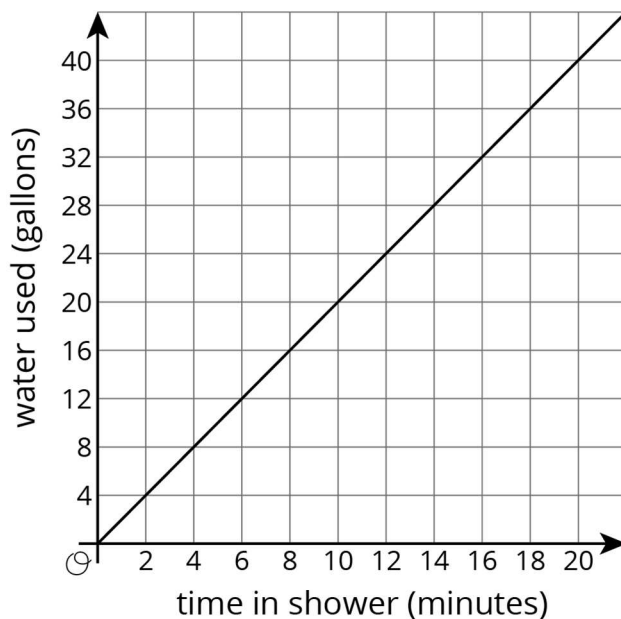
Student Task Statement

1. Continue considering the problem from the previous activity. Name two quantities that are in a proportional relationship. Explain how you know they are in a proportional relationship.

2. What are two constants of proportionality for the proportional relationship? What do they tell us about the situation?
3. On graph paper, create a graph that shows how the two quantities are related. Make sure to label the axes.
4. Write two equations that relate the quantities in your graph. Make sure to record what each variable represents.

Student Response

1. Amount of water used in the shower and time spent in the shower is a proportional relationship. Explanations vary. Sample explanation: The amount of water used divided by the amount of time spent in the shower is always the same constant.
2. Answers vary. Sample response: 2 gallons per minute and $\frac{1}{2}$ minute per gallon.
3. Answers vary. Sample response: Constant of proportionality: 2 gallons per minute.



4. Answers vary. Sample response: $w = 2t$ where w represents the amount of water used in the shower and t represents the amount of time in the shower.

Activity Synthesis

Instruct students to add this information to their displays from the previous activity. Invite students to share their reasoning.

Consider asking discussion questions like these:

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- “Do you agree or disagree? Why?”
 - “Did anyone solve the problem the same way but would explain it differently?”
 - “Who can restate ___’s reasoning in a different way?”
 - “Does anyone want to add on to ____’s strategy?”



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