Hamden Public Schools Science Department K-12 Overview

Presentation to HPS BOE Curriculum Committee
February 28, 2024, 6 pm

Tracy Stockwell, Director of Education
Christina Mesner, Science Specialist K-6
Brenna Symonaitis, Science Specialist 7-8

Agenda

Overview

Our vision
Our standards

K-6

Mystery Science and Engineering

7-8

Middle School Science: IQWST

9-12

High School Science

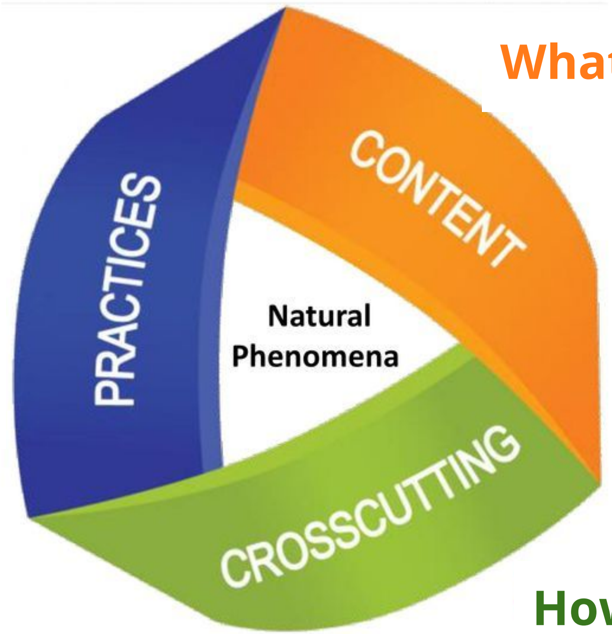
Our Vision for Science Learning in Hamden Public Schools

We envision a science program where *all* students – regardless of grade level, course, or ability – are inspired to learn about how the world works. Whether at the level of the atom, cell, population or galaxy, we strive to foster curiosity - with the goal that students are driven to ask questions about natural phenomena, current or local events, and future challenges and possibilities. A curriculum that generates enthusiasm and inquiry, is timely and relevant, is delivered with competence and passion, and necessitates sense-making and problem-solving, will satisfy the diverse interests of Hamden Public School students and prepare them for life beyond the walls of our classrooms.

All Standards, All Students

The 3 Dimensions of the Next Generation Science Standards

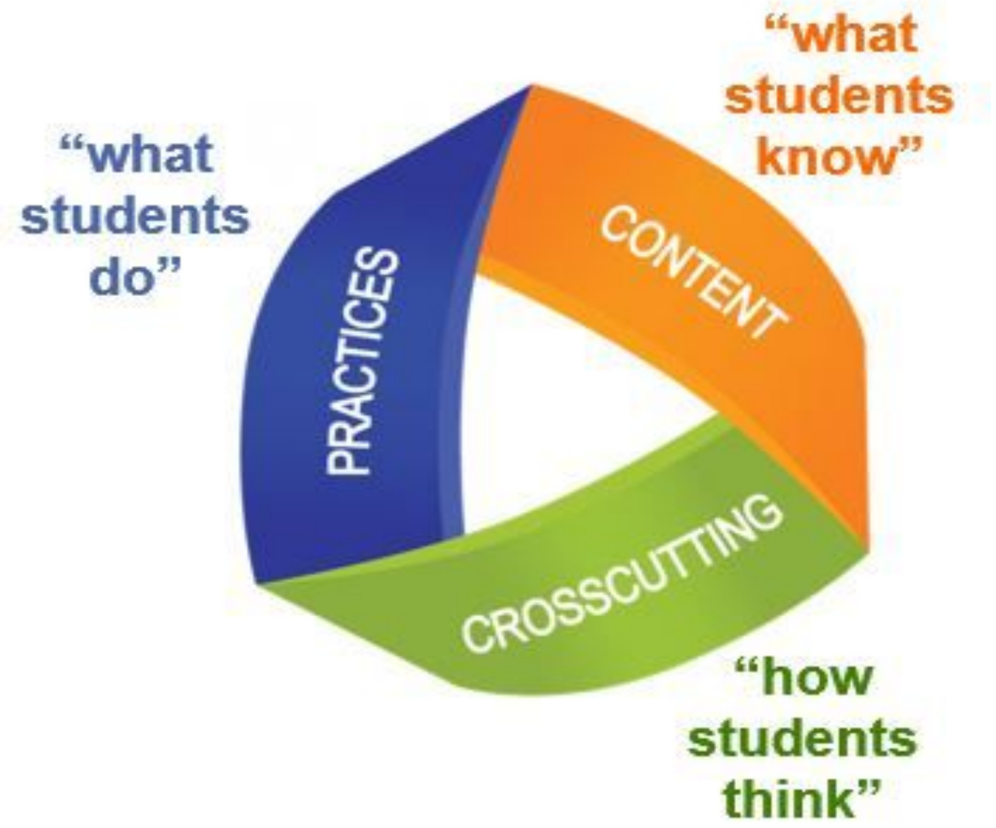
What scientists DO
E.g., Investigate, create models, analyze data



What scientists KNOW
The "big ideas"
E.g., organisms need certain things to survive

How scientists THINK about science
E.g., Are there patterns? Cause and effect?

The 3 Dimensions of the Next Generation Science Standards



Science and Engineering Practices

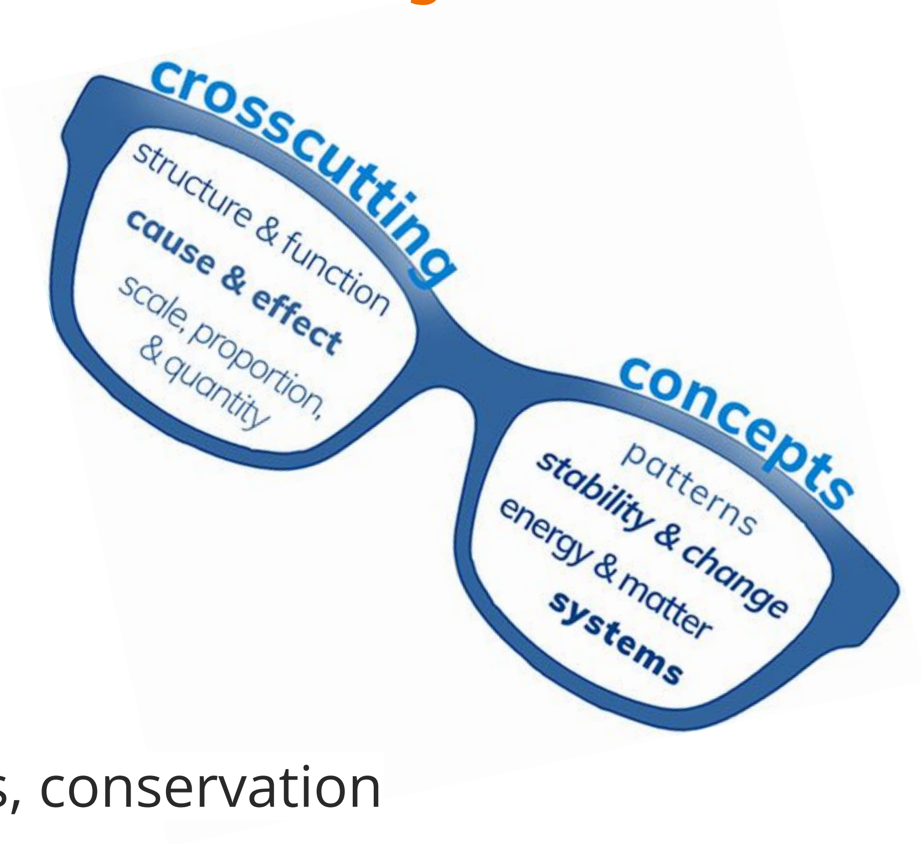
1. Asking Questions and Defining Problems (for engineering)
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and Computational Thinking
6. Constructing Explanations and Designing Solutions (for engineering)
7. Engaging in Evidence-based Arguments
8. Obtaining, Evaluating, and Communicating Information

