Numeracy in STEM/ STEAM Education

Meghan McFerrin, Allyson Morgan,
and Rontra Brown
STEM/ STEAM Program Specialists

Overview

- Federal plan
- STEM/ STEAM for all students
- Characteristics of STEM/ STEAM schools
- Contextualizing mathematics: lesson examples

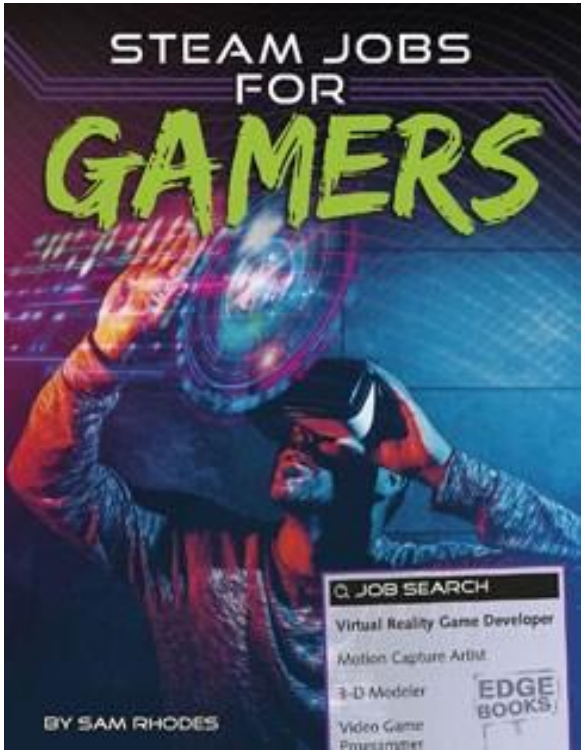
Federal Strategy

"Mathematics continues to serve as a gateway to STEM majors that leads to higher-paying jobs and economic mobility."

https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

STEAM Occupations: above-average growth

Employment in STEAM occupations grew by **10.5%** from 2009-2015 compared to **5.2%** growth in non-STEAM occupations



- Studies have shown that becoming anxious about math and avoiding the subject begins as early as 5 years old.
- Math anxiety is estimated to be moderate to high in:
  - 25% of 4-year college students and
  - 80% of community college students.

"I can't solve for X. I have a fear of the unknown!"

STEM and STEAM for all students

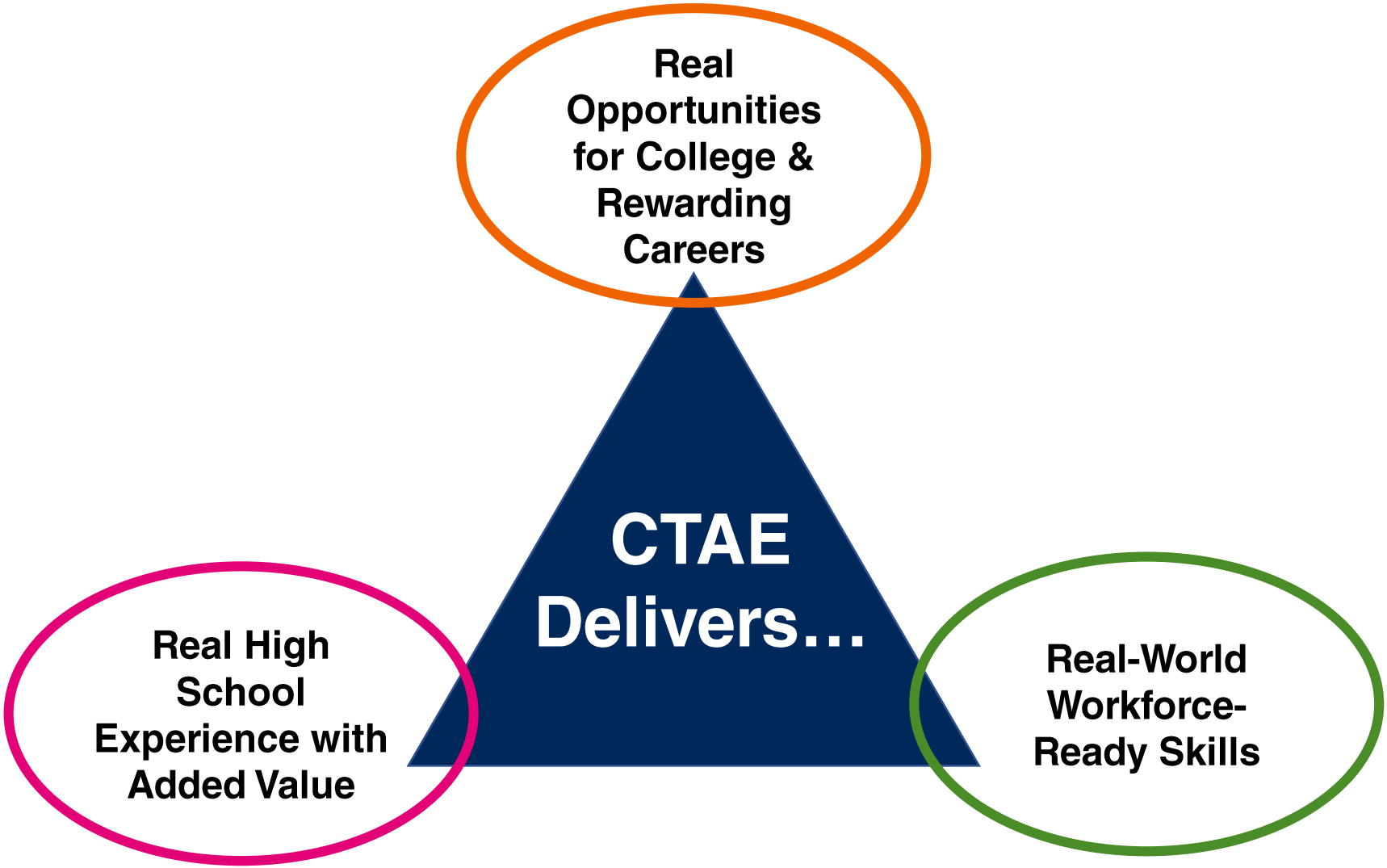
Half of all STEM jobs are available to workers without a four-year college degree.

https://www.brookings.edu/research/the-hidden-stem-economy/

- High-quality CTE can provide a deeper understanding of STEM career pathways, build interest and skills in STEM by making content more relevant and tangible, and grow the STEM workforce pipeline by encouraging underrepresented groups to enter these fields.

CTAE STEM/STEAM Focus Areas

- Agriculture
- Architecture
- Biotechnology
- Cyber Security
- Computer Programming
- Energy
- Engineering
- Food Science & Nutrition
- Forensic Science
- Health Care Science
- Information Technology


Real Opportunities for College & Rewarding Careers
CTAE Delivers…
Real High School Experience with Added Value
Real-World Workforce-Ready Skills

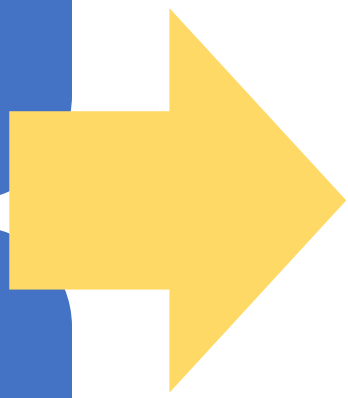
Project-Based Learning

Overarching grade-level or schoolwide focus

Students solve a real-world problem

Day-to-Day Interdisciplinary Instruction

Typical instruction integrates, at the minimum, science and math- for STEAM, arts as well

