# An Introduction to


**At Milltown Public Schools**

# Objectives for Today:

- Introductions
- STEM vs STEAM…
- What?
- Why?
- Key aspects of an integrated approach
- Strategies for Success
- Example Activities
- Considering our own lessons and instruction

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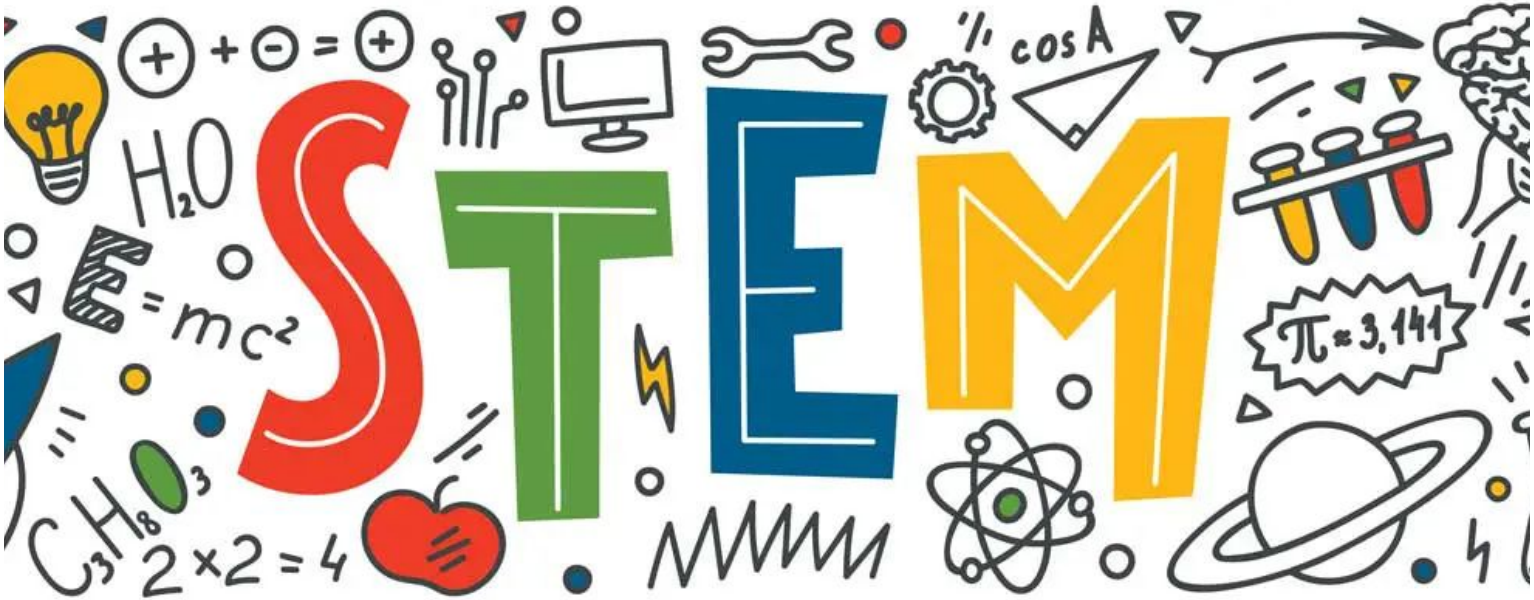
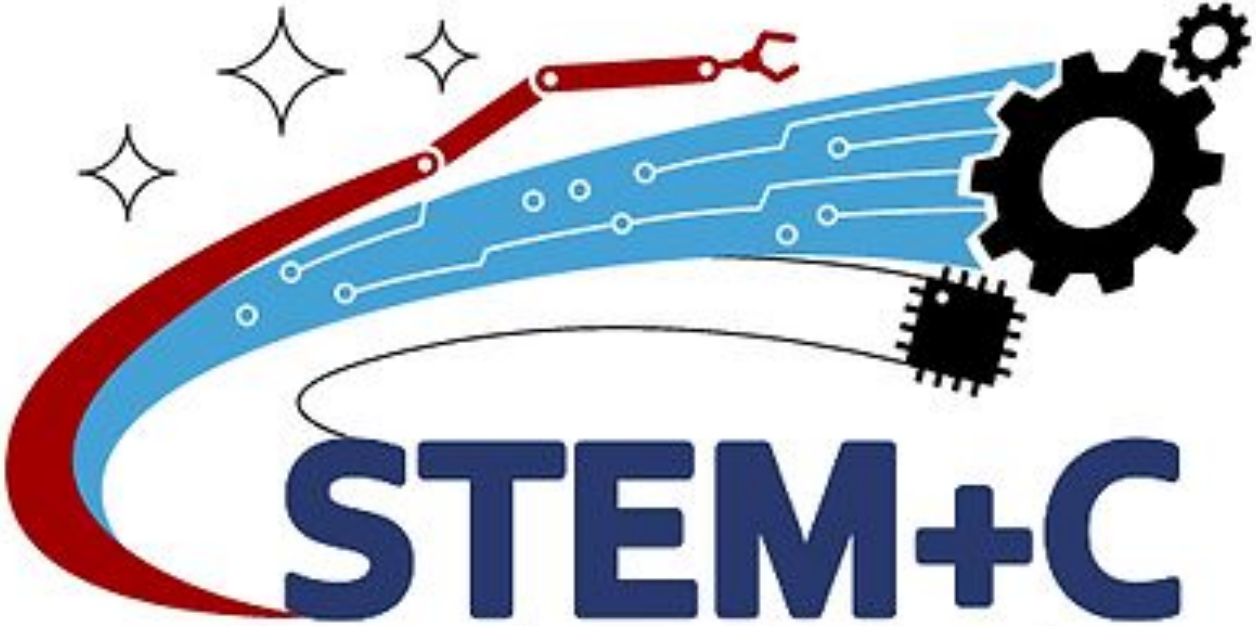