Disciplinary Core Ideas - Ideally, every year, K-12

Life Science	Physical Science
LS1: From Molecules to Organisms: Structures and Processes LS2: Ecosystems: Interactions, Energy, and Dynamics LS3: Heredity: Inheritance and Variation of Traits LS4: Biological Evolution: Unity and Diversity	PS1: Matter and Its Interactions PS2: Motion and Stability: Forces and Interactions PS3: Energy PS4: Waves and Their Applications in Technologies for Information Transfer
Earth & Space Science	**Engineering & Technology**
ESS1: Earth's Place in the Universe ESS2: Earth's Systems ESS3: Earth and Human Activity	ETS1: Engineering Design ETS2: Links Among Engineering, Technology, Science, and Society

Cross Cutting Concepts - lenses for viewing the world

- Patterns
- Cause & effect
- Scale, proportion & quantity
- Systems & system models
- Structure & function
- Stability & change
- Energy & matter: flows, cycles, conservation



Woven together, these 3 dimensions form NGSS Performance Expectations

MS-LS1-5 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

MS-LS1-5. **Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.** [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [*Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS1.B: Growth and Development of Organisms** • Genetic factors as well as local conditions affect the growth of the adult plant.	**Cause and Effect** • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Science in Hamden Elementary Schools

- For grades K-5, Mystery Science provides the core curriculum
- Standards for grade 6 fall within the NGSS Middle School grade band
- Engineering Design challenges are integrated in grades 3-6

MYSTERY science

https://about.mystery.org/pedagogy, 2 min

https://mysteryscience.com/astronomy/stars-the-solar-system- 5th grade units

Mystery Science Overview

- An NGSS-aligned, carefully sequenced curriculum for grades K-5
- 4 units per grade per year, at least one each in

  Life Science **Earth and Space Science** **Physical Science**

- Daily engagement in science and engineering practices allows students to *experience*, *investigate* and *explain* phenomena
- Promotes shift from **“learning about a topic”** to “**figuring out how something happens”**
- Several opportunities for interdisciplinary enrichment, including literacy and math, in every unit
- Adaptable for multilingual learners

. https://mysteryscience.com/astronomy/stars-the-solar-system- 5th grade units

Anchor Phenomenon frame all units

- ❏ The **unit kick off**! A mysterious, real world occurrence!
- ❏ This is ***what*** students will be figuring out!
- ❏ A good phenomenon
  - ❏ generate LOTS of questions
  - ❏ are not “googleable”
  - ❏ are compelling and complex and require “figuring out”

https://mysteryscience.com/anchor

Watery Planet: Anchor Layer Storyline

Water Cycle & Earth's Systems

5th Grade | NGSS Earth Science

Anchor Phenomenon: Dust Bowl

How did interactions between land, air, water, and living things cause the Dust Bowl?

Learning Sequence	Investigative Phenomena	What Students Figure Out in this Lesson	This Makes Students Wonder...	What Students Figure Out in the Anchor Connection	This Makes Students Wonder...
LESSON 1 How much water is in the world?		Students analyze and interpret data from world maps to determine the relative amounts of fresh, salt, and frozen water. Students figure out that while the Earth has a lot of water, most of Earth's water is not fresh and accessible. **5-ESS2-2**	If there aren't bodies of freshwater nearby, where does the water come from to support life & human activity (farming, bathing, etc.)? ***(Leads into Lesson 2)***	**Lesson 1 Anchor Connection:** The region where the Dust Bowl happened did not have large bodies of freshwater nor did it have significant rainfall.	How did a lack of fresh water and rain contribute to the Dust Bowl?
LESSON 2 When you turn on the faucet, where does the water come from?		Students learn that most people get their fresh water from underground sources. Students determine the best place to settle a new town by considering features of the landscape and the characteristics of the plants that thrive there. **5-ESS2-2, 5-ESS3-1**	Where does the water come from to fill/refill aquifers? ***(Leads into Lesson 3)***	**Lesson 2 Anchor Connection:** Plants with deep roots can access underground water sources. In the Dust Bowl region, the native grasses had deep roots.	Why are some plants better suited for certain environments than others?
LESSON 3 Can we make it rain?		Students create a model of the ocean and sky to investigate how temperature influences evaporation and condensation. Students figure out that higher ocean temperatures lead to more evaporation, thus leading to more rain. **5-ESS2-1**	How do ocean temperatures affect the amount of rainfall in an area? ***(Leads into Lesson 4)***	**Lesson 3 Anchor Connection:** Students reason that a severe drought led to dry soil and dying plants. Without the plants' roots, there was nothing to hold the soil in place.	How does the amount of rainfall in an area impact the soil of that area?
LESSON 4 How can you save a town from a hurricane?		Students define the problem that a town needs protection from flooding. They design solutions within a budget using different types of flood protection. Students realize that flooding is caused by severe rainfall generated by hurricanes. Hurricanes are created where ocean temperatures are warm. **5-ESS2-1, 3-5-ETS1, 3-5-ETS2, 3-5-ETS3**		**Lesson 4 Anchor Connection:** This investigation suggests that changes in ocean temperatures impact rainfall patterns. When the ocean temperatures cool, rainfall can decrease, causing droughts.	What interaction between air, water, land, and living things do you think had the biggest contribution to causing the Dust Bowl?

Performance Task:

