Welcome!

Gauge your knowledge of Simple Machines with SMATH-O!

HAWKEN SCHOOL

Simple Machines Design Challenge for Math & Science Students NCTM National Conference 2017 203 Session

Presented by: Anna Delia – Middle School Assistant Director & Science Teacher

Curriculum Created by Anna Delia & Kim Brandt

(7th Grade Math and Program Dean)

Hawken School

Our Purpose

Forward-focused preparation for the real world through the development of character and intellect.

Our Promise

Hawken School prepares students to navigate a complex and dynamic world with self confidence and determination; embrace challenges with disciplined analysis and creativity; and engage others with empathy and integrity.

Commitment to Innovation

The Future For Education: Why Hawken Has To Lead
by D. Scott Looney
www.hawken.edu

Hawken Program Specifics

- A diverse student body of 1045 boys and girls in grades PS – 12
- Average class size – 15
- Student/Teacher Ratio: 9:1
- Student/Computer Ratio: 1:1 in grades 6-12
- Flexible Block Schedule
- Focus on Innovation
- Emphasis on Interdisciplinary Learning
- Real World Problem Solving
- Administrative Support of new ideas and curricular projects

Project Evolution

- Tasked to refine a self-designated troubled curriculum area
- Seeking further integration and alignment of mathematics and science concepts
- Goal of construction, tinkering, using real materials
- Research on novice-to-developing learner interactions
- Have some fun!

Learning Overview

- Part 1: Simple Machines Exposure, Exploration, and Investigations
- Part 2: Real-Task Design Challenge & Construction

Part 1: Simple Machines

- Gather background on simple machines
  - Analyze various machines
  - Gather data (lab setting)
  - Introduce appropriate math concepts and physics principles
    - Class notes and practice opportunities
  - Research historical context for machines: local use, varied readings, student-led discussions
- Check questions, traditional assessment

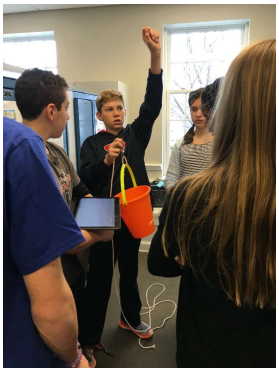
Part 2: Design Challenge

- Task specific, groups assigned
- Design Phase:
  - Ideate, design, research, diagram, gather materials & supplies, present
- Construction Phase:
  - Construct design, test & gather data, provide feedback
- Reflection
  - Self- and team-focused, photo timelines of learning, conference with teachers, selection of evidence of learning

Student Creations

- Presentation: historical rationale for machine and local uses
- Supply list & budget
- Construction Instructions & Diagrams
- Template for data collection
- Feedback to Design Team, with gathered data
- Reflections & Photos of process





Activity

- iPads: Video Physics
- Select a launch item to videotape
- Analyze path
- Email video & graph

Science Concepts

- Data Collection & Analysis, Graphical Representation of Data
- Task-Centered Design Process, Prototype Stages, and Modeling
- Force, Mechanical Advantage, Work, Mechanical Efficiency
- Function and Use of Simple Machines- Lever, Inclined Plane, Pulley
- Projectile Motion & Trajectories
- Historical use of Simple Machines
- Collaboration in a Project Team

Science Standards

Science & Engineering Practices

- Asking Questions & Defining Problems
- Planning & Carrying Out Investigations
- Analyzing & Interpreting Data
- Developing & Using Models
- Constructing Explanations & Designing Solutions
- Using Mathematics and Computational Thinking
- Obtaining, Evaluating, and Communicating Information

Core Standards

- PS2.A, B
- PS3.C
- ETS1.A, B, C
- ETS2.A, B

Crosscutting Concepts

- Cause & Effect: Mechanism & Explanation
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter: Flows, Cycles, and Conservation
- Structure and Function

Math Concepts

- Data Collection - Identify Variables, Collect & Graph Data, Add Regression Lines, Analysis of Patterns
- Calculations with Physics Formulas - Mechanical Advantage (Ideal & Actual), Work, Ideal System, Mechanical Efficiency
- Linear Equations – Slope, Determine Equation from Graph
- Geometric Concepts - Pythagorean Theorem
- Number Relationships - Percent, Proportion
- Quadratic Relationships - Graph, Determine Maximum Height & Time to Max Height, Determine Quadratic Function of Graph
- Critical Thinking, Problem Solving, Communicating Mathematically

Common Core Standards

8th Grade:

Define, evaluate, and compare functions:

CCSS.MATH.CONTENT.8.F.A.1 - Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.

CCSS.MATH.CONTENT.8.F.A.2 - Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

CCSS.MATH.CONTENT.8.F.A.3 - Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear.

Use functions to model relationships between quantities:

CCSS.MATH.CONTENT.8.F.B.4 - Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

CCSS.MATH.CONTENT.8.F.B.5 - Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Understand and apply the Pythagorean Theorem.

CCSS.MATH.CONTENT.8.G.B.7 - Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

High School Algebra:

CCSS.MATH.CONTENT.HSF.LE.A.1 - Distinguish between situations that can be modeled with linear functions and with exponential functions.

CCSS.MATH.CONTENT.HSF.LE.A.3 - Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

CCSS.MATH.CONTENT.HSF.IF.C.7 - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

Examples & Questions

- Other Integrated Projects:
  - Biodiversity Field Study
  - Unit Conversions
  - Monument Design Challenge (tomorrow at 8 AM)
  - Aerodynamics & Free Fall Unit (Expanded Egg Drop)
  - Car Crash Investigation
  - Common Language, Process & Use of TI-Nspire
- Take a few moments to consider examples of student work

Contact Information

Anna Delia adeli@hawken.edu

Kim Brandt kbran@hawken.edu

Curriculum Materials Link:
https://tinyurl.com/HawkenSimpleMachines

We welcome your Feedback! Please rate us using the NCTM App/website: 203 Session