

# Preparing STEM Students with Problem Solving Skills

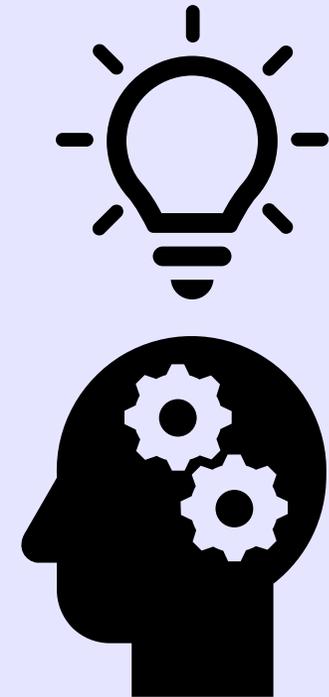
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# Innovation and Creativity

- Creativity is based on 2 things:
  1. Your knowledge base and/or experiences relative to the group
  2. Your ability to combine concepts from uncommonly associated concepts/disciplines/industries
- Few innovations are made in a vacuum
  - Baby steps built on the body of knowledge of a field of study
  - Adaptations from an entirely isolated industry
- A group of people with shared experiences, skill sets, and conceptual capabilities may not seem creative together, but when dispersed into other groups will shine with creativity and innovation.



# Problem Solving and Engineering

- Engineering is the use of scientific principles from all fields to solve a technical problem.
  - Design focuses on creating a solution that works as best as possible.
  - Redesign focuses on improving upon existing designs.
- The practice of problem solving lays the foundation for excellent engineers.
- Each discipline of engineering has a slightly different focus, but problem solving is at the foundation of all degrees.



# Closed and Open Ended Problem Solving

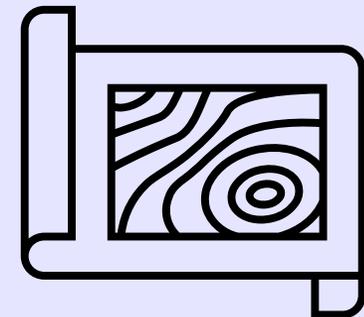
## ➤ Closed Form Solutions

- There is only one solution, and the student is either right or wrong.
- This is the traditional method of problem solving taught in schools for knowledge-based curriculum.
- Easy to evaluate.



## ➤ Open Ended Solutions

- There are many approaches, and potentially infinite solutions.
- This is what most people face in the real-world and is also the focus of design-based courses.
- Many instructors are hesitant to give open-ended problems because they will have to either understand all of the possible fields or the students perform poorly

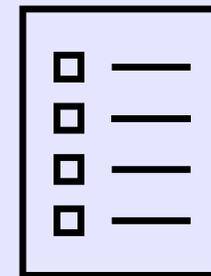


# Group Activity

Please have a paper and pencil/pen ready

# 30 Second Brain Building Activity

- List challenges are a simple activity to begin forcing the brain to create new neural pathways and connections.
- Even though the goal is to write down the most items in 30 seconds, the educational objective is to see the students transition from rote memory to memory exploration/evaluation.
- This can be used with prizes and you are limited to the number of categories you can imagine.
  - Use students to suggest categories so that they are not excluded.
  - Should be general enough for students to have ~15 seconds worth of rote memory listing.
  - Do not overdo it, even though this seems like a simple activity it is quite taxing on the brain and will wear students out quickly.

