

Runaway Rain

Goal: In cooperative groups, figure out a way to determine the yield (in gallons) of an average month's worth of precipitation on a roof model. Share and compare problem-solving strategies with other groups.

Investigative Question: If your building was real, how many gallons of water fall on your roof, on average, in a month?

Objectives:

Knowledge- Rainfall is measured with a rain gauge. Models are used in math and science to represent things and systems that are too big, too small, or too complicated to work with easily.

Skills- Students use rulers to measure length, work collaboratively in a small group, and compare mathematical problem solving strategies. Students convert measurements between inches, feet, and yards (multiplication, division, addition, subtraction). In discussion, students justify use of multiplication versus addition, or division versus subtraction. Students explain their problem solving process orally and on paper using pictures, numbers, and words.

Values- There often are multiple ways to approach/solve a problem and multiple ways to represent the process/solution. Working together sometimes yields more possibilities than working individually. The volume of rain water that falls onto some surfaces can be captured and put to better use.

Grade: 4th

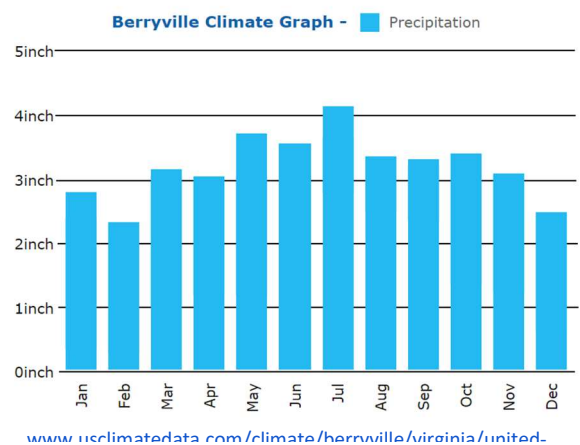
VA Standards addressed: Science (2018) 4.1, 4.2, 4.4; Math (2016) 4.4; 4.7 a; 4.8; 4.16

Materials:

- Dry erase/black board & markers/chalk for modeling the procedure and recording hints
- Student roof models in whole-inch measure (1/student group)
- 12 inch rulers
- Water use tables from Project WET and Picture Perfect Science
- Berryville Climate Graph - Precipitation
- Large paper and tools for recording the process
- 1-inch square (flat) and cube manipulatives to help students visualize rainfall (recommended that these be kept in a container that students can use if necessary - for a 7 x 5 inch roof, almost 100 will be needed!)
- Calculators (at teacher's discretion)
- Water use table (shows average volume of water used for common activities)
- Rain gauge (Optional)
- Student recording sheet (word problems – can be on one sheet or multiples)

Background Information

- For every square foot of space, 3 inches of rain, yields about 2 gallons (1.87 gal, exactly).
- Clarke County, VA gets approximately three inches of rainfall a month (actual annual average $38.27'' = 3.19''$ monthly)
www.usclimatedata.com/climate/berryville/virginia/united-states/usva0061
- Try solving the problems yourself to anticipate student processes.



References

Ansberry, K., & Morgan, E. (2010). *Picture Perfect Science Lessons: Using Children's Books to Guide Inquiry, 3-6* (Expanded 2nd ed.). Arlington, Va: NSTA.

Kazemi, E., & Hintz, A. (2014). *Intentional Talk: How to Structure and Lead Productive Mathematical Discussions*. Portland, Maine: Stenhouse Publishers.

Project WET Foundation. (2013). *Project WET Curriculum and Activity Guide 2.0*. Bozeman, MT: Project WET Foundation.

Schwan, M., & Smith, M. (2011). *5 Practices for Orchestrating Productive Mathematics Discussions*. Reston, Va: National Council of Teachers of Mathematics.

SUMMARY OF WORD PROBLEMS:

Word Problem #1: How many 1 inch squares does it take to cover a roof model 9 inches long and 4 inches wide?

Word Problem #2: On average each month, about 2 gallons of rain fall on each 1 foot by 1 foot square in Clarke County. How many gallons of rain fall on a roof model 9 “feet” long and 4 “feet” wide?

Word Problem #3: How many different combinations of daily household activities can you find to use all the water that can be collected from the model roof in an average month?