STEM
cos A
$H_2O$
$E = mc^2$
$C_3H_8O_3$
2 × 2 = 4
π = 3,141


STEM+C


STEÁM


STREAM

# TEAMS

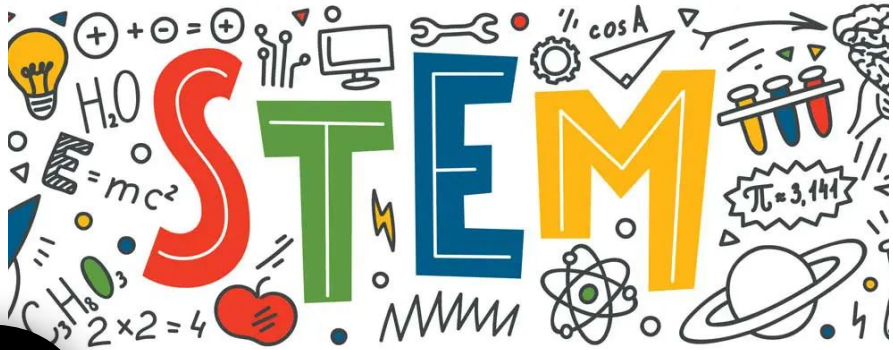
Technology, Engineering, Art, Math, Science
*through collaboration*

# DREAMS

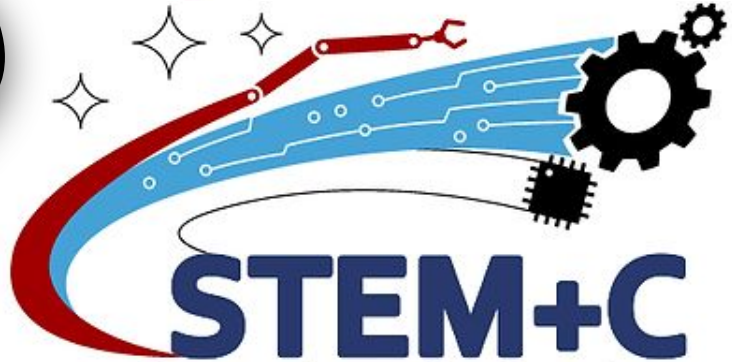
Design, Reading, Engineering, Art, Math, Science

SCHOOL

TEAMS








DREAMS


An Interdisciplinary
Learning Experience

# Why teach Interdisciplinary?

↑ Student Engagement

↑ Knowledge Retention

↑ Critical Thinking

↑ Differentiation Strategies

↑ Supporting Diverse Learners

↑ Instructional Time

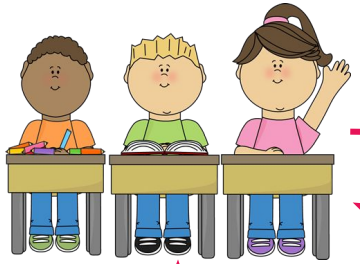
↑ Real-world Connections

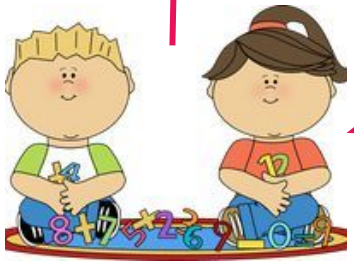
↑ Student Voice

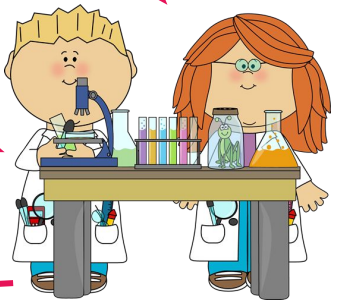
↑ Curiosity for Learning

↑ Collaboration

# SCHOOL



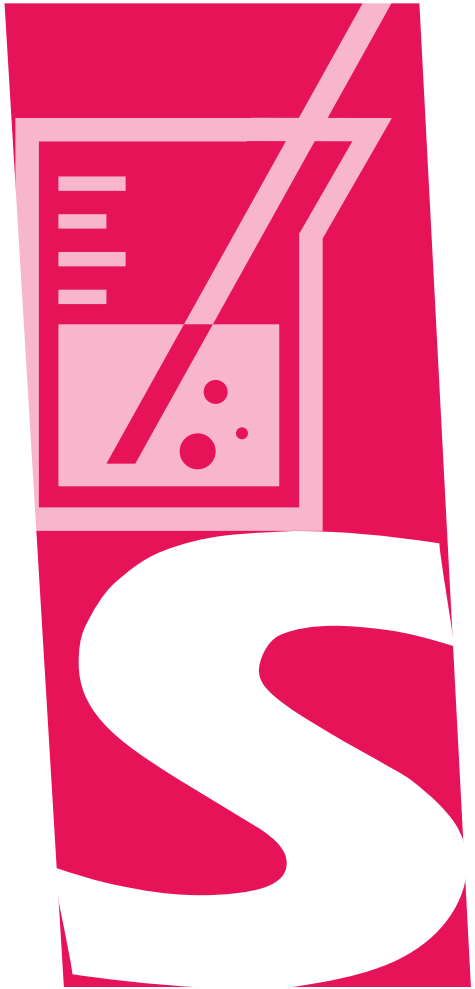




# Common barriers towards creating an effective interdisciplinary learning experience

- Instructional Time
- State Assessments / Benchmarks
- Planning and Prep Time
- Training and Instructional Resources
- Few Opportunities for Articulation

# Strategies for Success



# Integrating Science

- Increase student inquiry
- Build opportunities for students to hypothesis or predict what might happen
- Allow for students to experiment and test their ideas
- Create connections with weather
- Create connections with nature
- Create connections with space
- Create connections with us, our needs, our health and well being

# Integrating Technology

- Challenge students to use technology to perform tasks
- Challenge students to design using software
- Teach students how to use tools, like rulers, scissors, scales, etc
- Teach students how to maintain technology through organization skills and proper care
- Teach students how to communicate using technology effectively
- Teach students how to be effective digital citizens

# Integrating Engineering

- Challenge students to become effective problem solvers
- Challenge students to brainstorm
- Promote documentation
- Offer opportunities to test knowledge through physical projects or performance projects
- Teach through a design process
- Challenge students to work collaboratively in different roles
- Challenge students to create instructions or diagrams to explain how something works

# Integrating Art

- Promote creativity
- Allow for a wide range of mediums to be used for project creation
- Promote the use of imagery, color, text, and scale in projects
- Incorporate music in lessons or projects
- Create connections with influential art in relation to course topics and activities
- Challenge students to use software to design posters, advertisements, songs, or videos