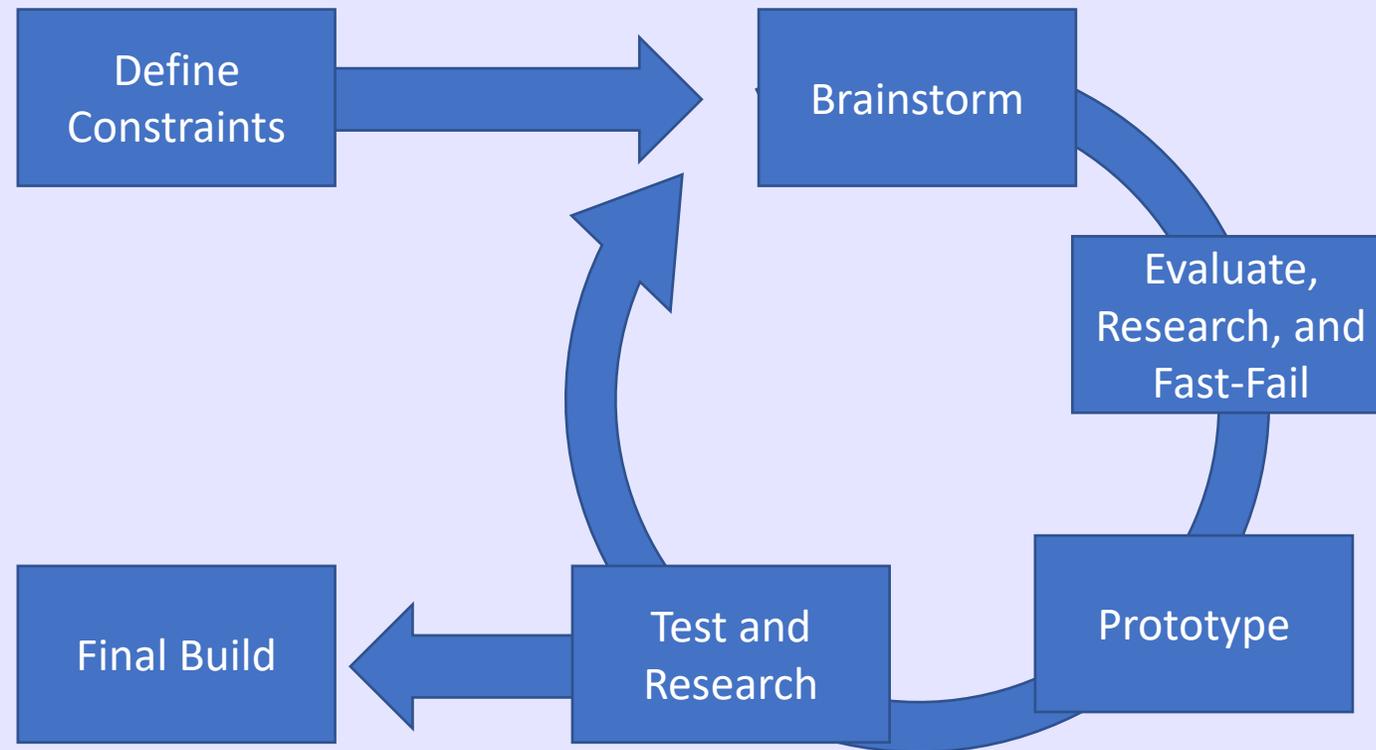


# Additional Strategies

- Keep track of your ideas in a journal
  - Some people make sure to have a journal nearby when they are in a “no-mind” state like when sleeping, showering, exercising, mowing, etc...
- Make a list of random fields and pull one from a hat to learn about on the internet for the week
- Purposely take different paths and try new ways of doing daily routines
- Take strange community education classes or join local craft clubs
- Active listening and attention to detail
- Stop and focus on one thing at random and ask “Why?”
- Read as much as you can, listen to intriguing podcasts, and be ok with failure.

# Design Process

- The Design Process has many forms depending on the intended use or who is teaching it.
- At its core, Design is about using scientific knowledge to make big leaps that have a reasonable possibility of success, test to see if performance is achieved, and iterate the design as needed based on what was learned.