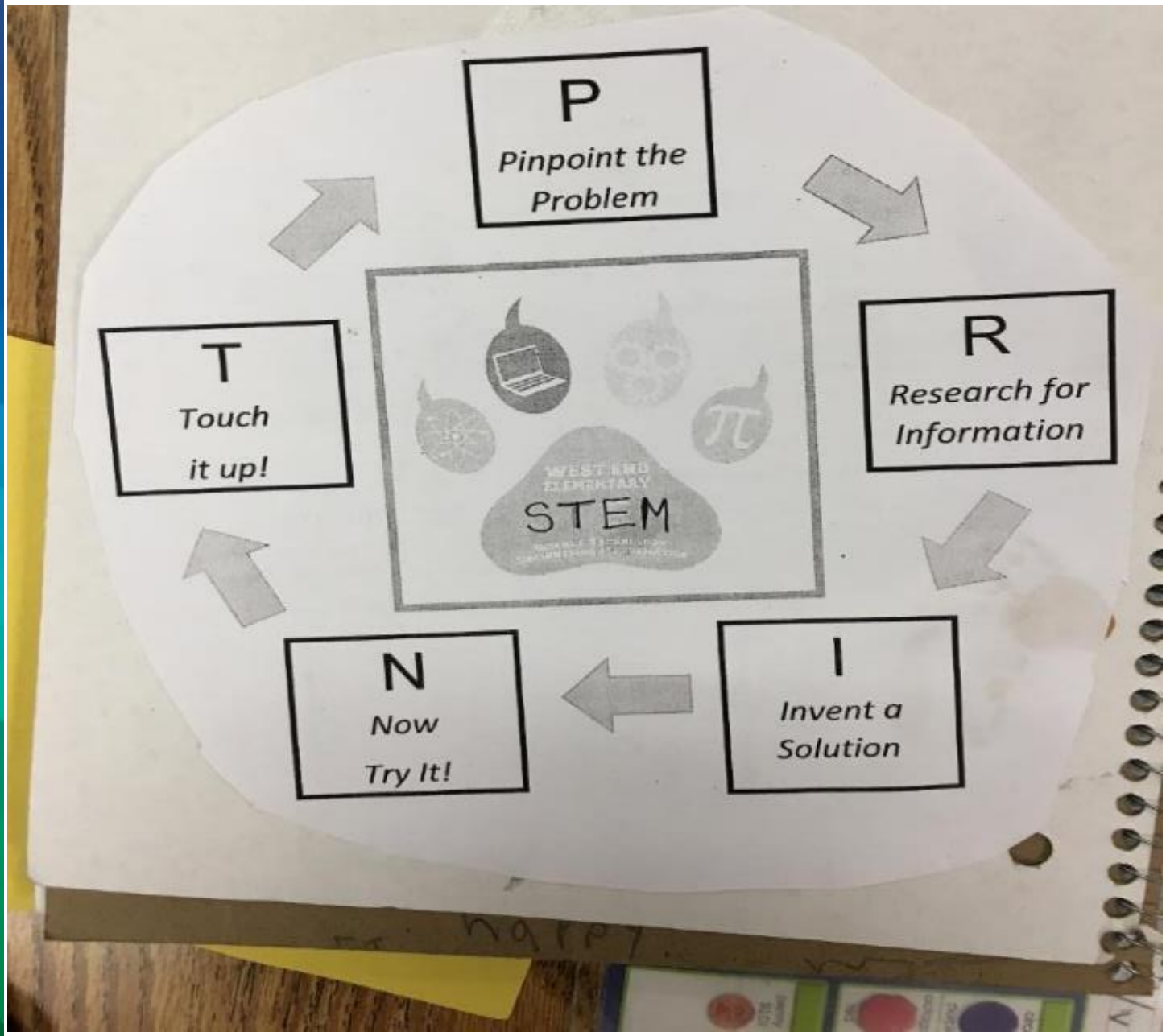


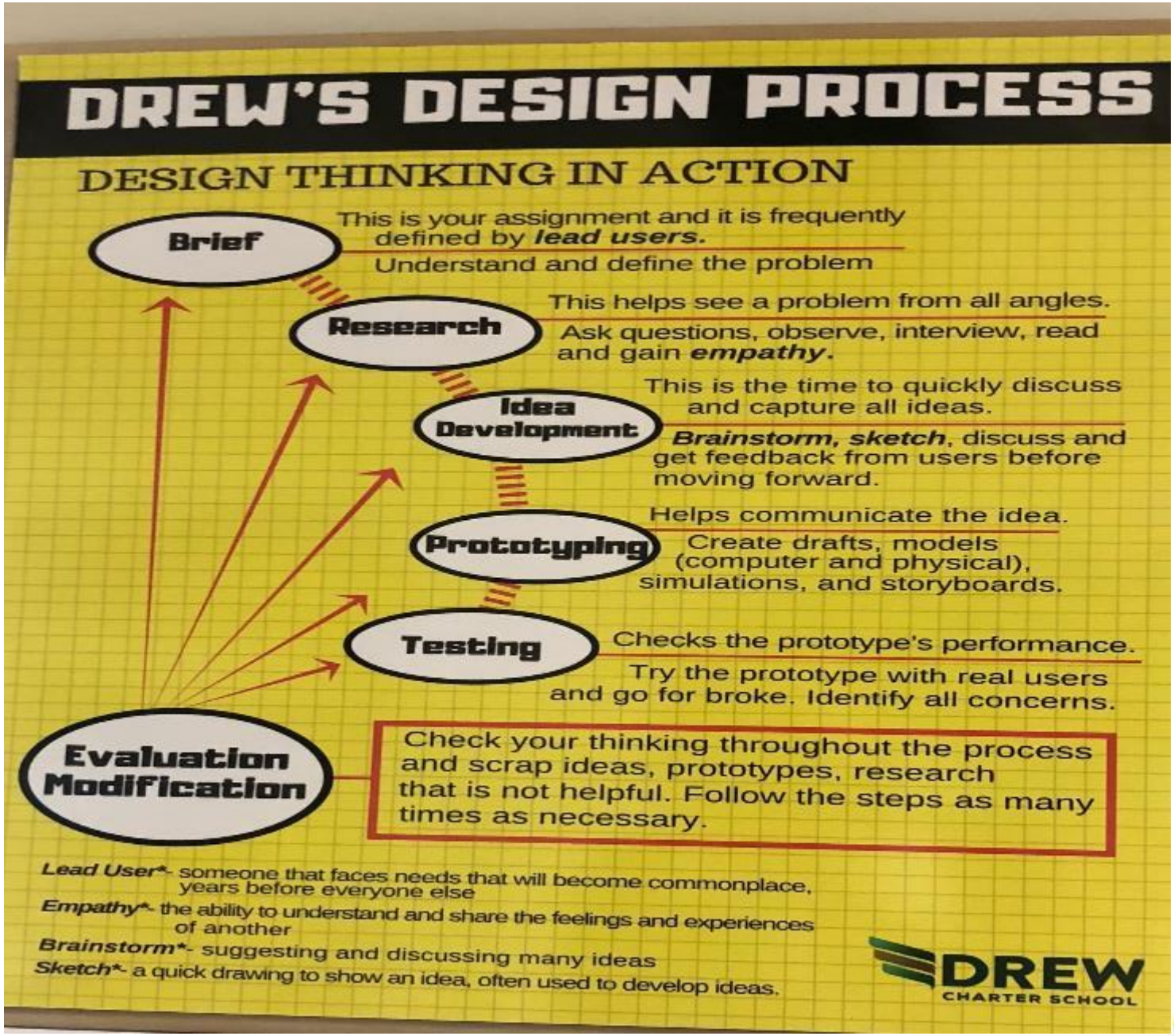
- Driven by grade-level Georgia Standards of Excellence
- Learning targets are identified
- Documented in STEM or STEAM Journal
- Students document data collection
- Students use school/program identified thinking process

Identify Schoolwide (or Program-wide) Process-Based Thinking Strategy

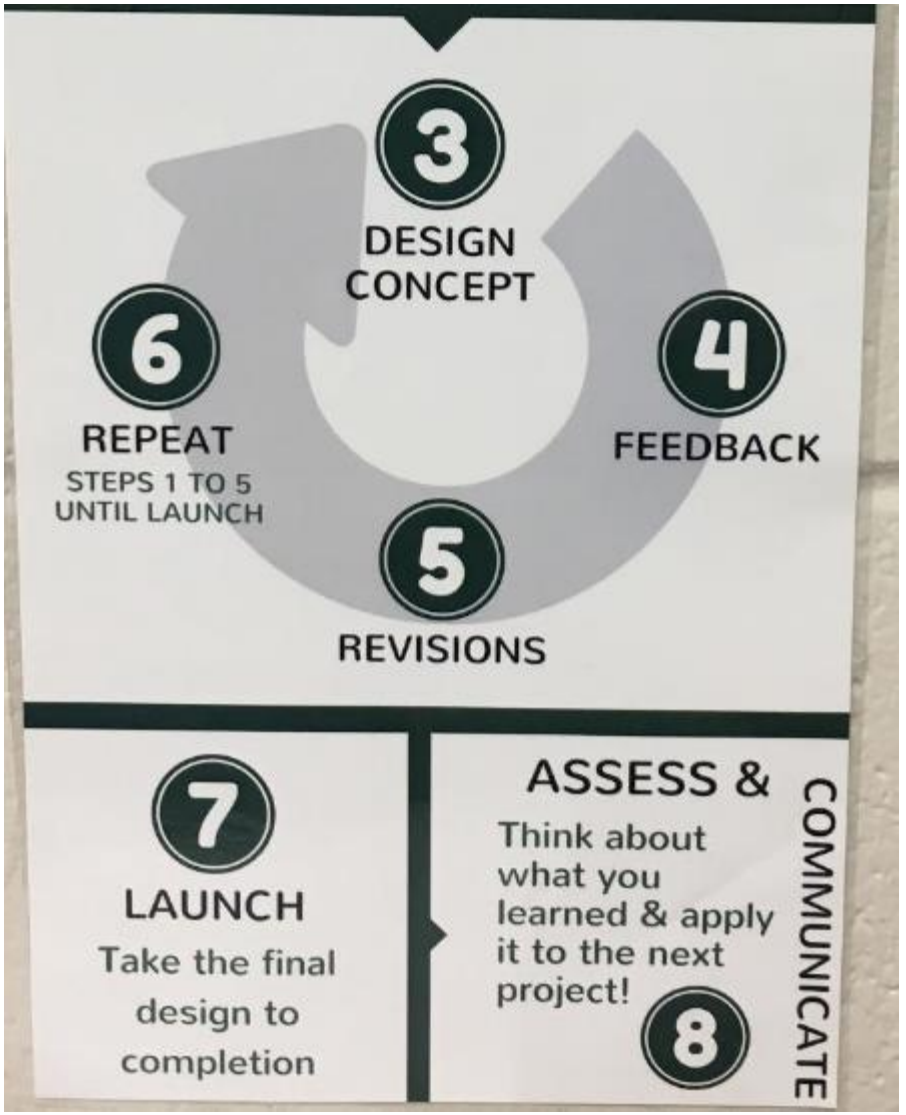
- Post it in every classroom
- Paste in student STEM/ STEAM Journals
- Use in all lesson planning
- Get students excited!