Drought Protection Kits

Mystery Packs

For each grade level teacher, supplies for 1 year of materials

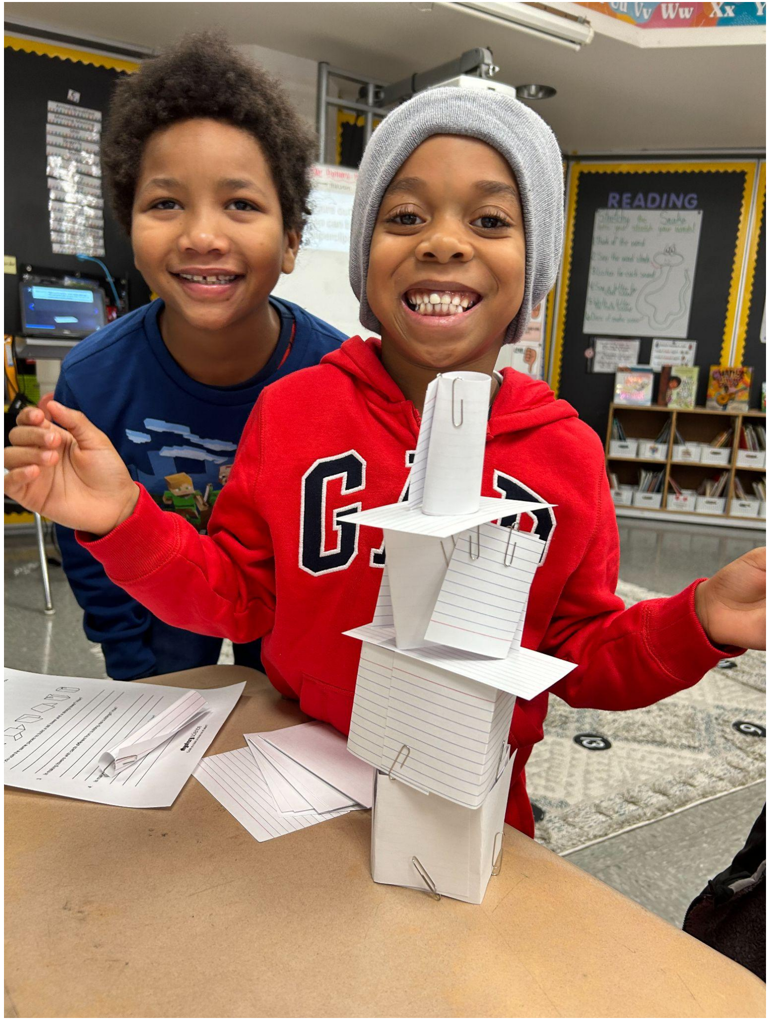
2023-2024 Hamden Public Schools K-6 Unit Matrix

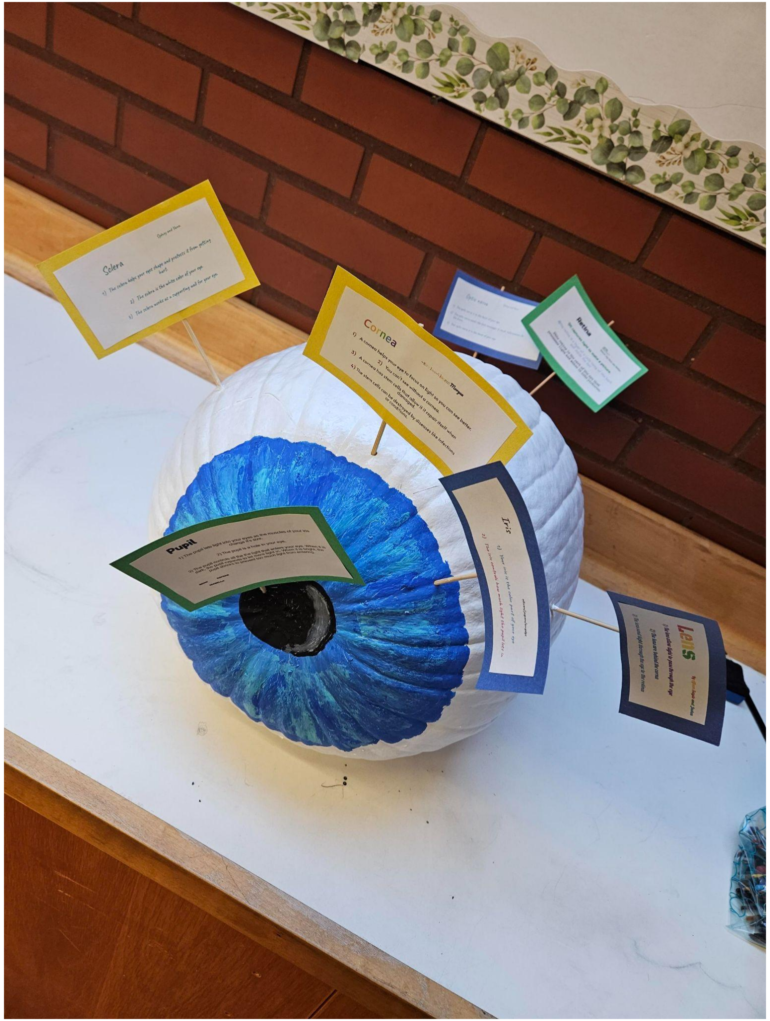
	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Unit 1	EARTH/SPACE Mystery Sci: **Wild Weather** **Circle of Seasons** **Sunny Skies**	EARTH/SPACE Mystery Sci: **Sun and Shadows** **Moon and Stars**	EARTH/SPACE Mystery Sci: **Work of Water**	EARTH/SPACE Mystery Sci: **Stormy Skies**	LIFE SCIENCE Mystery Sci: **Human Machines**	EARTH/SPACE Mystery Sci: **Spaceship Earth** ***EiE: Parachutes*** ***(Dec - Jan)***	EARTH/SPACE Mystery Sci: **Watery Planet (gr 5)**
Unit 2	PHYSICAL SCI Mystery Sci: **Force Olympics**	PHYSICAL SCI Mystery Sci: **Light and Sound**	PHYSICAL SCI Mystery Sci: **Material Magic**	LIFE SCIENCE Mystery Sci: **Power of Flowers** ***EiE: Hand Pollinators (Dec - Jan)***	PHYSICAL SCI Mystery Sci (gr 3) **Invisible Forces** ***EiE: Building Bridges (Dec - Jan)***	LIFE Mystery Sci: **Web of Life**	PHYSICAL SCI Mystery Sci: **Chemical Magic (gr 5)** IQWST Chemistry, Learning Set 1 **How Can I Smell Things from a Distance?**
Unit 3	LIFE SCIENCE Mystery Sci: **Plant Secrets**	LIFE SCIENCE Mystery Sci: **Animal Superpowers**	LIFE SCIENCE Mystery Sci: **Animal Adventures Plus, Butterflies**	LIFE SCIENCE Mystery Sci: **Animals through Time**	EARTH/SPACE Mystery Sci: **Birth of Rocks**	PHYSICAL SCI Mystery Sci **Waves of Sound (gr 4)**	
Unit 4**	Mystery Sci: **Animal Secrets plus Chicks**	Mystery Sci: **Plant Superpowers**	Mystery Sci: **Plant Adventures**	Mystery Sci: **Circle of Life**	Mystery Sci: **Energize Everything**	Mystery Sci:	***EiE: Designing Water Filters (April – June)***