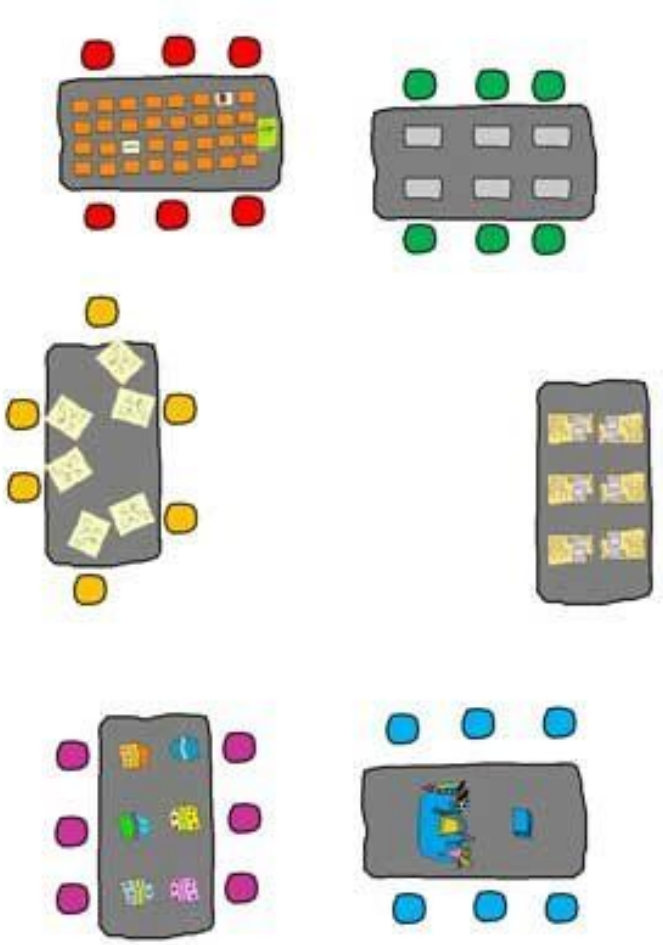
# Integrating Mathematics

- Promote critical thinking and problem solving
- Challenge students to find answers through puzzles, searches, or scavenger hunt like activities
- Utilize graphs or visuals to present data
- Incorporate distance, time, weight, and scale into lessons or activities
- Promote group work and collaboration
- Use visuals or manipulatives to create analogies as content is explained

# Teach with stations

Challenging students to work through different labs, activities, or experiments in stations is a great way to promote creative thinking and problem-solving, as well as foster collaboration among students.

This also promotes small group instruction, and allows for break-out sessions with the teacher.



# Teach through Project-Based Learning

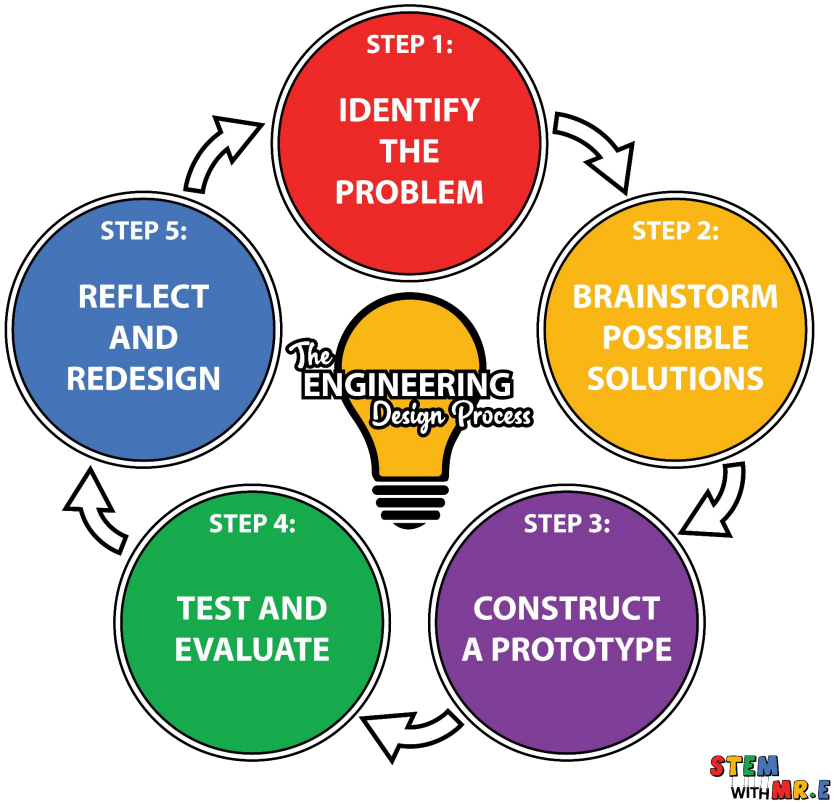
Project-Based Learning describes activities that allow for students to demonstrate their knowledge through the creation of a project as an assessment.

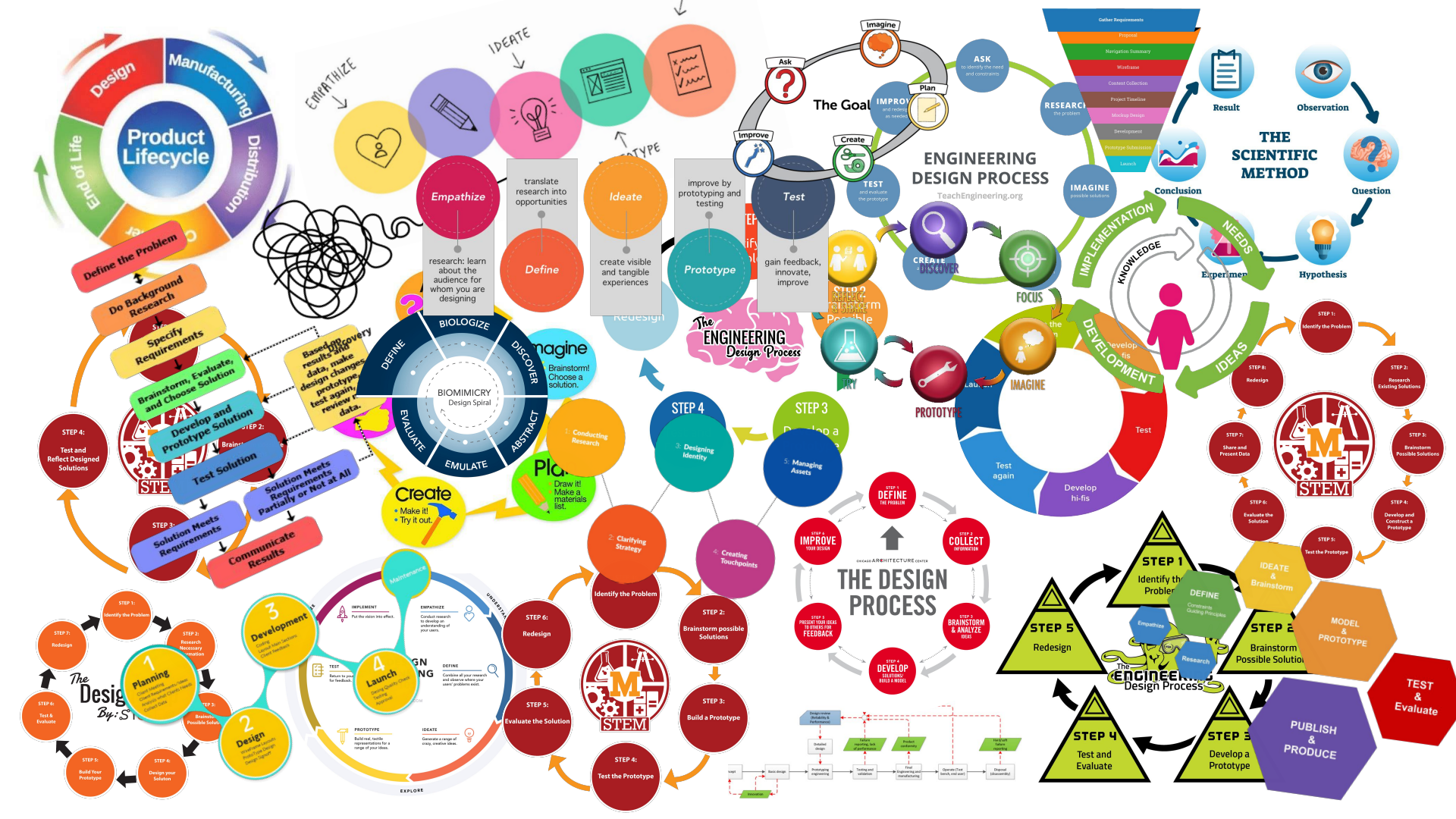
These types of activities are typically assessed using rubrics.