STEM
ASK
Find out more about the problem.
IMAGINE
Think of possible solutions.
IMPROVE
Look at the model. Make it better.
PLAN
Think ahead about the steps.
CREATE
Follow your plan.


P
Pinpoint the Problem
R
Research for Information
I
Invent a Solution
N
Now Try It!
T
Touch it up!
WEST END ELEMENTARY
STEM


DREW'S DESIGN PROCESS
DESIGN THINKING IN ACTION
Brief
This is your assignment and it is frequently defined by lead users.
Understand and define the problem
Research
This helps see a problem from all angles.
Ask questions, observe, interview, read and gain empathy.
Idea Development
This is the time to quickly discuss and capture all ideas.
Brainstorm, sketch, discuss and get feedback from users before moving forward.
Prototyping
Helps communicate the idea.
Create drafts, models (computer and physical), simulations, and storyboards.
Testing
Checks the prototype's performance.
Try the prototype with real users and go for broke. Identify all concerns.
Evaluation Modification
Check your thinking throughout the process and scrap ideas, prototypes, research that is not helpful. Follow the steps as many times as necessary.
Lead User*- someone that faces needs that will become commonplace, years before everyone else
Empathy*- the ability to understand and share the feelings and experiences of another
Brainstorm*- suggesting and discussing many ideas
Sketch*- a quick drawing to show an idea, often used to develop ideas.
DREW CHARTER SCHOOL

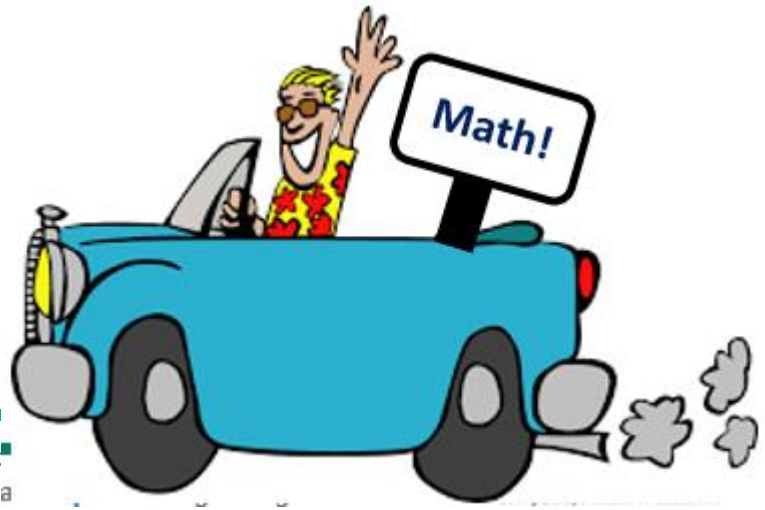

COLLINS HILL CLUSTER
Engineering Design Process
8 steps to make any design project a success
1
ASK QUESTIONS
WHO?
Who is the target audience?
Consider their interests, passions, and what inspires them.
WHAT?
What is your main goal? Why are you doing it?
Think about your desired outcome and what you want to achieve.
WHY?
HOW?
How can you measure success?
What tools can you use to measure the results?
2
BRAINSTORM
doodle
investigate
creativity
research
write
spark
flow
inspiration
explore
dream
visual
ideas
abstract
mindmap
fresh
think
word association


3
DESIGN CONCEPT
4
FEEDBACK
5
REVISIONS
6
REPEAT
STEPS 1 TO 5 UNTIL LAUNCH
7
LAUNCH
Take the final design to completion
ASSESS &
COMMUNICATE
Think about what you learned & apply it to the next project!
8

Numeracy in STEM/ STEAM

Integrating mathematics isn't an easy thing to do well. Oftentimes it is math that is put in the passenger seat to lightly serve another subject, project, or task.

- Gina Picha, 2018, "STEM has a Math Anxiety Problem"