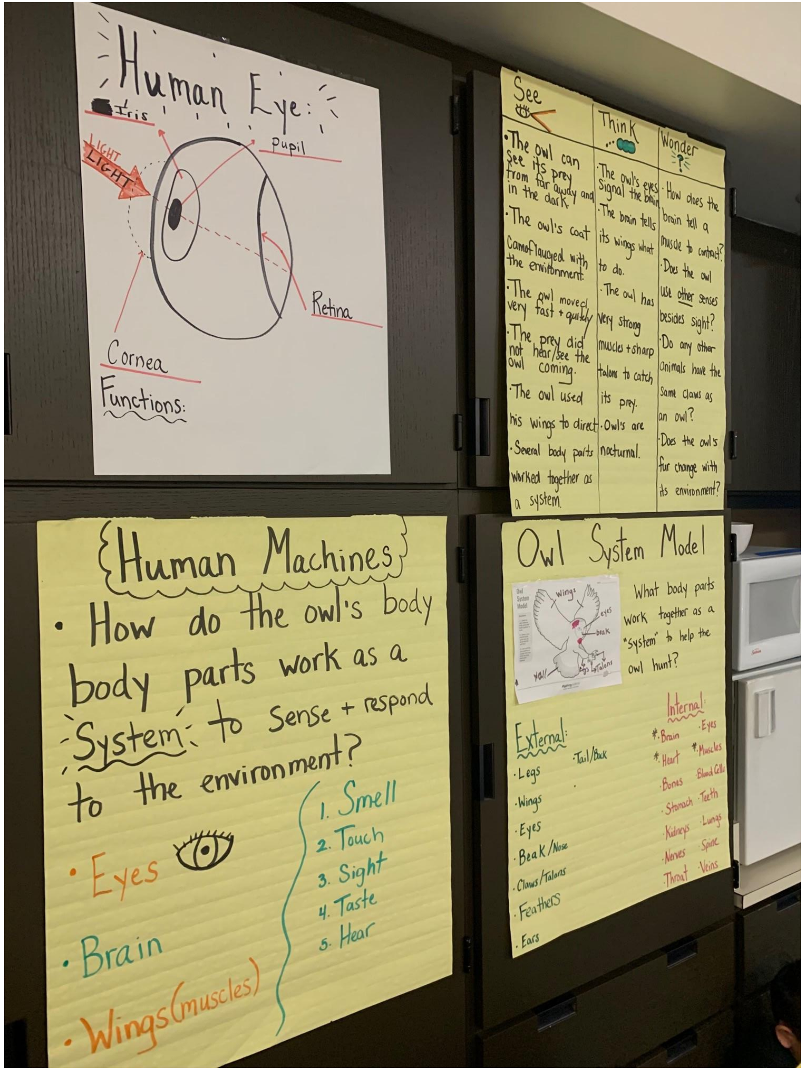

PIC·COLLAGE


Vic-toria
Luna


HELEN STREET
SCHOOL

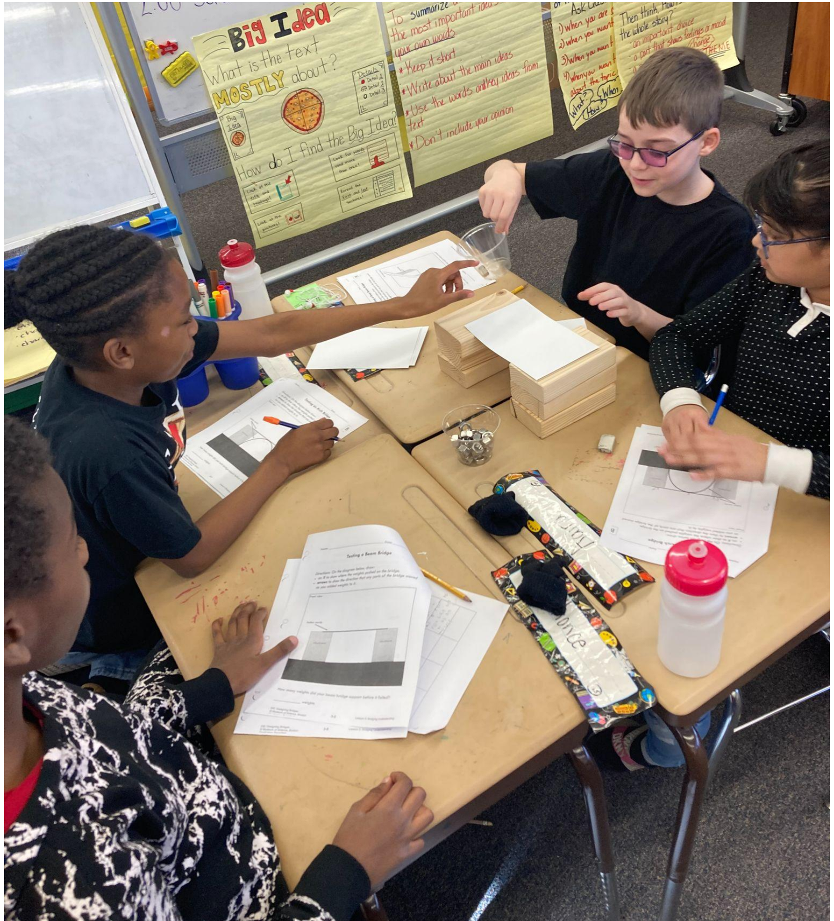

READING



Sclera
Cornea
Retina
Iris
Pupil
Lens

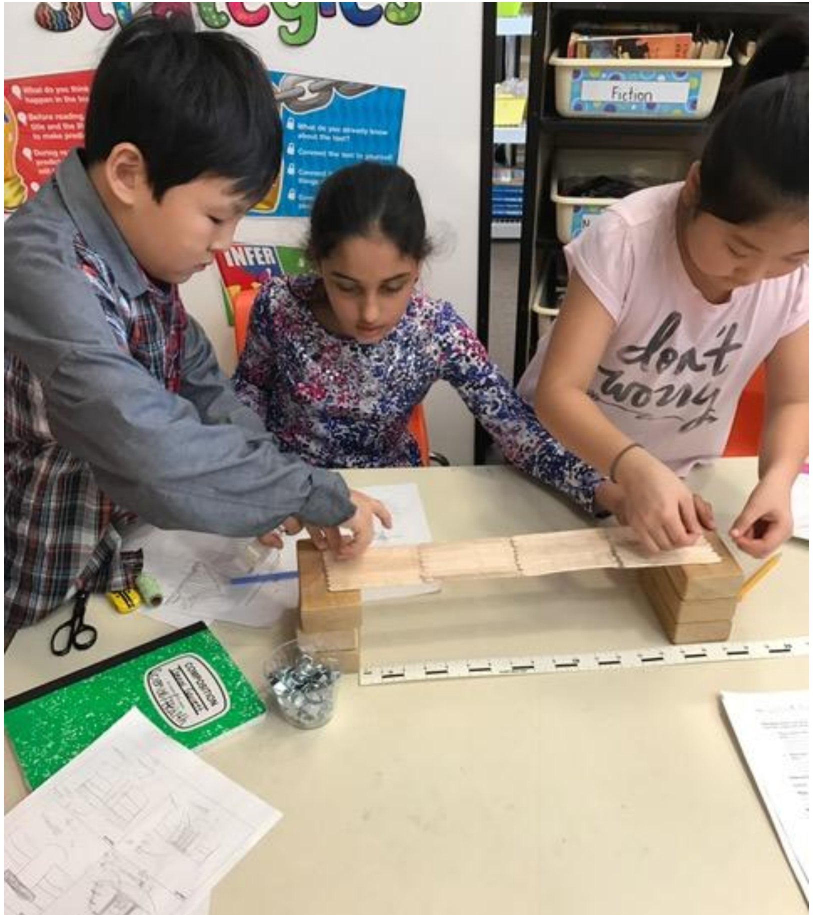

Human Eye:
Iris
Pupil
LIGHT
Retina
Cornea
Functions:
See
Think
Wonder
·The owl can see its prey from far away and in the dark.
·The owl's coat Camouflauged with the environment.
·The owl moved very fast + quietly
·The prey did not hear/see the owl coming.
·The owl used his wings to direct.
·Several body parts worked together as a system.
·The owl's eyes Signal the brain
·The brain tells its wings what to do.
·The owl has very strong muscles + sharp talons to catch its prey.
·Owl's are nocturnal.
·How does the brain tell a muscle to contract?
·Does the owl use other senses besides sight?
·Do any other animals have the same claws as an owl?
·Does the owl's fur change with its environment?
Human Machines
· How do the owl's body body parts work as a System to sense + respond to the environment?
· Eyes
· Brain
· Wings (muscles)
1. Smell
2. Touch
3. Sight
4. Taste
5. Hear
Owl System Model
What body parts work together as a "system" to help the owl hunt?
wings
eyes
beak
talons
External:
·Legs
·Wings
·Eyes
·Beak/Nose
·Claws/Talons
·Feathers
·Ears
·Tail/Back
Internal:
*Brain
*Heart
·Bones
·Stomach
·Kidneys
·Nerves
·Throat
·Eyes
*Muscles
·Blood Cells
·Teeth
·Lungs
·Spine
·Veins