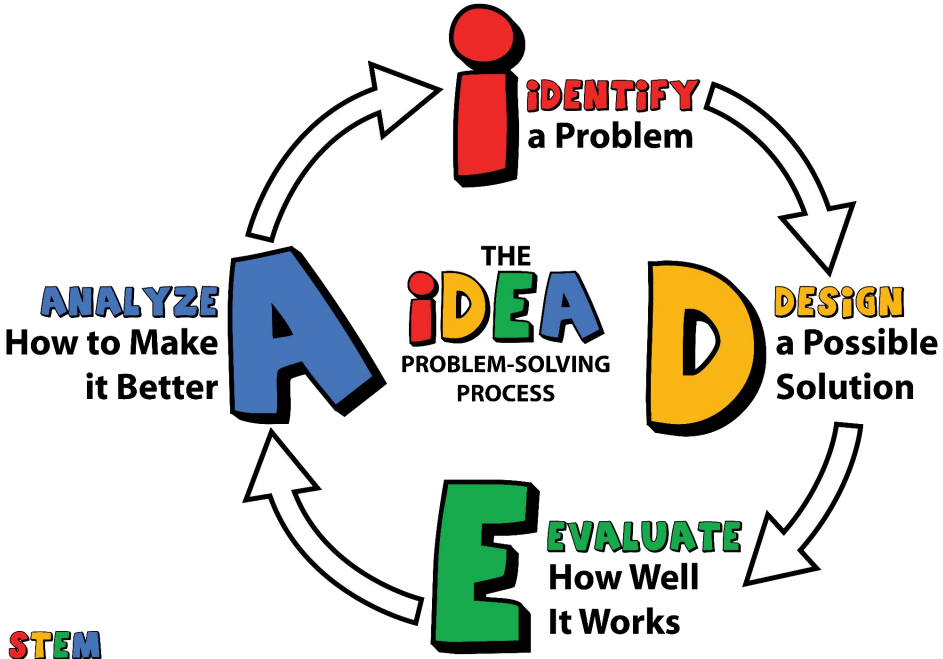
# Teach through Problem-Based Learning

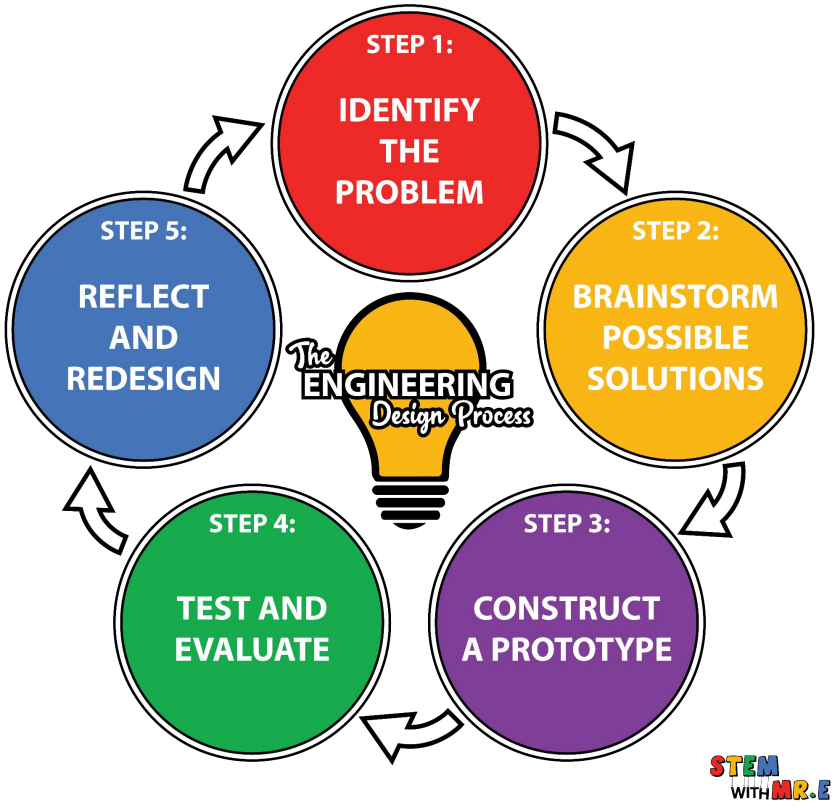
Problem-based learning describes instruction based around the utilization of a design process, sometimes called an engineering design process, or design loop.

This promotes open-ended instruction supported by constraints, allowing for students to gain a variety of skills in a real-world setting.