Word Problem #4: How many toilet flush and hand wash combinations can be done using an average month’s worth of water from your school’s roof? (47,000 sq. feet - DG Cooley Upper Campus or 52,000 sq. feet – Boyce Elementary).

Procedure/Instructional Strategy:

1. Hook/Engage: Initiate a class conversation about what happens to rainwater that hits the roof of their school.
 - a. Guiding Questions: Consider the following questions to guide the discussion:
 - i. How much water falls on a roof in a month?
 - ii. Does the same amount of water fall in all places in the United States, in Virginia?
 - iii. Where does the water go?
 - iv. Can the water from rainfall cause any problems?
 - v. Do people do anything to catch the rainwater? How and Why?
 - b. Discussion: Understanding the problem and making a plan: *Ask students:* What kind of information do we need to know to find out how much rain falls on our school roof in a month? Guide students to include: How big is the roof? (How can we figure out how big it is?) How much rain falls *in Clarke County* on a *monthly average*? (How could we find that out? See link and graph in background knowledge section)
 - c. Why are we using a model? Explain that students will use modeling (a mathematical and scientific tool that helps us understand the ways that big/small/complicated systems work) to build an understanding



of just how much rain can fall on a roof! Even with the model, it takes many steps to solve such a big problem so students can do the work step-by-step.

- d. Define expectations: Tell the class that they will work in their groups to find out how much water the average monthly **precipitation** their **model** yields, then share their problem solving strategy with the rest of the class.

1. **How big is it - Word Problem #1:** How many squares with sides of 1 inch does it take to cover a model roof 9 inches long and 4 inches wide? Student partners determine how many squares 1" x 1" fit on a small roof model using pictures, numbers, gestures, tools, and words to document the process.
 - a. Finding a solution: Students work with a partner to figure out how many squares one inch long and one inch wide (we call this a **square inch**) can fit on the roof model. Provide rulers, inch square manipulatives, pencils, and paper. Encourage them to talk through different methods, and to use pictures, numbers, gestures, tools, and words to document the process.
 - b. Mediate Discussion: Select groups to share in a deliberate order, or request volunteers. Make connections between different techniques, and ask other students for their thoughts on the method.
 - c. Discussion - Open Strategy Sharing: Students will share the variety of strategies they used to solve the problem.

2. **How much water - Word Problem #2:** On average each month, about 2 gallons of rain fall on each 1 foot by 1 foot square in Clarke County. How many gallons of rain fall on a roof model 9 "feet" long and 4 "feet" wide?
 - a. Background Information: Every month, about 2 gallons of water falls per square foot in Clarke County.
 - b. Finding a solution: Working independently, with a partner, or in small groups, students will figure out how much water would fall on the roof in an average month. Provide rulers, inch square manipulatives, pencils, paper, and their previous work. Encourage them to talk through different methods, and to use pictures, numbers, gestures, tools, and words to document the process. *Remind students that in the model, 1 inch represents 1 foot!*
 - c. Mediate Discussion: Select groups to share in a deliberate order, or request volunteers. Make connections between different techniques, and ask other students for their thoughts on the method.
 - d. Discussion - Targeted: This more focused sharing involves specific goals, like defining and using key terms or concepts correctly, revising an incorrect strategy, or making sense of a particular representation. The students listen to and contribute ideas in order to move toward consensus. (Kazemi & Hintz, 2014, p. 3)

3. **Make it relevant - Word Problem #3:** How many different combinations of daily household activities can you find to use all the water that could be collected from the roof model in an average month? Students figure out how the average monthly rainfall from their roof model could be used.
 - a. Connect to previous work: Ask students to look at their previous work to determine how much water falls on the roof model in an average month. *Inquire:* Can that water be captured? If so, how can it be used?
 - b. Interpret Data: Have students look at the Water Diary from the Picture Perfect Science lesson, *Down the Drain* (Ansberry & Morgan, 2010, p. 369). Describe some of the ways that we use water in our homes. *Ask:* How often do you do each of these activities? (one or multiple times in a month/week/day)
 - c. Finding a solution: Students work to find as many combinations of activities to use as much of the water as possible. If working in groups or partnerships, encourage them to talk through different methods, and to use pictures, numbers, gestures, tools, and words to document the process.
 - d. Observe and assess: Listen to and observe student methods as they work through the problem. There are an enormous number of possible combinations, students will need to devise strategies to keep track



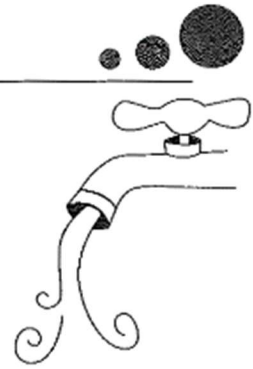
of the sets they have found. Guide as necessary, but also select the methods of a few to share during discussion.