EXIT
CLAIM
EVIDENCE

Engineering in grades 3-6



Engineering in grades 3-6



What our teachers are saying

"... how wonderful it is for our Spanish speaking students!!! Everything is translated. It has been a real savior for my student, who for the first time this year has been truly able to understand and participate with her classmates." – L.Kingston Bear Path, Grade 5

"Mystery science is very hands on and engaging…When returning from Winter Break we discussed what we wanted more of and less of in 2024. *"More Mystery Science!"* was stated with much eagerness and enthusiasm!" – L. Dwelle, Spring Glen, Grade 4

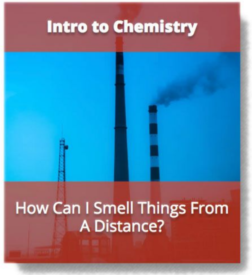
" As a teacher, I love that it is easy to follow and the materials are accessible. The videos are engaging and it includes a **lot** of opportunities for student discourse. I also appreciate that the people showcased are diverse. The students love the science experiments." – M. Clifford, West Woods, Grade 2

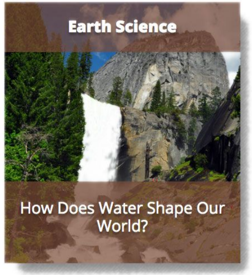
Science at Hamden Middle School

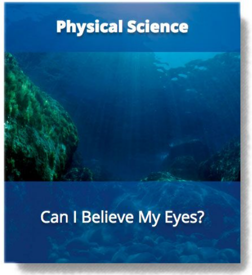
IQWST

Investigating and Questioning our World through Science and Technology

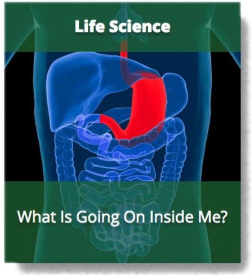
Gr. 6



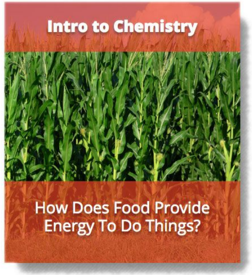


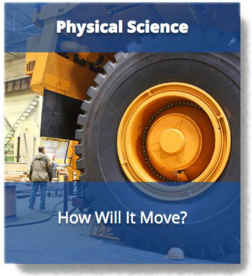


Gr. 7



Gr. 8





Activate Learning

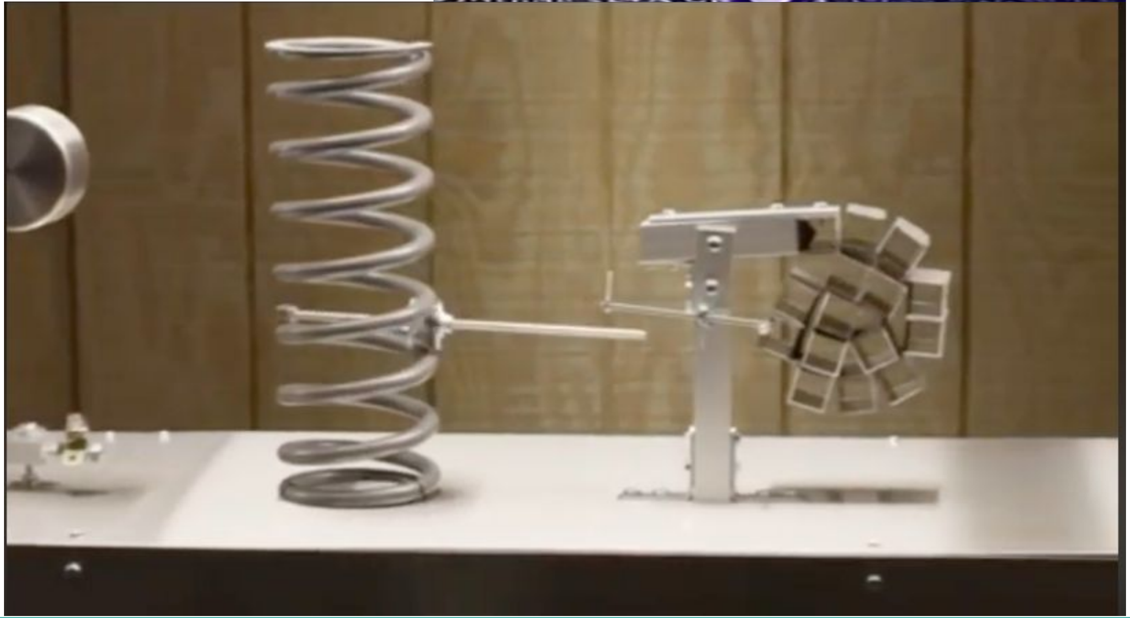
IQWST Overview

- A research-based, carefully sequenced 12-unit curriculum for grades 6-8
- 4 units per grade per year, one each in

  Life Science **Chemistry** **Earth Science** **Physical Science**

- Daily engagement in science and engineering practices allows students to *experience*, *investigate* and *explain* phenomena while learning core ideas
- A **Driving Question**, managed on a Driving Question Board**,** frames each unit
- Promotes shift from **"learning about a topic"** to "**figuring out how something happens"**
- Productive discourse is key to ongoing sense-making

Phenomenon



Emergency Room Report

Name: [redacted] Date: 2/26/2018 Time: 2:30 pm

Location of incident: middle school weight room during PE class

Type of injury:

- The left foot has lacerations (cuts) on the top.
- The skin is broken open and it appears there are broken bones.

Examination:

- The patient cannot put any weight on the foot.
- There is swelling around the injury.
- When different areas were tested for feeling, the patient had no feeling on the top of the foot.
- The bottom, sides, toes, and heel of the injured foot have feeling.