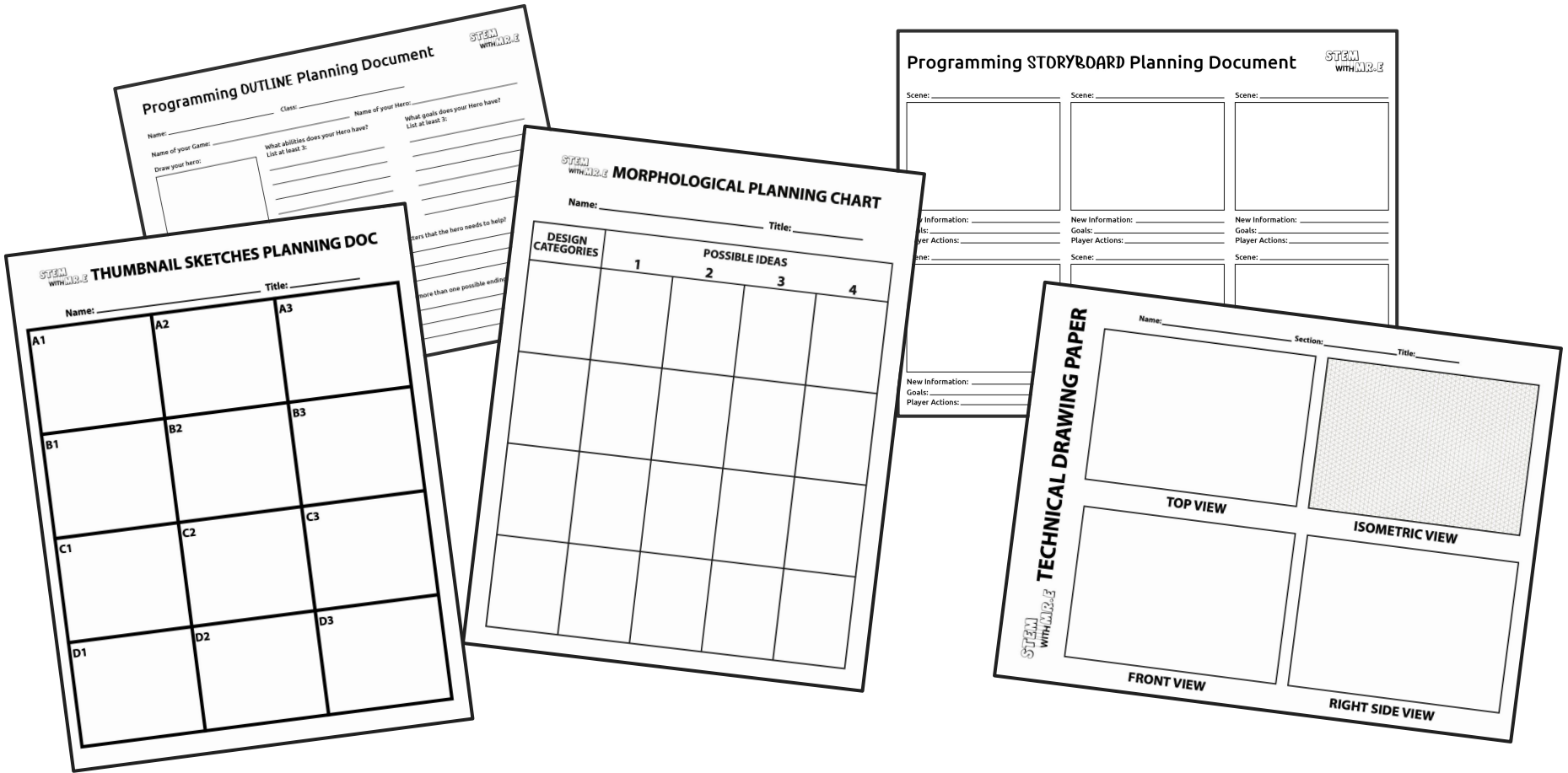



Design
Manufacturing
Distribution
End of Life
Product Lifecycle
EMPATHIZE
IDEATE
Empathize
Define
Ideate
Prototype
Test
translate research into opportunities
research: learn about the audience for whom you are designing
create visible and tangible experiences
improve by prototyping and testing
gain feedback, innovate, improve
Define the Problem
Do Background Research
Specify Requirements
Brainstorm, Evaluate, and Choose Solution
Develop and Prototype Solution
Test Solution
Solution Meets Requirements
Solution Meets Requirements Partially or Not at All
Communicate Results
STEP 1:
STEP 2:
STEP 3:
STEP 4:
Test and Reflect Designed Solutions
BIOMIMICRY
Design Spiral
BIOLOGIZE
DISCOVER
ABSTRACT
EMULATE
EVALUATE
DEFINE
Imagine
Brainstorm! Choose a solution.
Create
Make it!
Try it out.
Plan
Draw it!
Make a materials list.
Conducting Research
The ENGINEERING Design Process
STEP 3
Develop a
Managing Assets
Designing Identity
Clarifying Strategy
Creating Touchpoints
Identify the Problem
Brainstorm possible Solutions
Build a Prototype
Test the Prototype
Evaluate the Solution
Redesign
Ask
Imagine
Plan
Create
Improve
Test
The Goal
ENGINEERING DESIGN PROCESS
TeachEngineering.org
ASK
to identify the need and constraints
IMAGINE
possible solutions
CREATE
DISCOVER
FOCUS
TRY
PROTOTYPE
IMPLEMENTATION
KNOWLEDGE
DEVELOPMENT
IDEAS
Develop hi-fis
Test
Test again
Gather Requirements
Proposal
Navigation Summary
Wireframe
Content Collection
Project Timeline
Mockup Design
Development
Prototype Submission
Launch
Result
Observation
Conclusion
Question
Experiment
Hypothesis
THE SCIENTIFIC METHOD
NEEDS
STEP 1: Identify the Problem
STEP 2: Research Existing Solutions
STEP 3: Brainstorm Possible Solutions
STEP 4: Develop and Construct a Prototype
STEP 5: Test the Prototype
STEP 6: Evaluate the Solution
STEP 7: Share and Present Data
STEP 8: Redesign
STEM
THE DESIGN PROCESS
CHICAGO ARCHITECTURE CENTER
STEP 1 DEFINE THE PROBLEM
STEP 2 COLLECT INFORMATION
STEP 3 BRAINSTORM & ANALYZE IDEAS
STEP 4 DEVELOP SOLUTIONS / BUILD A MODEL
STEP 5 PRESENT YOUR IDEAS TO OTHERS FOR FEEDBACK
STEP 6 IMPROVE YOUR DESIGN
STEP 1
Identify the Problem
STEP 2
Brainstorm Possible Solutions
STEP 3
Develop a Prototype
STEP 4
Test and Evaluate
STEP 5
Redesign
IDEATE & Brainstorm
DEFINE
MODEL & PROTOTYPE
TEST & Evaluate
PUBLISH & PRODUCE
Empathize
Research
The ENGINEERING Design Process
1 Planning
2 Design
3 Development
4 Launch
Maintenance
IMPLEMENT
EMPATHIZE
DEFINE
IDEATE
PROTOTYPE
TEST
EXPLORE
STEP 1: Identify the Problem
STEP 2: Research Necessary Information
STEP 3: Brainstorm Possible Solutions
STEP 4: Design your Solution
STEP 5: Build Your Prototype
STEP 6: Test & Evaluate
STEP 7: Redesign