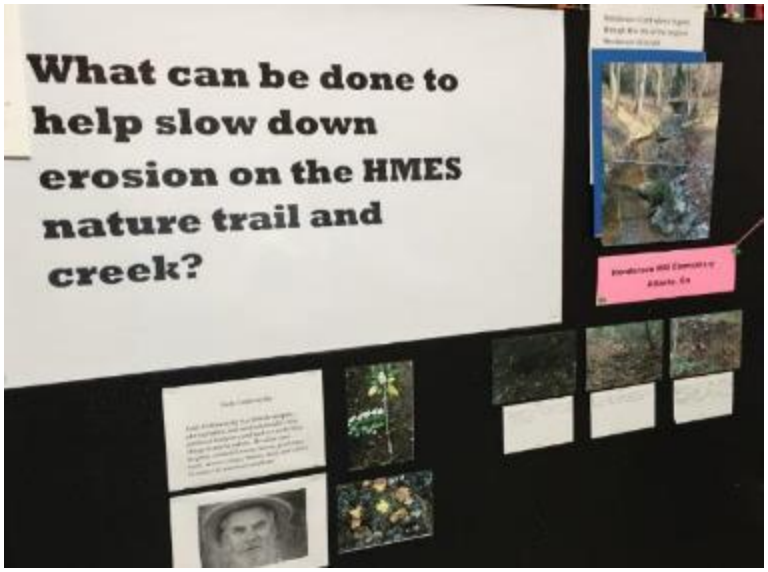
Locally Driven Project Based Learning

Field Studies Lab

Apple Orchard Research

Sustainable Energy

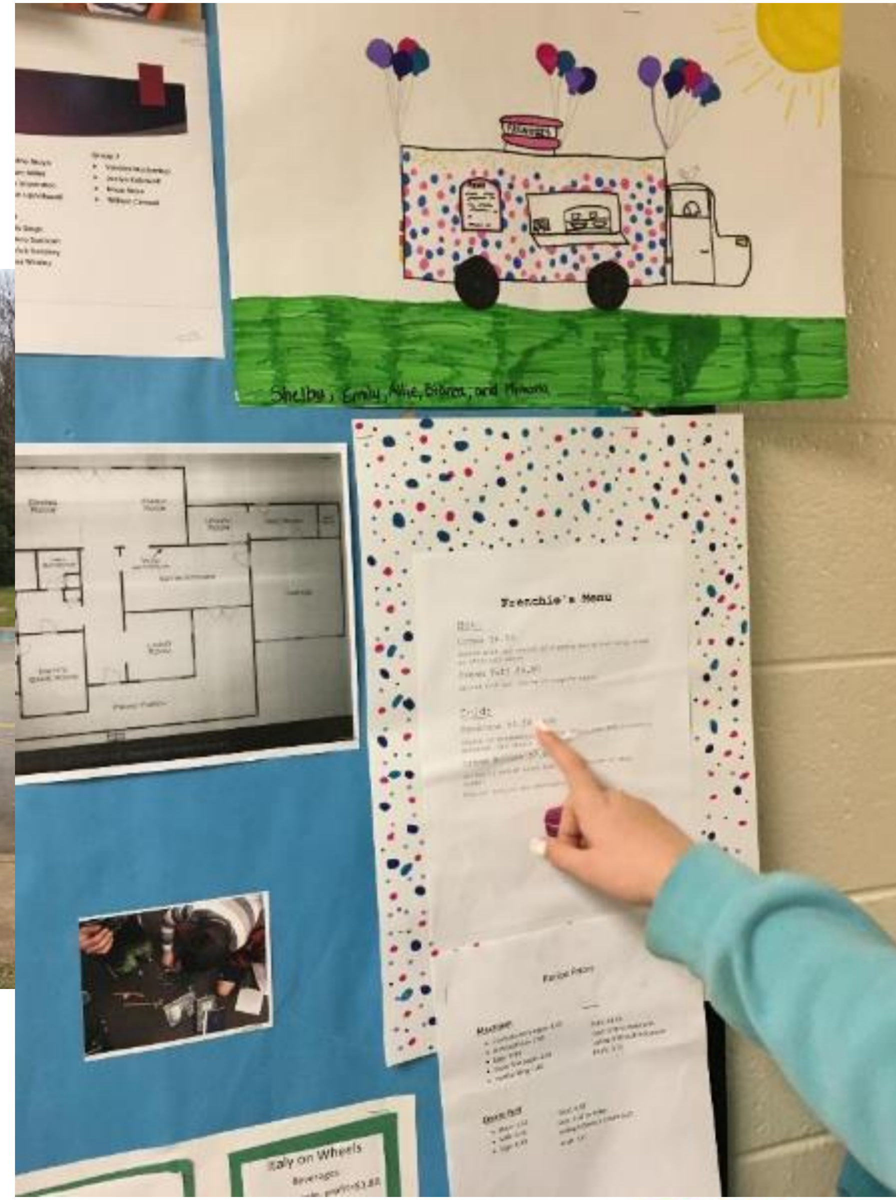
River Water Quality



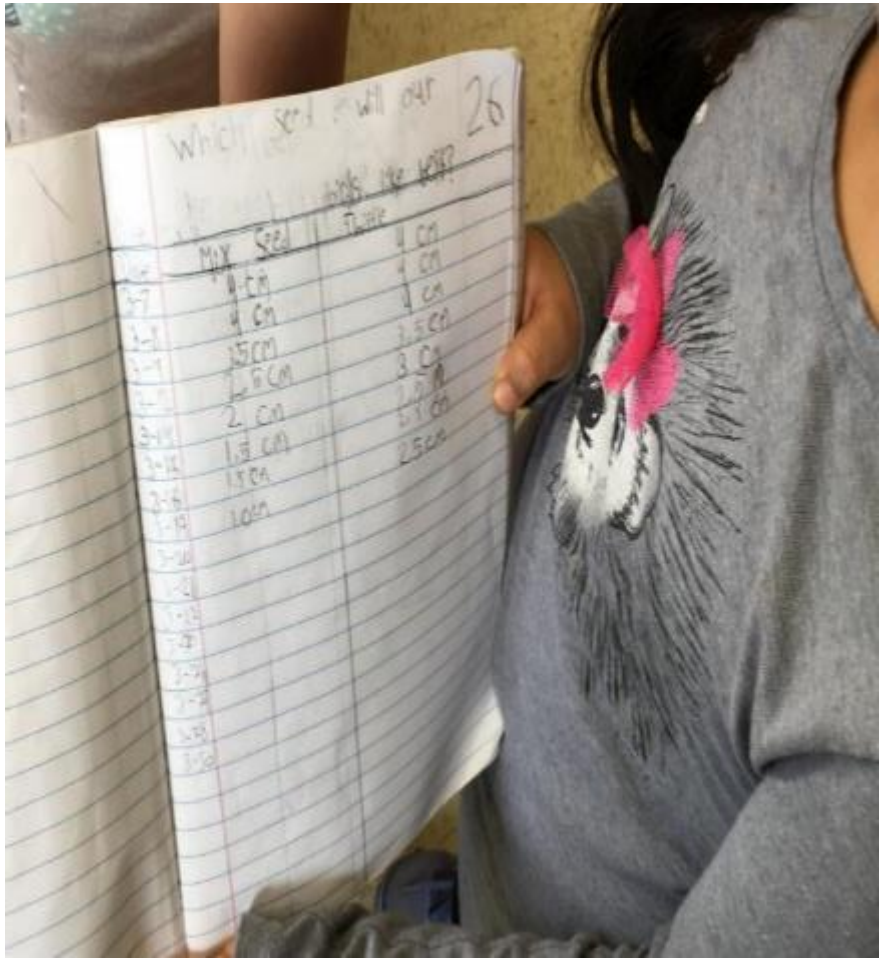
Erosion

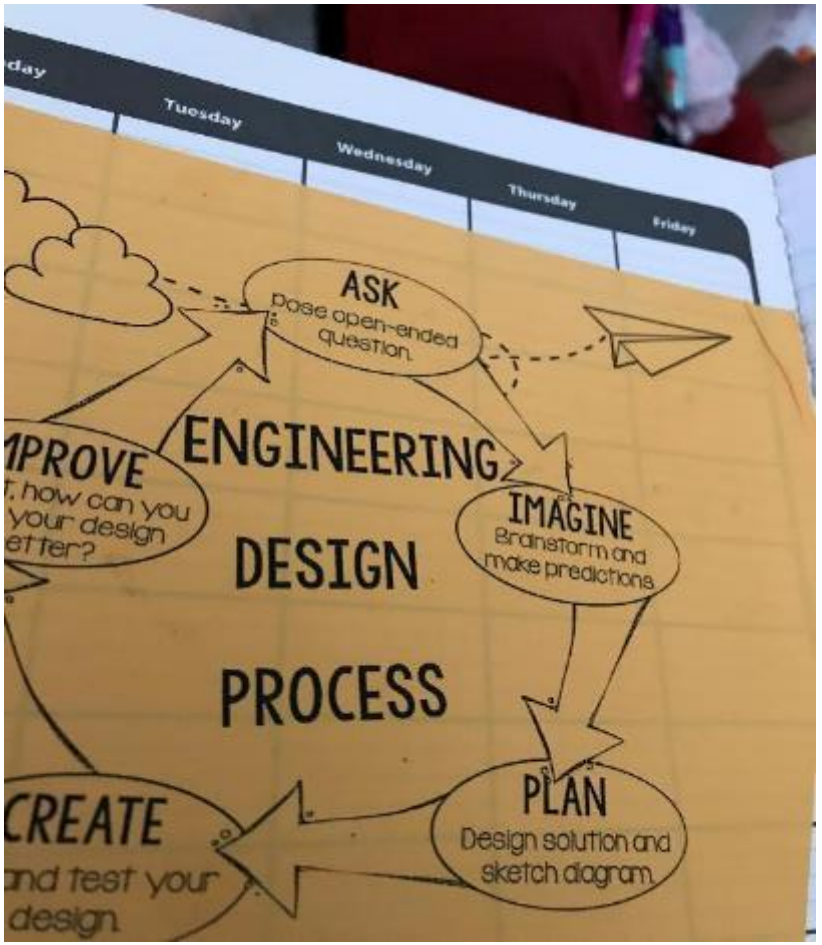
Sustainable Agriculture