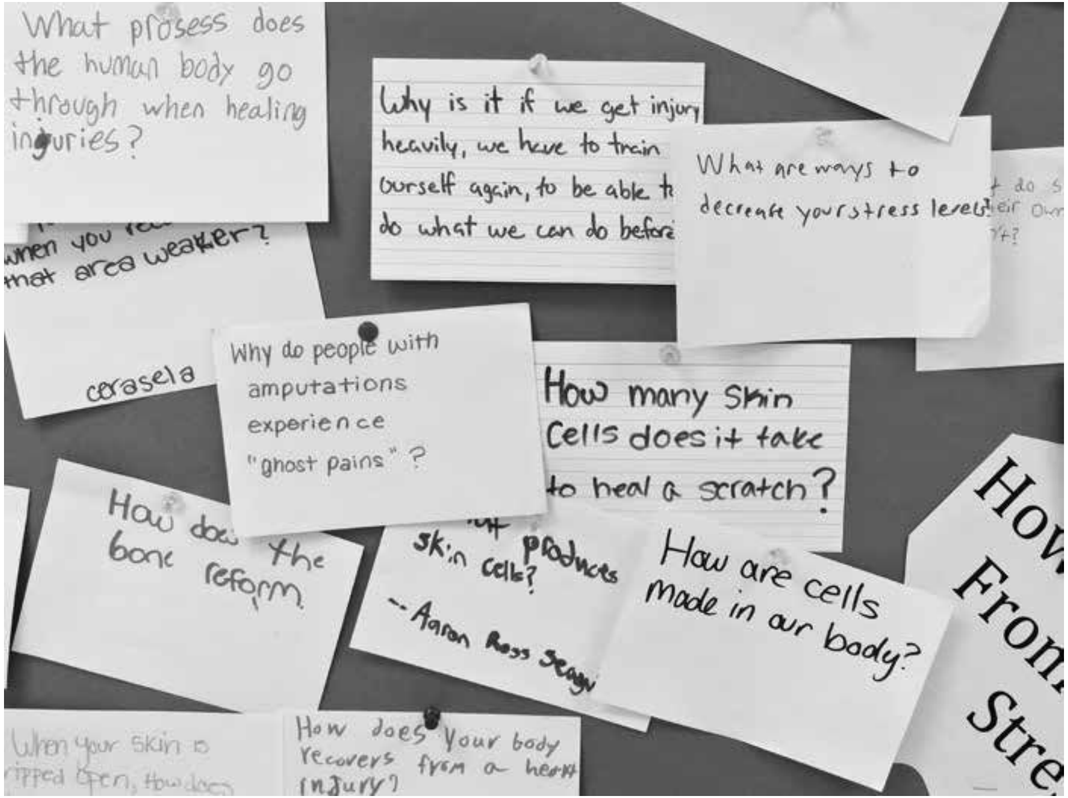
Testing:

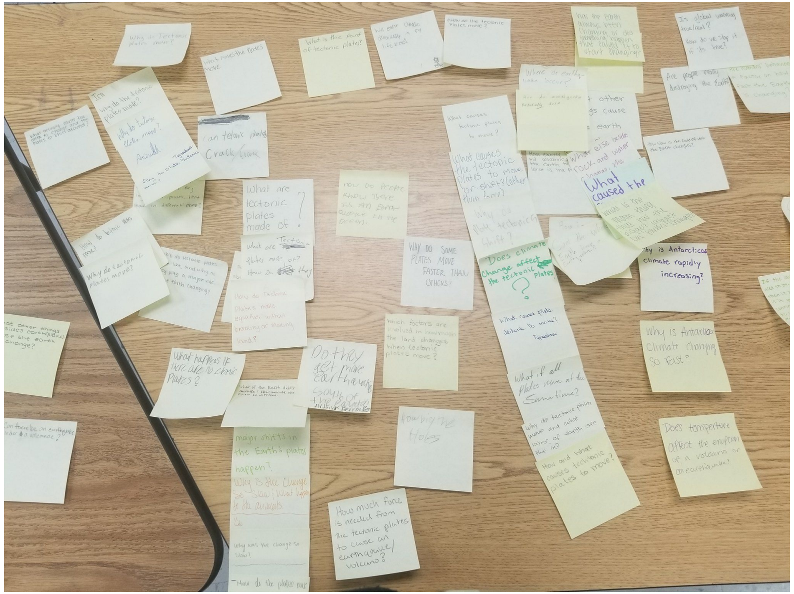
X-rays

Diagnosis:

2nd and 3rd metatarsal bones are fractured and shifted to the right. Surgery is needed to reduce the gap between bones, and to stabilize and realign them.

A **Driving Question Board** starts with students' questions...





...which they sort into categories

Driving Question Boards

PS2 Storyline: Why Do Some Things Stop While Others Keep Going?

Unit Overview	
Anchoring Phenomenon	Students observe a demonstration of a radiometer and a Newton vs Rube Goldberg video. They examine devices that operate for an unexpectedly long time, raising natural questions about how they work.
Driving Question	**Why Do Some Things Stop While Others Keep Going?**
Unit Goal	Energy is transformed from one type to another in every phenomenon. Usually, in the process, some of the energy is transformed into thermal energy or it is transferred to another system.The total amount of energy at the end of a phenomenon is the same as there was before the phenomenon, thought the energy may be in different places and be of different types. Energy is often stored as chemical energy and then transformed to the other types during chemical reactions. Energy is often transported from one place to another in the form of electrical energy. Things that keep on going have a continuous supply of energy.
Learning Set 1 Lessons 1-4 (11-12 class periods)	**Question: What determines how fast or high an object will go?** **Learning Goals:** Students will: • Plan and carry out investigations to determine the characteristics of multiple types of energy and their relationship to variables such as mass, speed elevation, and rigidity. • Develop models of how energy is transformed or converted from one type to another in everyday phenomena like bouncing a ball, sliding down a slide, skateboarding and dropping objects.
Learning Set 2 Lessons 5-7 (5-7 class periods)	**Question: Why do some things stop?** **Learning Goals:** Students will: • Analyze data to define the boundaries and components of a system and develop explanatory models that account for how energy can be transferred within a system and is always conserved. • Carry out investigations to determine the characteristics and factors that affect the amount of thermal in an object.

Lesson example Activity 3.1

Hamden scientists at work

Class Construction of Scientific Principles

- Scientific principles are **big ideas** that the entire class “arrives at” by the end of many lessons
- Helps students articulate “*what we know so far*” as they progress through the unit
- Provide common language to draw on when constructing explanations

What does it mean to Construct an Explanation?

A scientific explanation:

A written or oral response, supported by evidence, that explains how or why a phenomenon occurs.

A scientific explanation has 3 essential parts

- ❑ **Claim**: a testable statement that answers the question or phenomenon
- ❑ **Evidence**: relevant and sufficient scientific data that supports the claim
- ❑ **Reasoning**: a justification of *why* the data count as evidence to support the claim, based on appropriate scientific ideas and principles

A written “C-E-R”

CLAIM
A STATEMENT ABOUT THE RESULTS OF AN INVESTIGATION.

EVIDENCE
SCIENTIFIC DATA USED TO SUPPORT THE CLAIM.

REASONING
EXPLAINS AND JUSTIFIES WHY THE EVIDENCE SUPPORTS THE CLAIM.

	Substance	Properties: Color	Hardness	Solubility in Water	Density	Melting Point
Before Experiment	penny	copper brown	Hard	Not soluble	8.96 g/cm^3	1084°C
	Vinegar	No color	Liquid	Soluble	1.04g/cm^3	17°C
After Experiment	New solid	Green	gritty soft powdery	Soluble	1.88 g/cm^3	115°C

A chemical reaction occured between copper and acedic acid. After the experiment, the penny was a different color. The penny started brown, but then was green. Their hardness was different too. The copper was hard, but ended with a soft gritty powder outside of it. The copper was not soluble in water, but the green powder was. The copper penny had a density of 8.96 g/cm^3, and the powder had a density of 1.88 g/cm^3. They also had different melting points. Before the expeirement, the penny had a melting point of 1084°C, and the green substance coating it had a melting point of 115°C. Because these two substances had different properties, they are differen substances, meaning a chemical reaction occured

Sample response to, “Does acid rain make new substances?