THE
iDEA
PROBLEM-SOLVING
PROCESS
iDENTiFY
a Problem
DESiGN
a Possible
Solution
EVALUATE
How Well
It Works
ANALYZE
How to Make
it Better
STEM
WITH MR.E


STEP 1:
IDENTIFY
THE
PROBLEM
STEP 2:
BRAINSTORM
POSSIBLE
SOLUTIONS
STEP 3:
CONSTRUCT
A PROTOTYPE
STEP 4:
TEST AND
EVALUATE
STEP 5:
REFLECT
AND
REDESIGN
The
ENGINEERING
Design Process
STEM
WITH MR.E

# Encourage Brainstorming



# Encourage Experimentation

When working through a design process, students should be presented with opportunities to make mistakes and fail.

Through this, they should be supported in testing different ideas safely as they work to find the best approach, or a possible answer to a problem.

# Teach with Constraints

Designing an open-ended project can sometimes be a daunting task, and one that is difficult to plan for. A key aspect to designing a successful open-ended project or activity is to define constraints.

Constraints like time, materials, or specifications allow you to not only plan more effectively, but also better foster critical thinking, creativity, and problem solving in a real-world setting.


# Encourage Reflection

Regardless of how big a project is, students should always have the opportunity to consider how they would improve or make changes based on what they have learned. Possible reflection activities could be:

- Class Discussions
- Exit Tickets
- Creating an annotated sketch
- Creating a model
- Engaging in a re-do activity

# Help students overcome their fear of failure

# Make Learning Relatable

Creating connections between our lessons, activities, and projects with the “real-world” is a key aspect of promoting design thinking through an integrated approach.

With this, we want to provide students with a possible reason as to why they need to know this, or who out in the world uses this knowledge everyday. This builds student interest towards possible passions or careers, as well as increases motivation and engagement.

# Make Learning Relatable

“You and your team of engineers have been challenged to….”

“Our school needs help in designing a new….”

“Your neighbor wants to know….”

“We have recently been hired by NASA, and it is our job to….”

“Samantha, who is a computer programmer, is trying to figure out…”

“Our town is preparing for the winter season and they have asked us to….”

# Example Activity

After outlining your opinion on the removal of parks and wildlife, draft a five paragraph essay to argue your opinion towards those who may disagree with you.

# **Example Activity,** with an interdisciplinary approach

The *non-profit* you work for is trying to protect our local parks and wildlife. To help, we must share our opinions on this topic to argue these points to those who may disagree.

…to help, write a five paragraph essay to include in a local newspaper

….to help, we must create posters to inform our neighbors of our views on this issue

….to help, we are going to make a website to build awareness on this issue

…to help, we are going to design an app that allows users to learn more and support this cause


ADOPTER
MA(LE)S POULE(S)
Grille
poules adoptables

**Design thinking** is Inquiry based learning through the implementation of a problem solving process in order to develop a model or solution to a proposed problem.