- e. Discussion - Open Strategy Sharing or Targeted Discussion: After a few moments of independent work, a quick sharing of organization strategies may help students keep track of their math. Ask students to share how they're keeping track of and finding new combinations.
 - f. To continue calculating?: It is unlikely that the class will find all possible combinations in a single class period. Instead, ask for insights about how the water collected could be used. Would it last very long? What about if the roof were bigger?
4. **Apply it! Word Problem #4**: If the school roof is (47,000 square feet - DG Cooley Upper Campus or 52,000 square feet – Boyce Elementary), how many toilet flush and hand wash combinations could be done with an average month's worth of water from your school's roof? Inform students that they will be working in teams to figure out how much rain falls on their school roof in an average month, and how that water can be used.
- a. Finding a solution: Students will work to find a solution working independently, with a partner, or in small groups. Provide rulers, inch square manipulatives, pencils, paper, and their previous work. Encourage them to talk through different methods, and to use pictures, numbers, gestures, tools, and words to document the process.
 - b. Observe and assess: Listen to and observe student methods as they work through the problem. Guide as necessary, but also select the methods of a few partnerships to share during discussion. If students are 'stuck', suggest they first review their previous work to search for similar problems and then consult another group that has already addressed the issue they're having. If many groups have a similar issue, address it as a class.
 - c. Discussion - Open Strategy Sharing or Targeted Discussion
5. Close the activity(s): Have student groups share their problem-solving process. Compare processes to illustrate multiple methods of problem solving, or to support particular mathematical skills/concepts. Connect the project to real-world issues, and encourage students to extend the problem into new questions.
- a. Real-World Application: Take time to investigate the water use chart, and consider other ways you use water. In addition, what problems could the water that falls on a roof pose to the building or landscape? How could those problems be addressed?
 - b. Develop own word problem: Point out to students, this is like a science experiment, now that you have your conclusion, what questions can you test next? Students can create their own word problems.



Name: _____ Date: _____

Water Diary



Word #1: How inch does it cover a model 9 long and wide?

Number of people living in household: _____
 How many gallons of water do you predict your household uses in one day? _____

Problem many 1 squares take to roof inches 4 inches

Directions: During the day, make a tally mark in the appropriate row each time someone in your home uses water. Then calculate the total gallons your household used for each activity by multiplying the total number of times for each activity and the average amount of water used for that activity. Finally, calculate the total number of gallons your household actually used for the whole day by adding the water totals for each activity. (This total will be shared with the class anonymously.)

Water Use Activity	Number of Times (tally marks)	Total Number of Times (number)	Average Amount of Water Used (gallons)	Total Water Used for Each Activity
Washing machine			25	
Bath			20	
Dishwasher			20	
Shower			10	
Toilet flush			3	
Brushing teeth with water running			1	
Washing hands with water running			1	

Total gallons used in a day	
Number of people in your household	
Average water use per household member (Total gallons used ÷ number of people)	

How did your prediction compare to the actual amount of water your household used in one day? _____



Word Problem #2: On average, each month of the year, about 2 gallons of rain fall on each 1 foot by 1 foot space in Clarke County. How many gallons of rain falls on a model roof 9 “feet” long and 4 “feet” wide?



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Word Problem #3: Use the Water Diary table from your teacher to solve this problem.

How many different combinations of daily household activities can you find to use all the water that can be collected from the roof model in an average month?



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Word Problem #4: How many toilet flush and hand wash combinations can be done with an average months' worth of water from your school's roof?

D. G. Cooley Elementary School roof is 47,000 square feet

Boyce Elementary School roof is 52,000 square feet

