MAKING WAVES AT DCS

DHS Math Classes Collaborate on Water Bottle Rocket Experiments

When DHS math teacher Drake Reinert shared a classroom water bottle rocket project during the “good news” portion of a staff meeting, little did he know that it would grow into a cross-collaboration between four math classes ranging from pre-algebra to AP calculus.

Reinert, during an earlier conversation with DHS science teacher Beau Kimmey, mentioned he would like to incorporate a hands-on component to his quadratics unit. Kimmey replied that his students have launched water bottle rockets when learning about aerodynamics, but it could easily be applied to quadratics as well. When Reinert shared the “good news” about that productive conversation, fellow DHS math teachers Ryan Fisher, Matt Inch, and Al Snider agreed it was an exciting project and wanted to bring their classes on board. The group began brainstorming how they could use the experiment and collected data in their individual lesson plans.

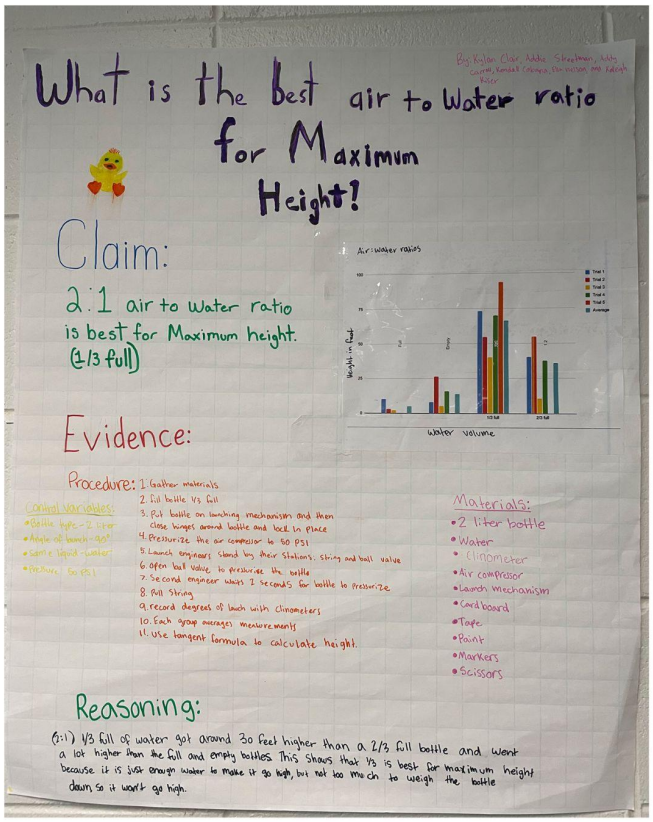
Designing the rockets and collecting data took place over a three-day period. Students worked in small groups to perform test launches on the first day, gathering observations and asking questions to fine-tune their rocket. On the second day, each group built a clinometer (an instrument used for measuring angles of slope, elevation, or depression of an object with respect to gravity's direction) to measure height, then practiced using it on stationary targets such as the school roof or the flagpole. Using the data collected on days one and two, groups then turned their questions into experiments such as "how high will the rocket launch with 100 psi," or "how can we calculate the optimal psi?" These questions were the basis for day three's launch protocol. Rockets are pressurized using water and air, and launched by string pull from a distance of 20 feet.

Because the level of difficulty between the classes ranges from beginning algebra to advanced calculus, the five teachers determined specific parameters for each class's launch. Pre-algebra and algebra students (mostly freshman and sophomores) explored the optimal type of bottle, PSI needed for launch, water to air ratio, and angle of the launch. All students determined independent, dependent and controlled variables for their experiment; pre-algebra students had set procedures from which to build their rockets, while algebra students had more design flexibility. Both classes used linear data and some quadratic equations to plot a graph line of best fit based on the data from the trials. The goal was to calculate the optimal height and distance their rocket can achieve.

AP Calculus and IB Math students then took the data provided by pre-algebra and algebra students a step further, performing quadratic equations to calculate how the rockets they design can hit precise targets.

This project demonstrates first-hand math competencies including calculating averages, graphing linear data, using quadratic equations to make predictions, using math to create CER (Claim, Evidence, Reasoning), and using math and engineering to design the rockets. Calculus and IB Math students also used functions to predict flight patterns, which are very difficult math calculations.

Reinert hopes to implement this project every year; he and Inch teach all sections of algebra, so students will come into algebra knowing this class is where you get to shoot water bottle rockets and create experiments from scratch. This hands-on, project-based learning style helps students make more meaningful connections with math concepts, showing real-life applications of the calculations and encouraging higher-level thinking and problem-solving.


What is the best air to Water ratio for Maximum Height!
Claim:
2:1 air to Water ratio is best for Maximum height. (1/3 full)
Air: Water ratios
Weight in Feet
Water Volume
Evidence:
Procedure:
1. Gather materials
2. Fill bottle 1/3 full
3. Fill bottle on launching mechanism and then close hinges around bottle and lock in place
4. Pressurize the air compressor to 60 PSI
5. Launch engineers stand by their stations: string and ball valve
6. open ball Valve to pressurize the bottle
7. Second engineer waits 2 seconds for bottle to pressurize
8. Pull String
9. record degrees of launch with clinometers
10. Each group averages measurements
11. use tangent formula to calculate height.
Control Variables:
•Bottle type - 2 liter
•Angle of launch - 90°
•same liquid - water
•Pressure - 60 PSI
Materials:
•2 liter bottle
•Water
•clinometer
•Air compressor
•Launch Mechanism
•Cardboard
•Tape
•Paint
•Markers
•Scissors
Reasoning:
(2:1) 1/3 full of water got around 30 feet higher than a 2/3 full bottle and went a lot higher than the full and empty bottles. This shows that 1/3 is best for maximum height because it is just enough water to make it go high, but not too much to weigh the bottle down so it won't go high.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