**Design thinking** is

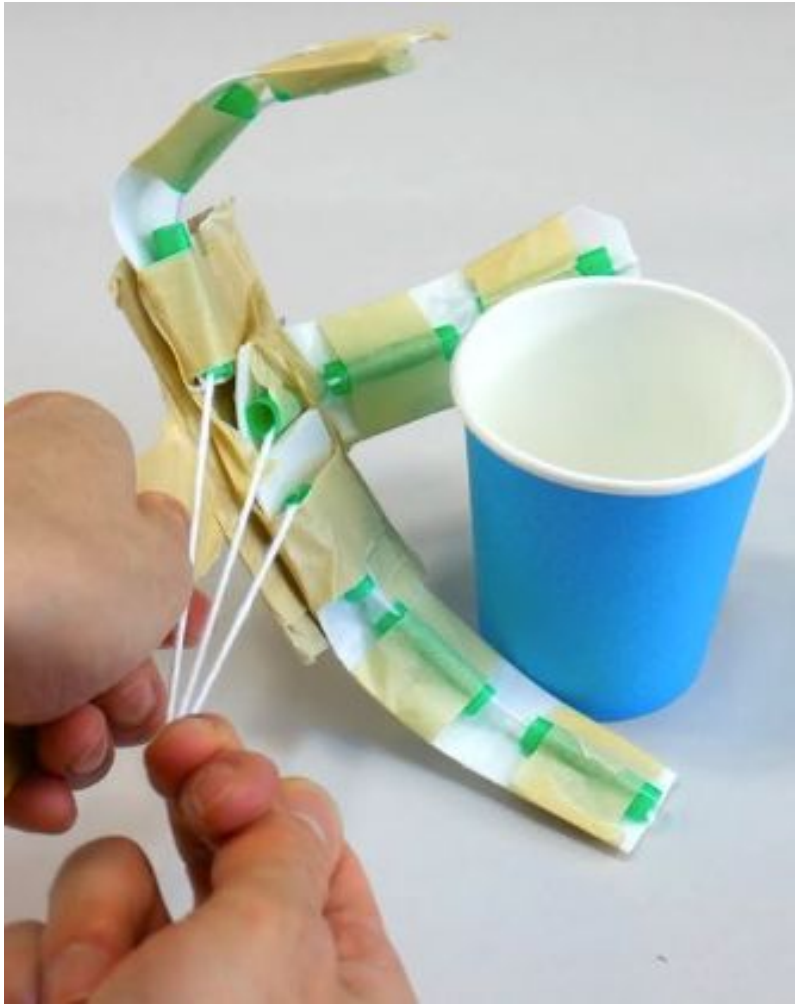
providing the **WHY**

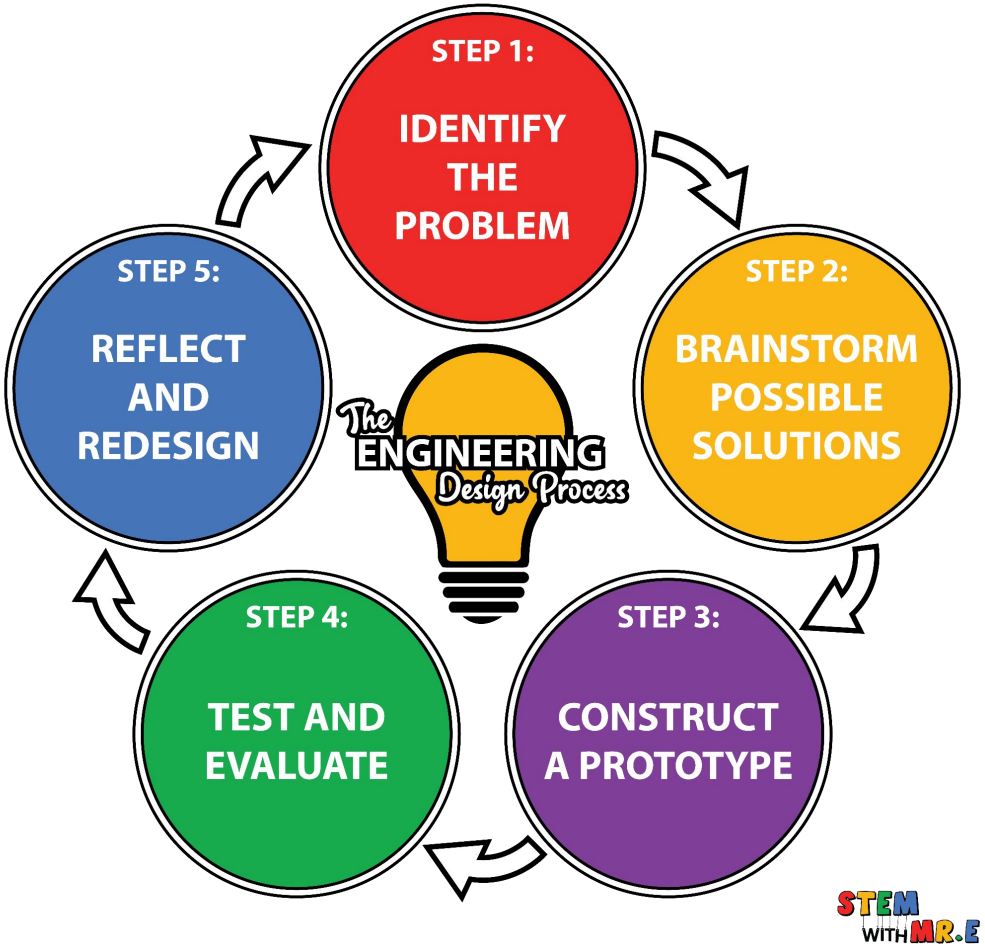
so students create the **WHAT**

# Promote Empathy

Empathy should be encouraged in all projects, lessons, and activities cross K-12 education.

As you choose real-world connections, relatable experiences, and constraints for your projects, challenge students to design solutions to help others.




STEP 1:
IDENTIFY THE PROBLEM
STEP 2:
BRAINSTORM POSSIBLE SOLUTIONS
STEP 3:
CONSTRUCT A PROTOTYPE
STEP 4:
TEST AND EVALUATE
STEP 5:
REFLECT AND REDESIGN
The ENGINEERING Design Process
STEM WITH MR.E

STEP 1:

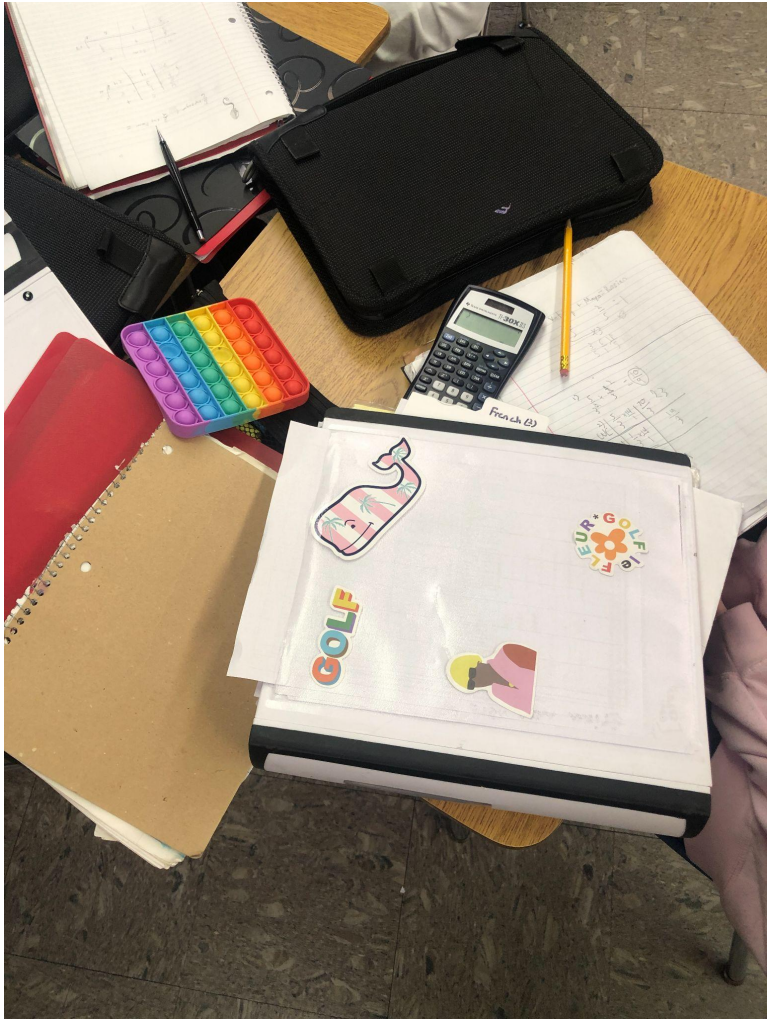
IDENTIFY THE PROBLEM

# The Problem

Our school has noticed that your desks are becoming more cluttered with all of the things you need to bring back to class.

Unfortunately there isn't room for bigger desks, but we are hoping you can help design a solution to this problem.

