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The Rubber Duck Race

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Grade level: 8th – 9th grade,
Topics:

- Math: equation of a line, analyzing graphs, real life applications, word Problems
- Earth Science: Transport sediments via water, streams

Rationale: We developed the Rubber Duck Race to demonstrate different currents associated with meanders of a stream. This demonstration could be used during the unit on streams in an Earth Science classroom. We would investigate about how the meander, or bend in a river, affects the speed of the current in the stream. Through this project, we could demonstrate visually the affects meanders have on a river's natural flow. In a mathematics classroom, the Duck Race could be used to investigate a distance problem. We could observe how the ducks moved over a certain distance at various rates and therefore affected the time required to finish the race.

The students will be asked to make a comparison between the ducks behavior floating down stream and how sediment may travel down stream. This demonstration is a basic model of the differing velocities across a stream; therefore there are several limiting factors that have not been taken into account such as deposition and erosion within the river.

The concept of velocity differences through meanders of a stream appears to be difficult for students to understand. This concept is not easily observable (unless you can take a field trip and have access to a fast moving meandering stream to make these observations on).

In excel we have a linear representation of distance over a specified time. For the Duck Race the ducks are traveling at different velocities throughout the race. The ducks' velocity is dependent on the path the ducks follow in the stream. The question we would present to the students is; if the velocity of a duck is changing, how would this graph look different? Could one estimate the distance traveled for a duck based on the graph?

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Importance/purpose: Mathematically the purpose of this exercise is to show that graphs are not a perfect representation of a concept; there are flaws and assumptions made. Students will be engaged in higher order thinking as they work through word problems for this demonstration.

Scientifically, the concept of erosion/deposition along a meandering stream and the water's differential velocity can come into play in several areas of life. Recreationally; this would be important for rafting, canoeing, kayaking, fishing etc. When looking for a place to buy or build a house, erosional and depositional features of a stream would be important to understand when trying to make an educational decision on where to live.

Standards

- Math Standards: CCSS.Math.Content.HSF-LE.A.1a Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals, CCSS.Math.Content.HSF-LE.A.1b Recognize situations in which one quantity changes at a constant rate per unit interval relative to another, CCSS.Math.Content.HSF-LE.A.1c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

- Old Standards: Science Standard: Performance Indicator 2.1 Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.

    - 2.1v Patterns of deposition result from a loss of energy within the transporting system and are influenced by the size, shape, and density of the transported particles. Sediment deposits may be sorted or unsorted.

- Next Generation Standards:
    - HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.[Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples

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of mechanical investigations include stream transportation and deposition.

- Crosscutting Ideas:
  - Stability and Change
  - •Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7)
- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2)

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Rubber Duck Race Worksheet

The Rubber Ducks will race through a meandering stream during this demonstration.

While watching the ducks float downstream:

What are your observations?

What do you notice about the speed of the ducks?

Who finishes first, last? Why might they have finished in this order?

How can the speed of the ducks be related to the features of the stream?

Compare the duck race to how sediment/rocks would act in a stream? Will sediment always make it to the end?

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Duck Trip: NYC to West Palm Beach

1. According to our information, if Daffy Duck leaves NYC on Monday July 22 and is headed towards West Palm Beach which is 1245 miles away, what day should he expect to arrive?

2. In the same fashion, if Daffy got to West Palm Beach and turned around immediately to go home, what day would he arrive in NYC?

3. Please construct a roughly sketched graph depicting Daffy leaving NYC and traveling four days towards Florida, stopping three days to see his cousin Donald Duck in North Carolina, and finishing his trip to West Palm Beach.

4. After arriving in West Palm Beach, Daffy decides he is going to buy flippers to make his trip home faster. If Daffy buys flippers that will reduce his travel time by 35%, how many days will it take him to get home?

5. This graph representation is not fully realistic. Name two factors that could impact the progress Daffy makes.

6. Using the factors you listed in question 5, create the a realistic graphical representation of Daffy's trip from NYC to West Palm Beach.