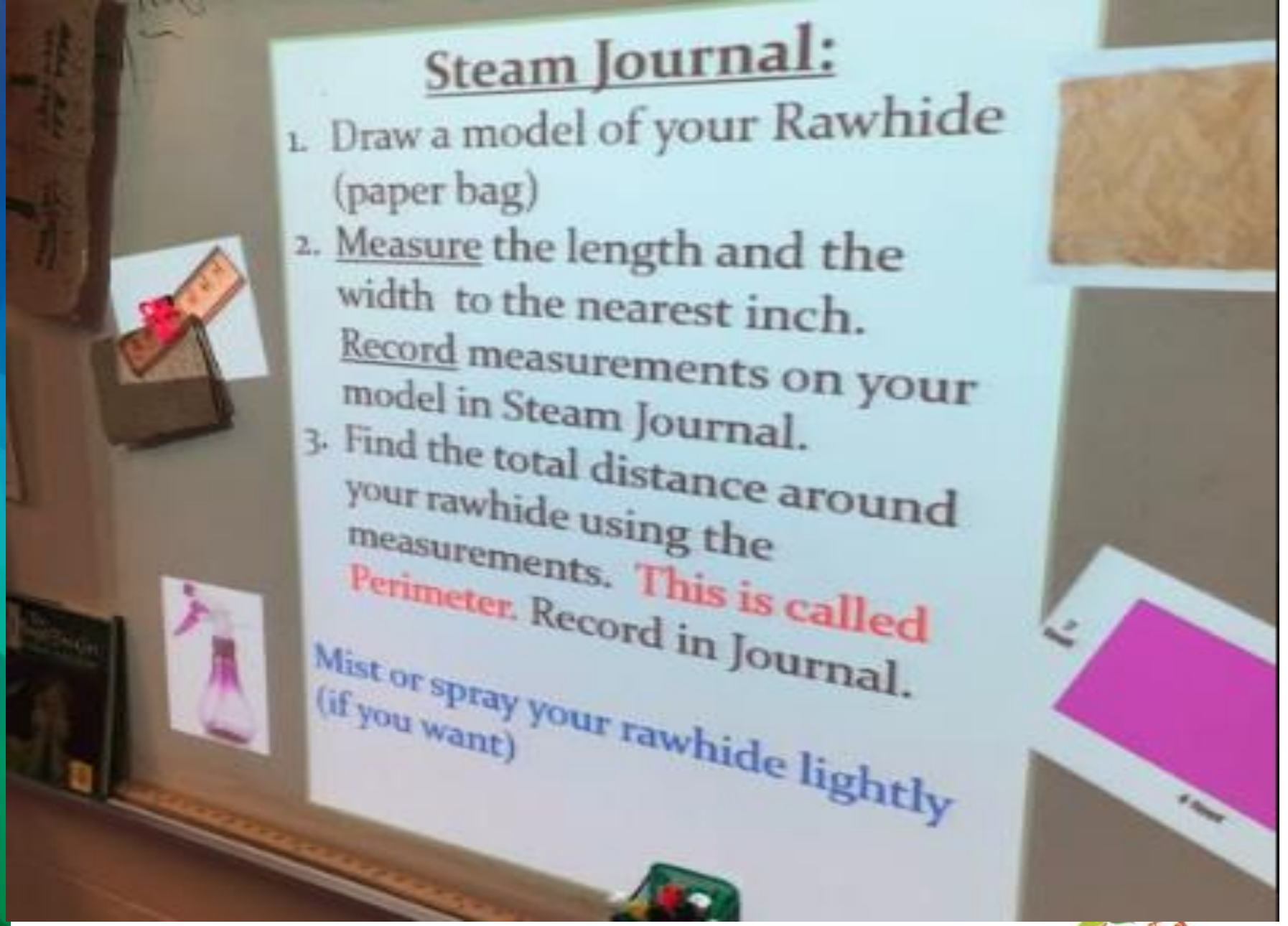
Film


Pero's

Frenchie's Menu
Italy on Wheels
Beverages

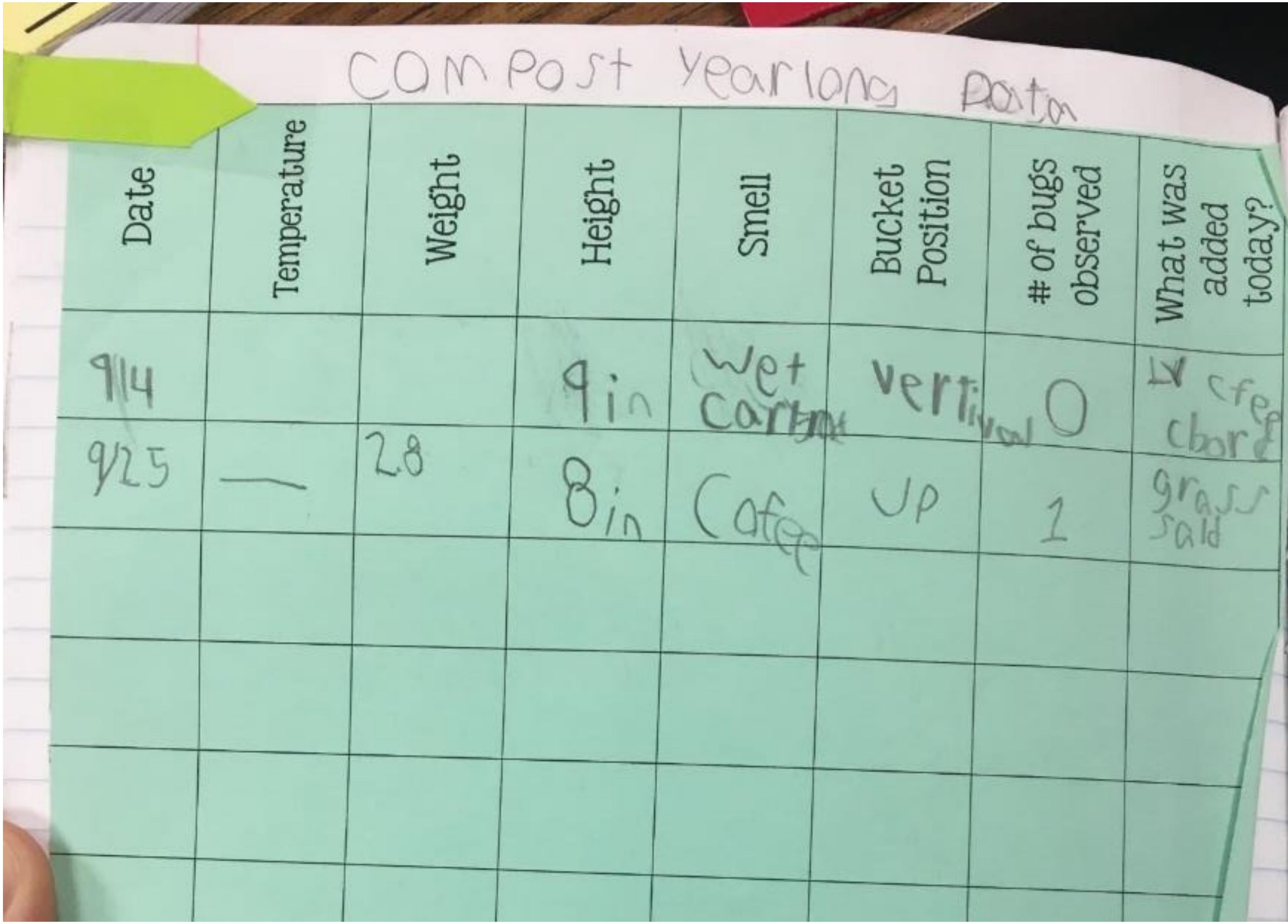
Investigative Research





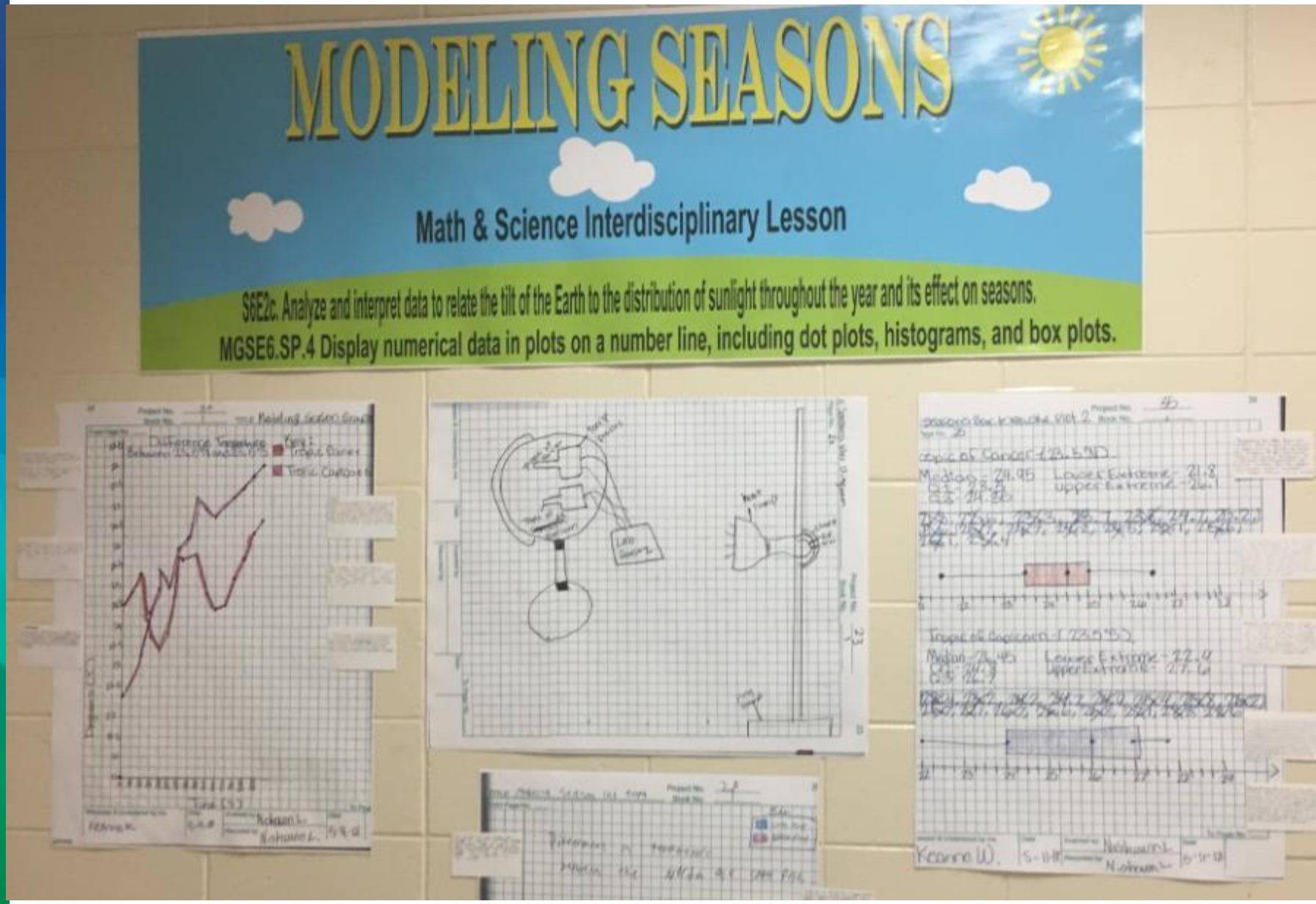

Steam Journal:
1. Draw a model of your Rawhide (paper bag)
