Lesson Title	Water: How fast does it flow; How much can be held?
Length of Lesson	50 minutes
Created By	Corey Ladner
Subject	Geometry – Measurements
Grade Level	10^{th} – 12^{th}
State Standards	4.c
DOK Level	DOK 2
DOK Application	Cause/Effect, Infer, Interpret, Distinguish, Make Observations, Relate and Compare.
National Standards	Geometry Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships Problem Solving Build new mathematical knowledge through problem solving Apply and adapt a variety of appropriate strategies to solve problems
Graduate Research Element	In my research, water discharge of streams is influenced by combining properties of stream cross-section area, stream flow velocity and volume of water the stream is capable of supporting.

Student Learning Goal:
The students will solve real world and mathematical problems involving area and volume of three-dimensional figures, such as cylinders, prisms, and spheres. This lesson will observe on the relationship of volume, velocity, and area with the use of water and cylindrical, prismatic, and spherical shaped objects.

National Standards:
Geometry:
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
Problem Solving:
Build new mathematical knowledge through problem solving
Apply and adapt a variety of appropriate strategies to solve problems

Materials Needed (supplies, hand-outs, resources):

Hand-outs of assessment and dataset (Ladner_assmt_dataset_6.29.12), clear containers, drainage valves, various sizes of PVC pipe and fittings, various sizes of funnels, measuring cups, water.

Lesson Performance Task/Assessment:
The students will be presented with a real world situation and be asked to provide a mathematical analysis of a given dataset of stream discharge values. They will exhibit their knowledge on the subject by participating in an inquiry based discussion and proper analysis of the given data. The students will choose a combination of the given discharge values that will combine to fill a reservoir lake of a certain volume in the least amount of time while not exceeding a given threshold volume of flow per unit of time. After developing possible solutions to the problem, students will be asked to explain how volume, velocity, and area affected each other in the situation.

Lesson Relevance to Performance Task and Students:
The lesson provides the students with real world problems involving volume, area and three-dimensional figures as well as their effect on velocity and time.

Anticipatory Set/Capture Interest:
The teacher will capture the students' interest by initiating inquiry with the question: How fast does water flow? Then have short class discussion on how could you find out the answer to this question.

Guided Practice:
The teacher will begin by presenting the students with the real world situation and describe a dataset related to the situation. A dataset of real world discharge values will be provided to the students. The data sheet will be explained to the students as the values needed to solve the problem described in the lesson performance task. The teacher will use a PowerPoint presentation to describe where the data were collected, why they were collected, and how the data are related to the simulated problem they are being asked to solve. The students will then go through a review of the equations and calculations involved with the problem. Afterwards, the students will be allowed time to calculate a solution to the problem. Once the students have had time to solve the problem, the teacher will discuss the solution with the students and consider other inferences that can be made from the data. Following the discussion, the students will apply the real world example to a similar hands-on activity presented in the independent practice.

Independent Practice:
The students will be divided into groups of three and introduced to an activity where the students will experience the relationship of volume, velocity, and area by attempting to transfer a given amount of water from one container to another while trying to avoid induced limits. Each group will be given a clear container, each having a drainage system of a different size or volume. The students will also be given a second container, each

having an entrance funnel of a different size opening and volume. Based on the set of equipment each group receives, the students will be asked to make a prediction of whether they will be able to transfer the volume of water from one container to the other at a steady rate of flow without spilling water from the funnel or overflowing the second container. The equipment should be designed so that some systems can transfer the volume of water effectively, while the others cause spilling or overflowing due to unequal configurations. Once the students have shown that they have completed the assignment, the following questions will be asked:

Why did your system transfer or fail to transfer the water effectively?

Do you think the outcome is correlated to the volumes of the two containers?

If your system did not work effectively, how would you change it based on area, volume, and flow velocity, so that the water can be transferred without spilling or overflowing?

Remediation and/or Enrichment:

Remediation:

In the case that remediation is needed, the student can meet with the instructor for individual tutoring. The student can also be grouped with a higher performing student that understands the lesson.

Enrichment:

In situations where there is complete understanding and performance, the lesson can be extended by incorporating the concepts and equations of area, velocity, and discharge into methods used for calculating discharge through a cross-section of stream channels.

Check(s) for Understanding:

The students will be asked to provide answers to the following questions related to the independent practice section.

How are area and volume related?

How does area effect flow velocity?

How is the time required to fill a certain volume with a liquid affected by restricting the flow velocity?

Closure:

The teacher will close the lesson by asking the students about their personal experiences that can be related to volume and flow such as: Have you ever overflowed the dishwater in the kitchen sink or bathwater in the tub?, Have you ever spilled your cereal or soup

because you mistakenly didn't have a big enough bowl? Additionally, I will share with the students how the concepts of the lesson relate to problems addressed in my research.

Possible Alternate Subject Integrations:
This lesson can be easily incorporated into high school physics, physical science, biology, and chemistry courses.

Teacher Notes:

Attachments

- PowerPoint Presentation(Ladner_ppoint_6.29.12), Assessment and Dataset document(Ladner_assmt_dataset_6.29.12)
- Note: Specifics of Guided and Independent Practices are tentative and subject to change if needed.