Science at Hamden High School

- 3 science credits are required for graduation in CT; must include biology
- 17 full year courses - including AP and engineering - and 6 half year electives

FULL YEAR COURSES

- Biology (plus EL Biology)
- Earth Science (plus EL Earth)
- Physical Science
- Chemistry
- Physics
- Applied Physical Science
- Anatomy and Physiology
- Biochemistry
- Environmental Sustainability

- AP Biology
- AP Chemistry
- AP Physics 1
- AP Physics 2
- AP Physics C
- AP Environmental Science

Project Lead the Way (PLTW):

- Intro to Engineering Design
- Principles of Engineering

HALF YEAR COURSES

- Forensic Science
- Marine Biology
- Astronomy
- Meteorology
- Botany
- Science You Should Know

Common 3-year sequence prepares students for CT NGSS Assessment in 11th grade

Biology

- 1.0 credits
- Offered at 3 academic levels
- Required for graduation
- A course for Multilingual Learners is offered every other year

Chemistry

- 1.2 credits
- Offered at 3 academic levels

or

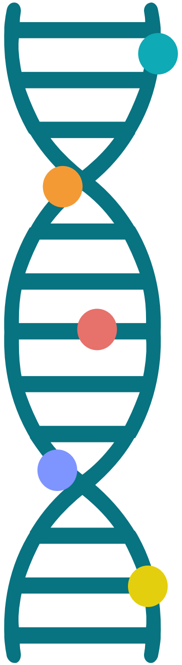
Earth

- 1.0 credits
- Offered at 2 academic levels
- A course for Multilingual Learners is offered every other year (alternates with biology)

Physics

- 1.2 credits
- Offered at 3 academic levels

Example of a Unit Sequence - Biology



Introduction to Phenomenon	Lucy and Maria are twins! What questions do I have?
Students Initial Models	Based on what I already know, what can possibly explain this phenomenon?
Ongoing Evidence collection	Investigations, activities, data analysis, readings
Model Revisions	Whole class discussions, consensus around investigations and activities...how can we revise our initial models?
Final causal explanation	Use evidence-based, scientific reasoning to support your claim about what caused the phenomenon.

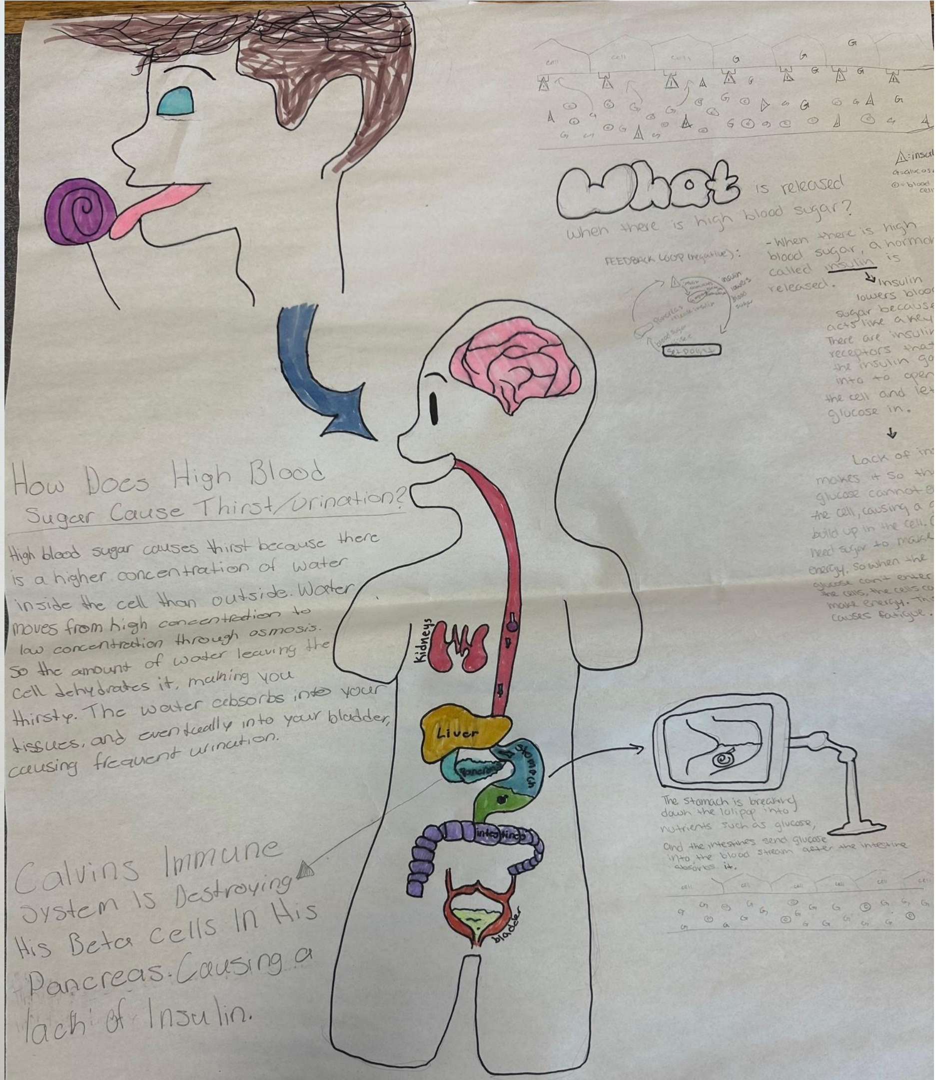
P3 All About Calvin

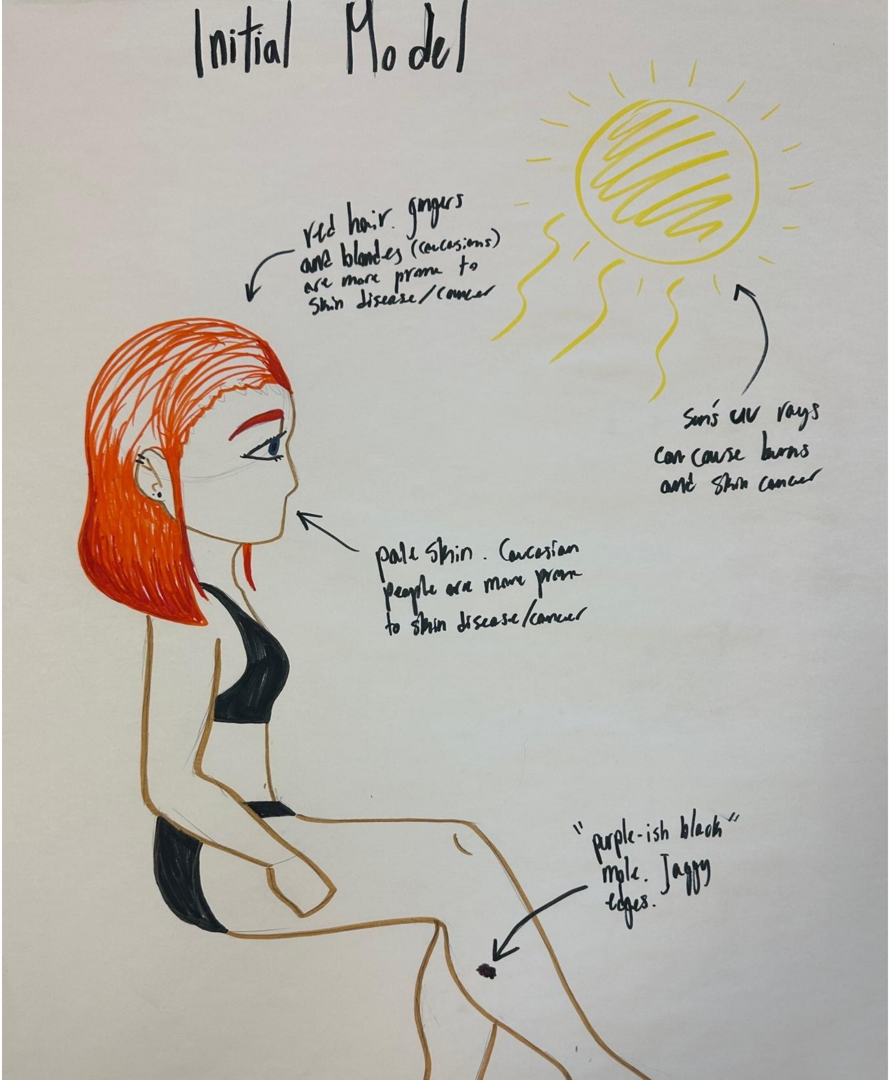
What we know...