2. Measure the length and the width to the nearest inch. Record measurements on your model in Steam Journal.
3. Find the total distance around your rawhide using the measurements. This is called Perimeter. Record in Journal.
Mist or spray your rawhide lightly (if you want)

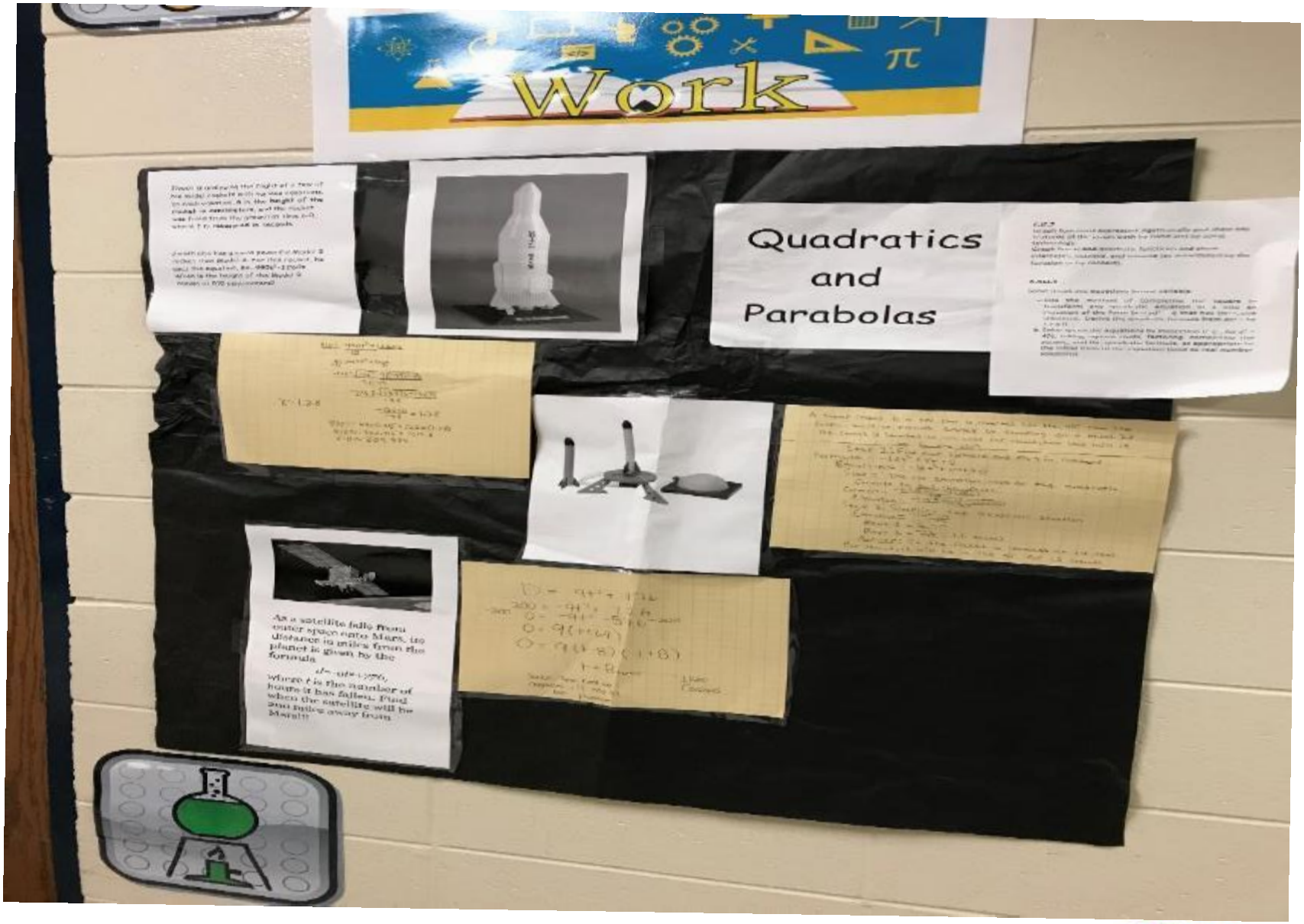

How do you think rocks and mi
agriculture?

