WAMC Lab Template

Math Concept(s): Evaluate how diameter of a pipe affects the flow rate of liquid and model
Source / Text: NA
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Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

Students will construct a flow tank that allows for different size pipes (straws) and measure the flow rates given the size of the pipe. The students will create three linear equations, one for each size pipe. Students will then answer questions about how large pipes they will need to meet the demands of customers.

Lab Plan

Lab Title: Why Water Towers?

Prerequisite skills: Students will need to know how to write a linear equation given data from a table, use a ruler, measure a diameter, calculate volume, and calculate area of a circle.

Lab objective: Students will construct a flow tank that allows for different size pipes (straws) and measure the flow rates given the size of the pipe and apply this information to real life problems.

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*

Mathematics K–12 Learning Standards:

- F-BF.1 “Write a function that describes a relationship between two quantities.”’
- S-ID.7 “Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.”
- S-ID.8. “Compute (using technology) and interpret the correlation coefficient of a linear fit.”

Standards for Mathematical Practice:

- SMP 1. Make sense of problems and persevere in solving them.
- SMP 4. Model with mathematics.
- SMP 5. Use appropriate tools strategically.
- SMP 6. Attend to precision.

K-12 Learning Standards-ELA (Reading, Writing, Speaking & Listening):

- SL.9-10.1 “Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics,

texts, and issues, building on others' ideas and expressing their own clearly and persuasively"

- SL.9-10.1d "Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented."

K-12 Science Standards

- HS-PS3-3 Energy Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy

Technology

- 1.c. Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

Engineering

- HS-ETS1-2 "Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering."

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☒ Global Awareness ☐ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☒ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION

Creativity and Innovation
☐ Think Creatively
☒ Work Creatively with Others
☐ Implement Innovations

Critical Thinking and Problem Solving
☒ Reason Effectively
☐ Use Systems Thinking
☒ Make Judgments and Decisions
☒ Solve Problems

Communication and Collaboration
☒ Communicate Clearly
☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS

Information Literacy
☒ Access and Evaluate Information
☒ Use and manage Information

Media Literacy
☐ Analyze Media
☐ Create Media Products

Information, Communications and Technology (ICT Literacy)
☒ Apply Technology Effectively

LIFE & CAREER SKILLS

Flexibility and Adaptability
☒ Adapt to Change
☒ Be Flexible

Initiative and Self-Direction
☒ Manage Goals and Time
☐ Work Independently
☐ Be Self-Directed Learners

Social and Cross-Cultural
☒ Interact Effectively with Others
☐ Work Effectively in Diverse Teams

Productivity and Accountability
☒ Manage Projects
☒ Produce Results

Leadership and Responsibility
☒ Guide and Lead Others
☒ Be Responsible to Others

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

- Large Plastic Cups
- Multiple varied size straws (coffee, traditional, milkshake, etc…)
- Water
- Water Dye
- Water sealing putty (Loctite/Epoxy Putty Stick)
- Scissors
- Ruler
- Computer or Chromebook with access to desmos online calculator
- Stopwatch
- Micronometer

Set-Up Required:

- Get all of the supplies.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Students will work in groups of 3. The students will have the roles of facilitator, constructor, and data analysts. The facilitator will get material, keep the group on task, will write answers on handout, and will lead the presentation at the end of the lab. The constructor will direct the build of the flow tanks, maintain the flow tanks, and record time of water flow. The data analysts take all other measurements and document them and input values and equations into desmos.

Cooperative Learning:

- Students will be required to work in cooperative groups to produce results and develop a presentation.

Expectations:

- Students will construct a flow tank and test multiple size pipes and develop linear equations to model flow. Then, students use data, and equations to answer consumer questions on flow rate demands.

Timeline:

- 5 days or 275 minutes.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- What careers need this type of information? What day to day activities require a consistent flow rate? How would this affect our economy if the government could not predict flow rate?

Career Applications

- Public Works
- Engineering
- Plumbing

Optional or Extension Activities

- How would the flow rate change with a different liquid? How would the flow rate change if the size of the hole in the top container was different from the opening at the end? Would the flow rate change if the straw or pipe was really long?

Lab Instructions

- Ask students what are the point of water towers? Follow up with a discussion about how they help maintain flow rate and pressure. Give New York High risers as an example.
- Launch the lab explaining they will be creating small scale water towers which we will call flow tanks.
- Then explain the roles of facilitator, constructor, data analysts along with the learning goal and expectations of the lab.
- Have the facilitator get supplies and the students begin working on the project.
- Monitor student progress and facilitate learning.

Hints

- Have the students use the ruler to mark centimeter height on the cups to use for flow rate.
- If volume flow rate would be too challenging, instead have the students measure how quickly the height decreases or increases.

Why Water Towers?

Names:_____

_____

_____

1. Construct your flow tank using the scissors, straws, cups, and putty. Test for a water tight seal.
2. Fill the top container with different amounts of liquid and measure the amount of time it takes for the container to empty. Record all data and do this for three different size pipes and at least 4 different amounts of liquid.

Diameter of Pipe:	
Starting height (cm)	Time to empty (sec)

Diameter of Pipe:	
Starting height (cm)	Time to empty (sec)

Diameter of Pipe:	
Starting height (cm)	Time to empty (sec)

3. Write an linear equation for the flow rate for each size pipe. Show all your thinking.

4. How long will it take to move 500 cm^3 of liquid using each size pipe? Show all your thinking.

5. How much liquid could you move in 36 minutes for each size pipe? Show all your thinking.

6. Write an equation for the with the flow rate as the dependent variable and the diameter of the pipe as the independent variable. Show all your thinking. Hint: it may be helpful to use the table given.

Diameter of Pipe (cm)	Flow rate

7. Research flow rate equation. What connections does your equation has with what information you found? You may need to convert your units.

8. Using your equation answer the following questions. Show all your thinking.
    a. How large of a pipe would you need 2 gallons per minute.

    b. What would be the flow rate of a pipe 10-inch diameter pipe.

9. What jobs or careers would this information be useful?

Partner Evaluation

Name of Partner________________________

Key
Not Observed
Approached
Met
Exceeded

		Participation and Involvement					
		0	1	2	3	4	5
Persevered through Stuck Points	0						
	1						
	2						
	3						
	4						
	5						

Name of Partner________________________

Key
Not Observed
Approached
Met
Exceeded

		Participation and Involvement					
		0	1	2	3	4	5
Persevered through Stuck Points	0						
	1						
	2						
	3						
	4						
	5						

Evaluation Rubric for Lab

Evidence can come from the presentation, observations, and student handout.	Great job! Fully developed reasoning (3 Points)	Almost there: Partially developed reasoning (2 points)	Getting there: Incomplete thinking (1 point)	Missing: No reasoning (0 points)
Construct a Flow Tank (problem 1)				
All data has been collected (problem 2)				
Has three equations of the flow rate for each pipe (problem 3)				
Accurately answered the applied flow rate problems (problems 4 and 5)				
Has a reasonable flow rate equation (problem 6)				
Complete research of the flow rate equation online (problem 7)				
Accurately answered the applied flow rate problems (problem 8)				
Precision and Accuracy				
Communicates clearly and uses appropriate mathematical vocabulary				
Uses appropriate tools, including technology, strategically				
Total out of 30 points				