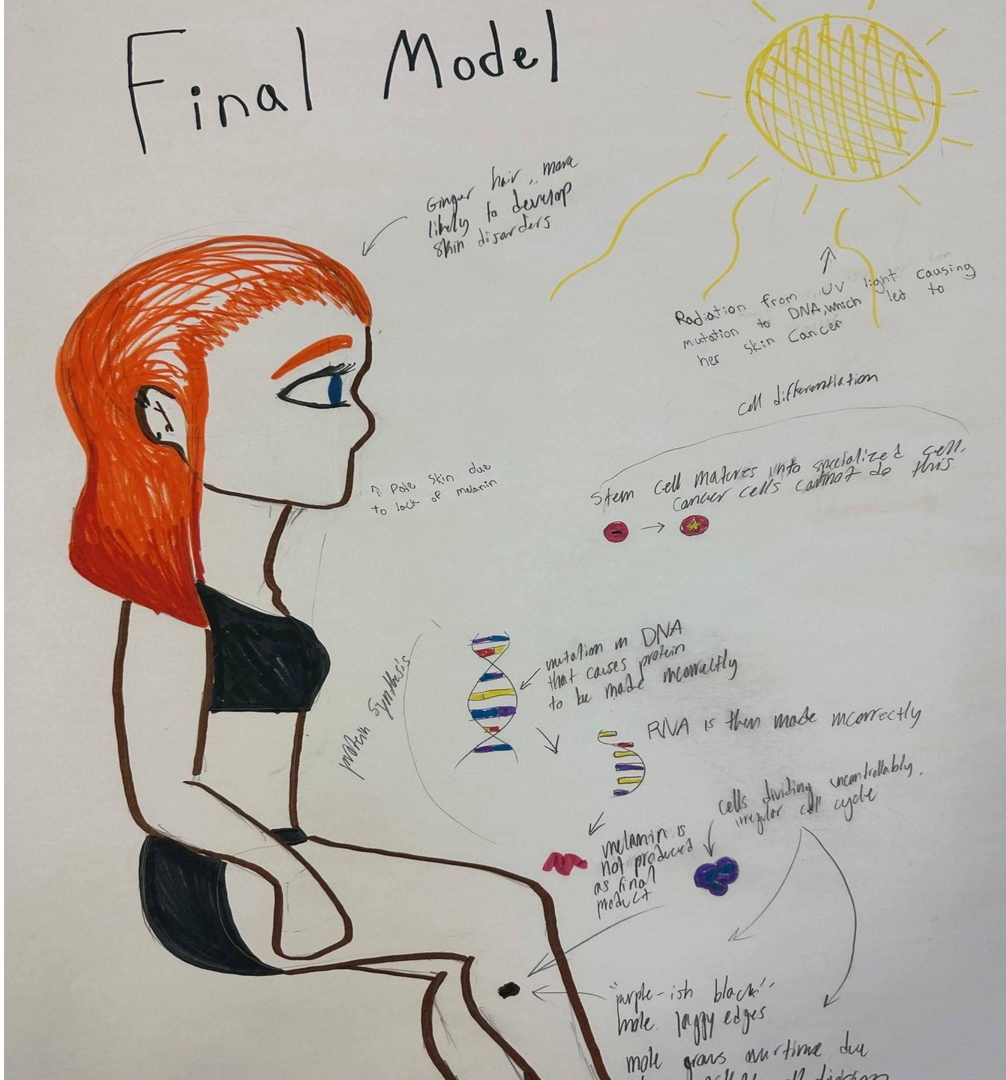
* 6 or 7 year old boy in 1st grade
* Always thirsty
* Frequent urination (bathroom trips)
* Always tired
* His great uncle has diabetes
* Blood levels of glucose measured (585 mL/dL)
* Average blood sugar level 200 or less
* Drinks a lot of root beer

What we need to figure out...

* Family history of diabetes?
* Normal sugar intake/stable
* ✓ Why is he drinking so much?
* ✓ Why tired?
* How to get rid of high blood sugar levels?
* Why did the potential of diabetes require more water/liquid intake?
* Heredity or environmental




Initial Model
red hair. gingers and blondes (caucasions) are more prone to skin disease/cancer
Sun's UV rays can cause burns and skin cancer
pale skin. Caucasian people are more prone to skin disease/cancer
"purple-ish black" mole. Jaggy edges.


Final Model
Ginger hair, more likely to develop skin disorders
Radiation from UV light causing mutation to DNA, which led to her skin Cancer
cell differentiation
Pale skin due to lack of melanin
Stem cell matures into specialized cell, Cancer cells cannot do this
protein synthesis
mutation in DNA that causes protein to be made incorrectly
RNA is then made incorrectly
melanin is not produced as final product
cells dividing uncontrollably, irregular cell cycle
"purple-ish black" mole. Jaggy edges
mole grows over time due

PROJECT LEAD THE WAY

PLTW

HHS:

Introduction to Engineering Design

Principles of Engineering

In exploring how engineers help improve the world through product design, mechanical design, infrastructure, and sustainability, students learn and use some of the cutting edge tools engineers use in robotics, 3D modeling, programming, and prototyping.


Using Mathematics and Computational Thinking
Constructing Explanations
Constructing Arguments from Evidence
Obtaining, Evaluating, and Communicating Information
Developing and Using Models
Planning and Carrying Out Investigations
Science and Engineering Practices
Analyzing and Interpreting Data
Asking Questions
FIRE EXIT
M T W TH F
2/6
2/7
2/8
2/9
No HW
Test Review
Review packet
NGSS SCIENCE AND ENGINEERING PRACTICES
MILESTONES

Next Steps

- ❑ Continued work to provide more time for science K-6. Interdisciplinary integration will be key.
- ❑ Plan for common assessments at multiple grade levels, including use of state interim assessments in elementary, middle and high school
- ❑ As budget allows, continue to offer curriculum related field trips

Questions?