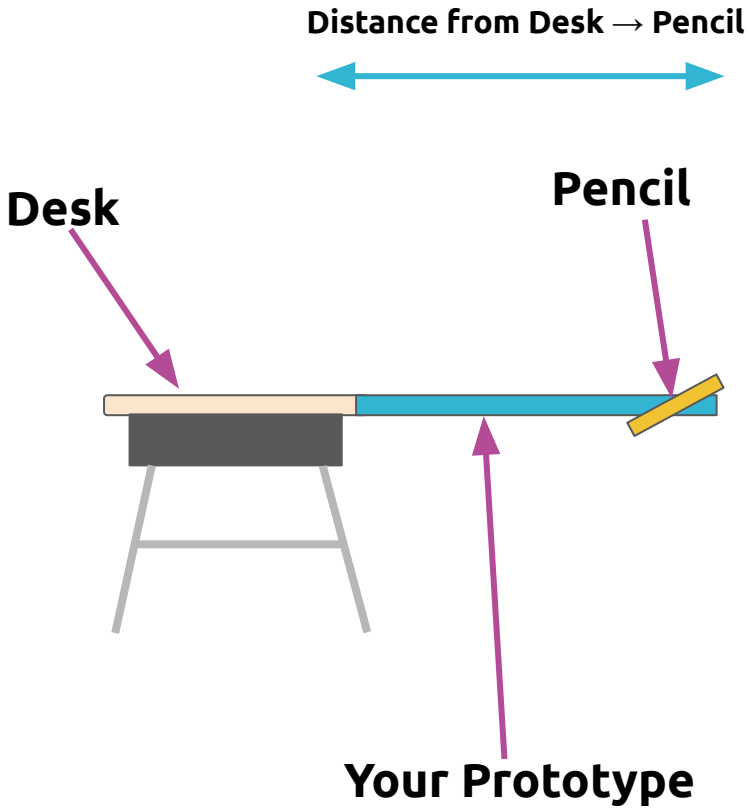
Can you and your team of engineers design a prototype to attach to a desk to hold some of your things?



# Starting with a Prototype

While a device that can hold your books, chromebook, and other things may be really helpful, let's start by making a small-scale **prototype** which can hold just one item - **a pencil**!

But to measure your prototype's effectiveness, your team should strive to create a device that **holds a pencil as far away from the desk** surface as possible.



## Specifications and Constraints:

- You may work individually or in small groups
- You may only use the provided materials to build your structure
- You may only use the tools provided to construct your prototype, they may not be part of your structure
- Your structure must be a **cantilever** and may only be fixed at one end
- You must support a pencil **at least 32” above the ground** and as far away from the surface as possible
- You will have ~15 minutes to construct your prototypes

# CANTILEVER -

a long projecting beam or structure fixed at only one end

# Materials and Tools:

## Materials:

- 5 sheet of 8.5” x 11” paper
- 24” of masking tape

## Tools:

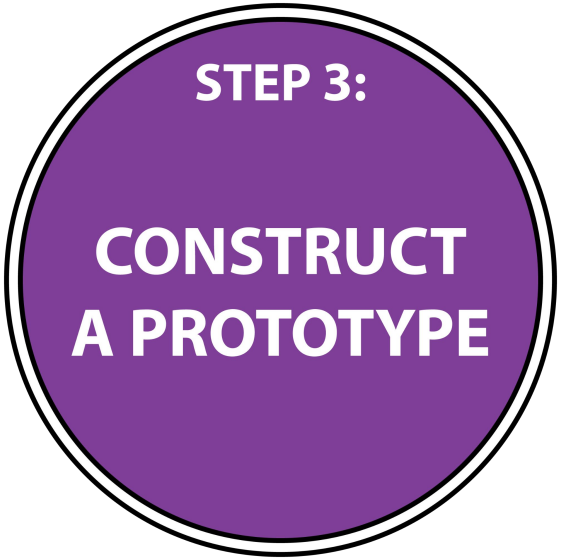
- Scissors
- Pencil
- Rulers


# Do Now:

You may now begin brainstorm your prototype solution.

# Brainstorming with a Morphological Chart

| Criteria | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |




# Do Now:

You may now begin construct your prototype solution.


# Redesign & Reflection

How did our prototypes perform? Were they able to meet the constraints of the challenge?

What worked well? What could be improved?

If we were to do this again, what would we do differently?

What materials or tools do we wish we had access to during this challenge? What would be needed to actually make this into a product?

# Common Strategies for Assessment

- **Formative Assessments**
  - check-ins, visual observations, surveys, polls, exit-tickets, group conversations, etc
- **Standards-Based Assessments**
  - NJSLS Core-Area Standards
  - NJSLS 8.1 Computer Science and 8.2 Design Thinking
  - NJSLS Career Readiness, Life Literacies & Key Skills
  - ISTE Standards for Students
- **Rubrics**

| COMPONENT | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| BRAINSTORMING POSSIBLE SOLUTIONS | Student effectively determines design constraints - develops all thumbnail sketches that are used to create a detailed final 2D sketch | Student determines design constraints with some guidance - develops most thumbnail sketches that are used to create a clear final 2D sketch | Student needs guidance in determining design constraints - develops some or most thumbnail sketches that are used to create a final 2D sketch | Teacher provides design constraints - student develops a few thumbnail sketches that are used to create a final 2D sketch |
| DEVELOP A PROTOTYPE | Student effectively uses CAD software and prototyping techniques to create a 3D model of their prototypes based on their final 2D sketch and design constraints with detail | Student uses CAD software and prototyping techniques to create a 3D model of their prototypes that largely represents their final 2D sketch and design constraints | Student uses CAD software and prototyping techniques to create a 3D model of their prototypes that meets constraints of the challenge | Student's 3D model fails to represent their 2D designs or constraints of the challenge |
| TEST AND EVALUATE | Student develops a presentation that meets all specifications and constraints, and effectively evaluates their prototype solution with peers | Student develops a presentation that meets most specifications and constraints, and effectively evaluates their prototype solution with peers | Student develops a presentation that meets some specifications and constraints, with elements of evaluation with peers | Student develops a presentation that meets some specifications and constraints with elements of evaluation |
| REDESIGN | Student effectively evaluates their design solution and develops a clear and labeled 2D sketch of their redesigned solution | Student evaluates their design solution and develops a labeled 2D sketch of their redesigned solution | Student evaluates their design solution and develops a 2D sketch of their redesigned solution | Student's redesigned sketch is unclear or demonstrates few elements of evaluation or redesign |


**In your classrooms**

# Thank you!

MR. E'S DIGITAL CLASSROOM

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