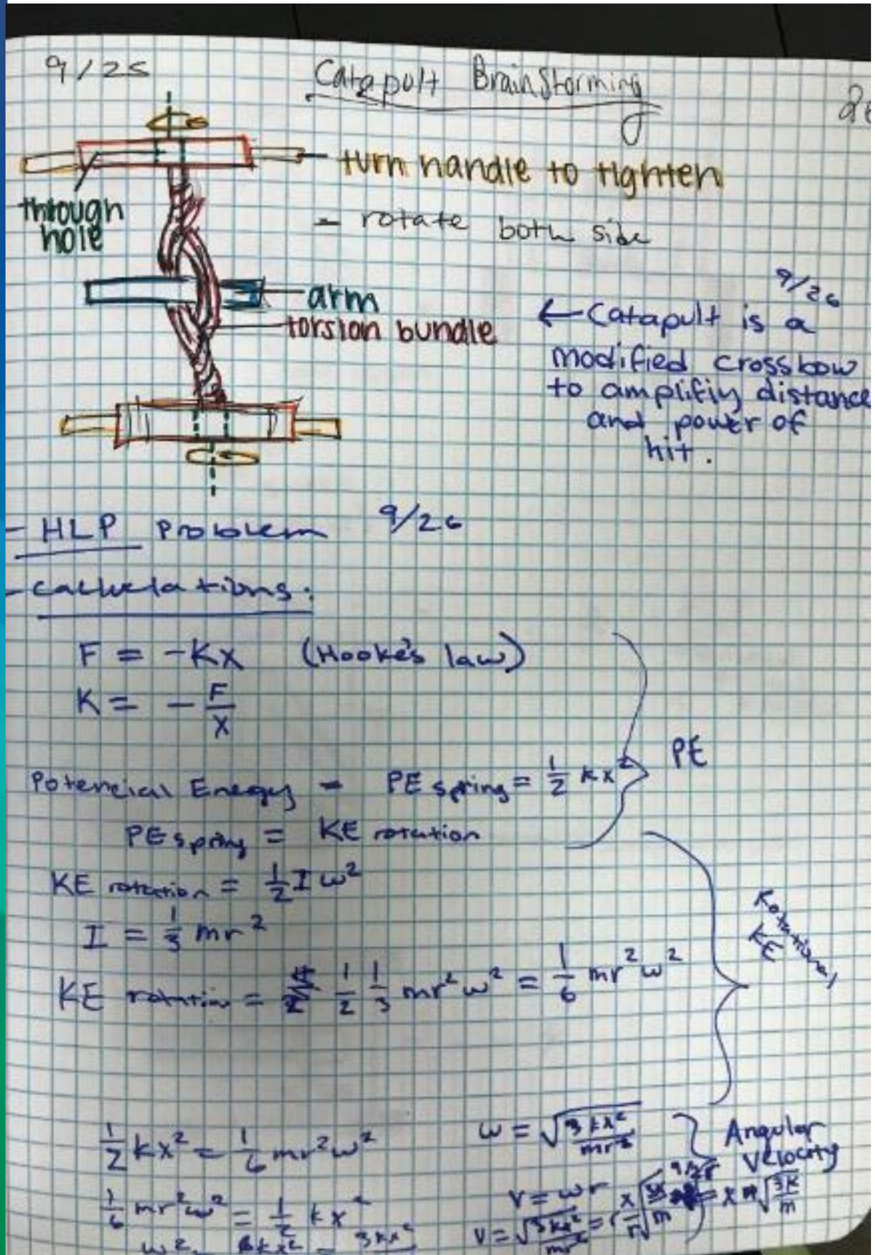


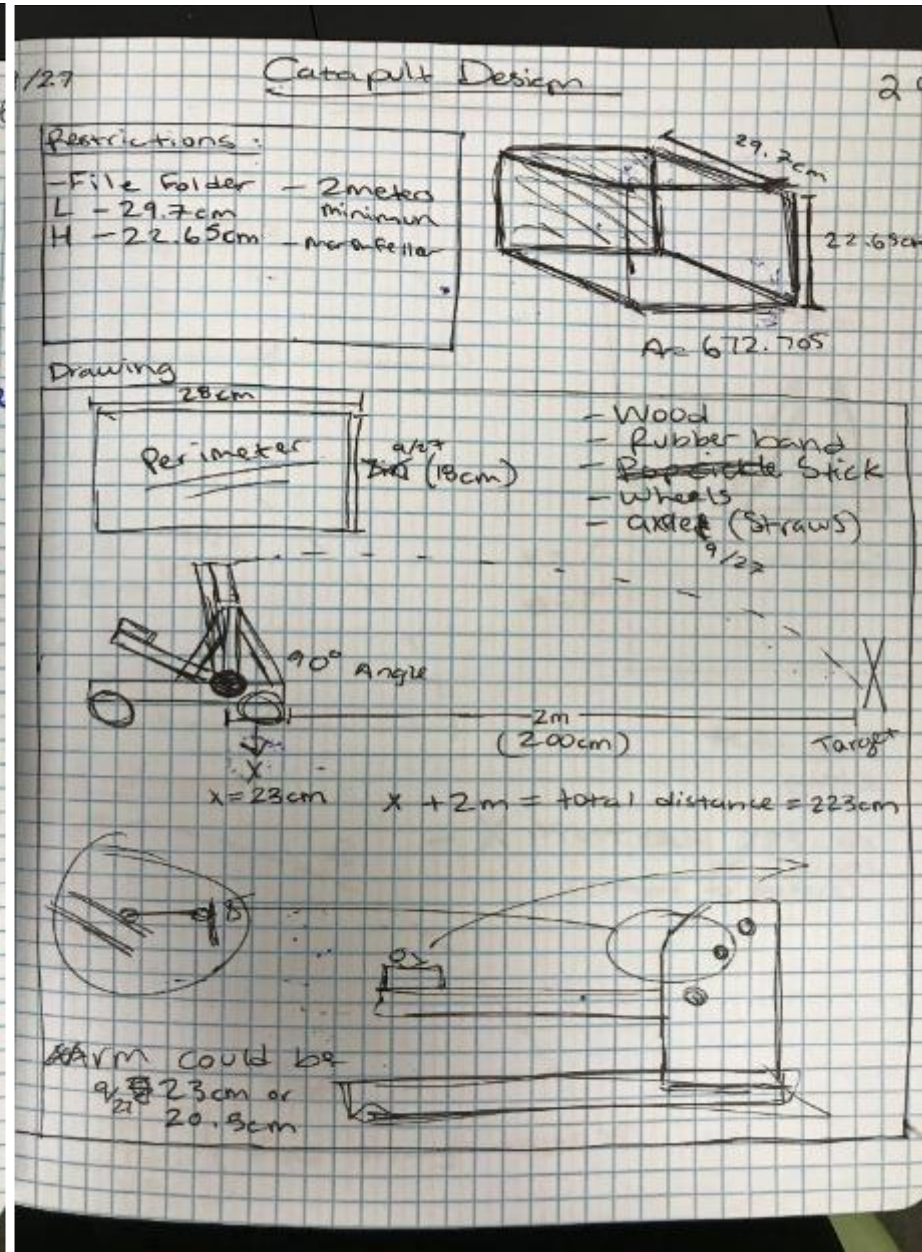
Compost yearlong Data

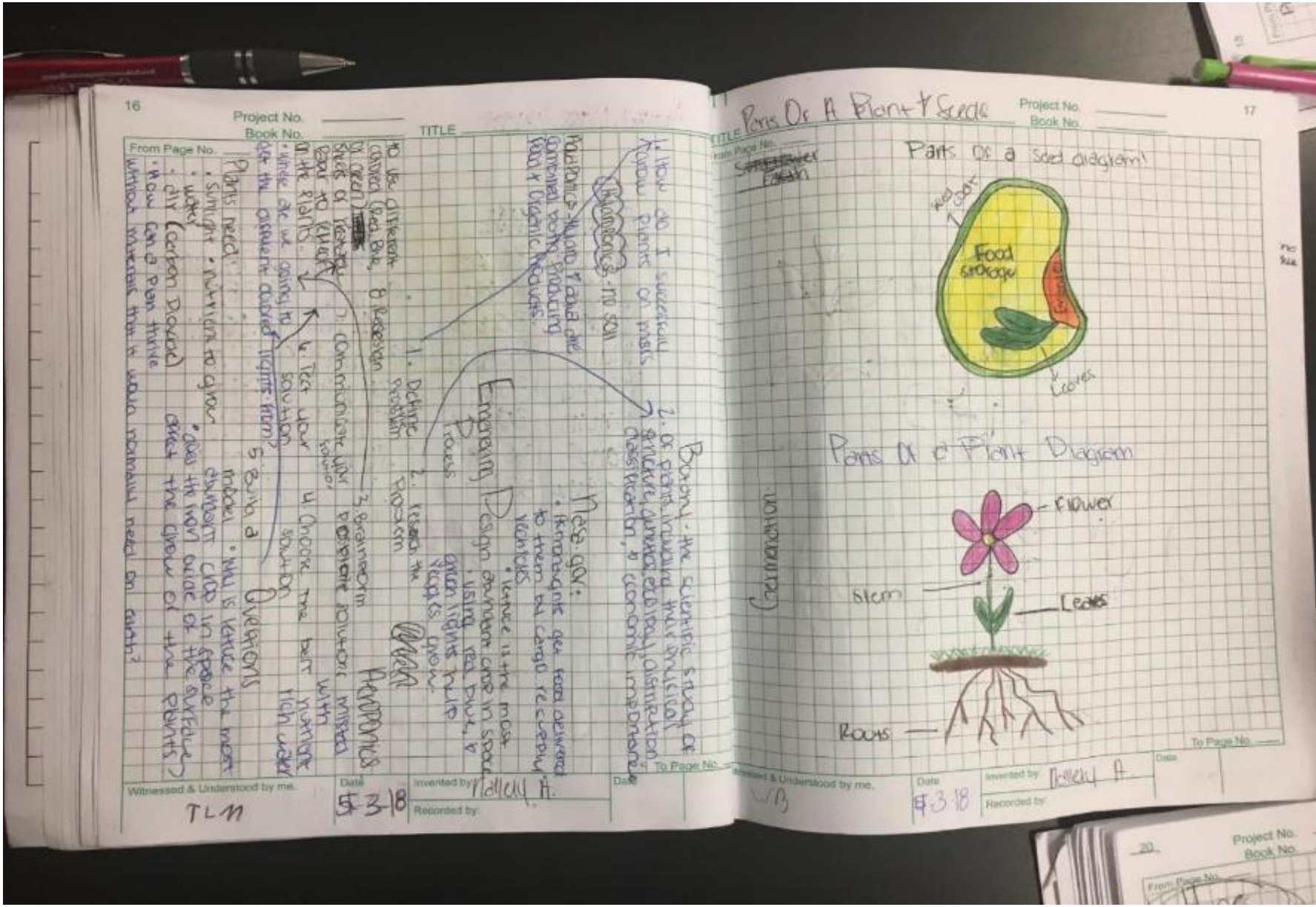
Date	Temperature	Weight	Height	Smell	Bucket Position	# of bugs observed	What was added today?
9/14			9in	wet carton	vertival	0	LV cfee cbord
9/25	—	28	8in	Cafee	up	1	grass sald


MODELING SEASONS
Math & Science Interdisciplinary Lesson
S6E2c. Analyze and interpret data to relate the tilt of the Earth to the distribution of sunlight throughout the year and its effect on seasons.
MGSE6.SP.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.


Work
Quadratics and Parabolas


9/25
Catapult Brainstorming
turn handle to tighten
- rotate both side
through hole
arm
torsion bundle
9/26
← Catapult is a modified crossbow to amplifiy distance and power of hit.
- HLP Problem 9/26
- calculations:
F = -Kx (Hooke's law)
K = - F/x
Potencial Energy = PE spring = 1/2 kx²
PE spring = KE rotation
KE rotation = 1/2 I ω²
I = 1/3 mr²
KE rotation = 1/2 1/3 mr²ω² = 1/6 mr²ω²
PE
Rotational KE
Angular Velocity

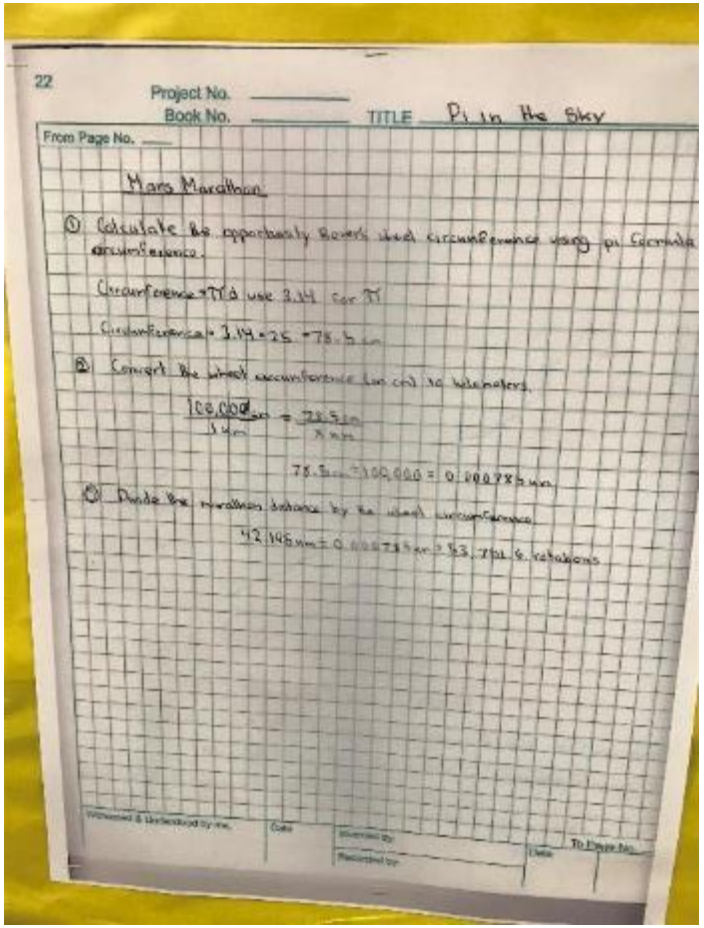

9/27
Catapult Design
Restrictions:
- File Folder
L - 29.7cm
H - 22.65cm
- 2 meters minimum
- More fellar
29.7cm
22.65cm
A= 672.705
Drawing
28cm
Perimeter
(18cm)
- Wood
- Rubber band
- Stick
- wheels
- axles (Straws)
90° Angle
2m (200cm)
Target
x = 23cm
x + 2m = total distance = 223cm
Arm could be 23cm or 20.5cm


Parts Of A Plant + Seeds
Parts of a Seed diagram!
Food storage
Leaves
Parts of a Plant Diagram
Flower
Stem
Leaves
Roots

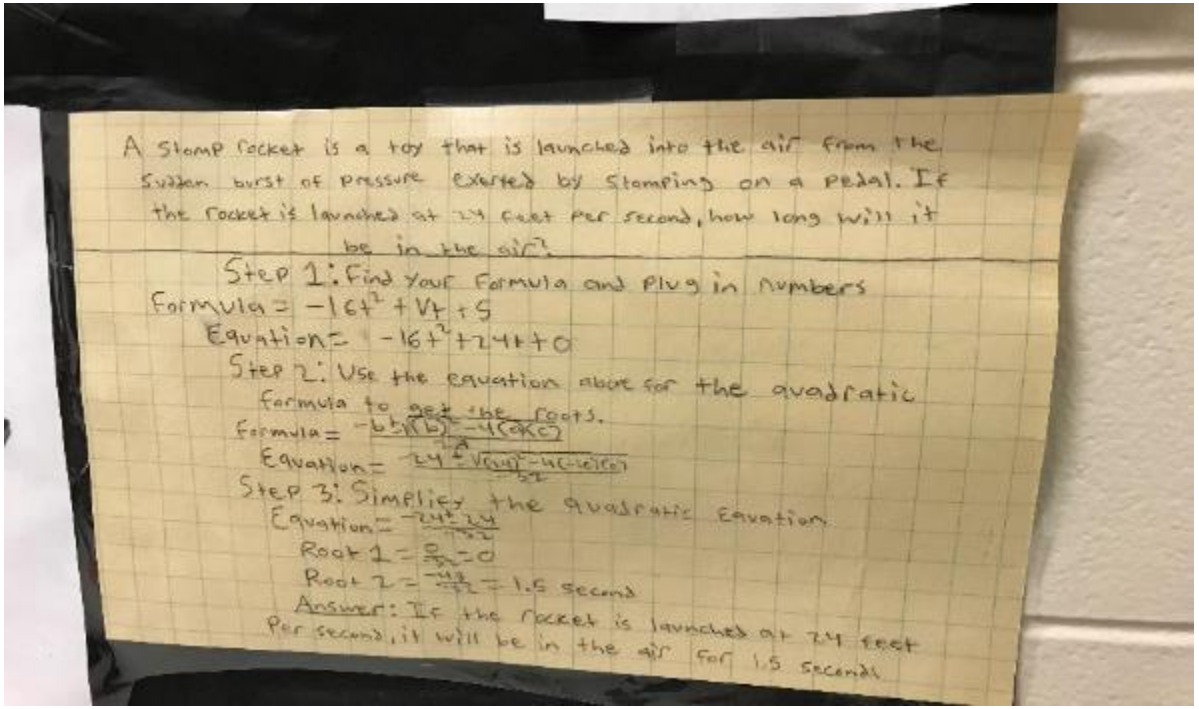
Promising practices to improve mathematics literacy:

- **integration** of mathematics **across disciplines**
- teaching mathematics through
  - **experiential**
  - **meaningful**
  - **applied** contexts

To be numerate is to confidently and effectively use mathematics to meet the everyday demands of life.



Numeracy is important for individuals to develop logical thinking and reasoning strategies in their everyday activities.



A stomp rocket is a toy that is launched into the air from the sudden burst of pressure exerted by stomping on a pedal. If the rocket is launched at 24 feet per second, how long will it be in the air?

Step 1: Find your Formula and Plug in Numbers

Formula = $-16t^2 + Vt + S$

Equation = $-16t^2 + 24t + 0$

Step 2: Use the equation above for the quadratic formula to get the roots.

Formula = $\frac{-b \pm \sqrt{(b)^2 - 4(a)(c)}}{2a}$

Equation = $\frac{-24 \pm \sqrt{(24)^2 - 4(-16)(0)}}{-32}$

Step 3: Simplify the quadratic equation

Equation = $\frac{-24 \pm 24}{-32}$

Root 1 = $\frac{0}{-32} = 0$

Root 2 = $\frac{-48}{-32} = 1.5$ seconds

Answer: If the rocket is launched at 24 feet per second, it will be in the air for 1.5 seconds.

Characteristics of STEM/STEAM Schools

- Project- Based Learning
- Integrated math, science, CTAE, and, for STEAM, fine arts
- Strong business/post-secondary/community partnerships
- Investigative research as part of the curriculum

Common Thread

Collaborative Planning Time

Georgia STEM/ STEAM Forum

OCTOBER 20-22, 2019

ATHENS, GEORGIA: CLASSIC CENTER

Designed to support K-12 efforts to include STEM and STEAM education in the school curriculum.

STEM/ STEAM Georgia Teachers Academy

JUNE 2020

STEM/ STEAM Leadership Cohort

SPRING 2020

STEM/ STEAM Georgia Online:
http://stemgeorgia.org

Enables users to find STEM/ STEAM resources, materials, links to STEM/ STEAM schools, grants, competitions, lesson plans, and more.

Follow us on Twitter:
http://twitter.com/stemgeorgia

@stemgeorgia enables users to receive tweets about STEM/ STEAM updates, grants, scholarships, workshops, information, articles, resources, and more.

Instagram

Be our first followers!

@gadoe_stem_steam

Join our STEM/ STEAM Georgia Listserv

To join our listserv to receive email notices and updates from the GADOE STEM/STEAM program, please send an email with no message to the email address listed below.

join-STEM-Georgia@list.doe.k12.ga.us

Contact information:

Felicia Cullars
fcullars@doe.k12.ga.us
404.516.1535

Meghan McFerrin
mmcferrin@doe.k12.ga.us
470.755.9197