# Open-Ended Problem Solving Loop

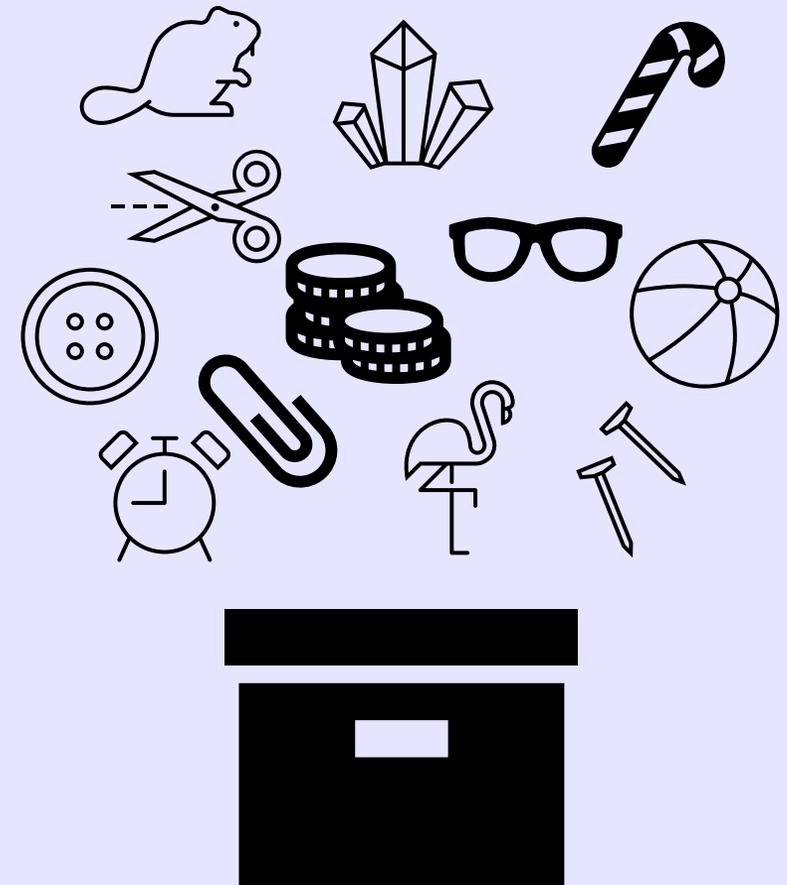
- Define the problem
  - Be explicit. If you do not have a rule restricting breaking the intent of the activity, then it is a creative solution.
  - Do not leave it too open. Bounds make it easier to focus. So does a time limit.
- Provide some examples of preferred (optimal) ways to solve the problem.
- After sharing the best way(s) to solve the problem, remove that as an option and start the timer for other solutions.
- After time is up review the solutions with the class and talk thru variations on the solution attempted.
- Allow students time to formulate a different version of the problem for the next class.

# Problems with getting the solutions flowing

- Students may be reluctant to participate or be intimidated
  - First... really important, there is nothing wrong with finding a way not to do something. It is valuable to learn ways not to do things and it takes courage to try something that may seem silly.
  - Provide a structured strengths/weaknesses chat of different key items and/or aspects of what is needed to solve the problem.
  - Provide each student with a “secret skill card” that shows them an idea or provide them with some training
    - You could also pair this activity by doing a skills based small group activity before and then break each of the specialized groups into diversified groups for the problem solving
- Show many different solutions and move onto a different setup or problem
- Set up the problem on a Friday to do on Monday

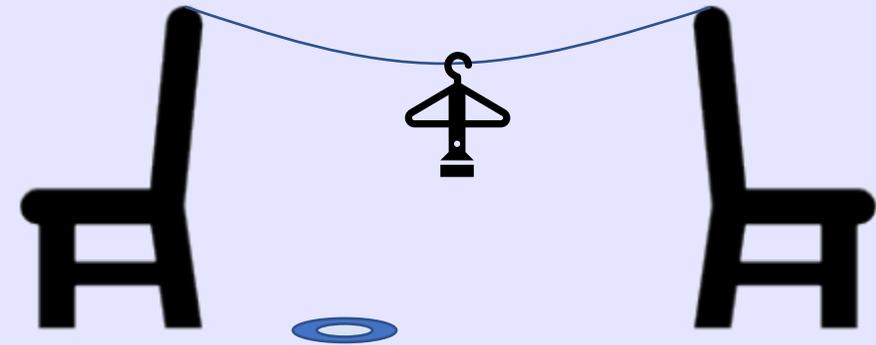
# Junk Drawer Problem Solving

- Most people have a junk drawer of random items
  - If you do not, talk to a coworker or parent.
- There are typically going to be many office supplies in a junk drawer
  - There will also be random items from past projects
  - Junk drawer challenges are inherently unique because everyone's junk drawer is different
  - Year over year, items can change either by cleaning, use, or curation



# Hanging Light

- Tie a string to two chairs and tape a flashlight to a coat hanger.
  - You may need to add weight to the chairs (books)
- Place a target on the floor off center from the chairs
  - Could be tape, a coaster, a frisbee, ...
- Goal is to hang the light on the string and somehow get it to shine on the target using an object or technique
- Once that object or technique is used, document and remove it from future solutions
- It is up to you to decide if items can be manipulated...
- At the end of the activity have them come up with 3 common items to put in the box for next year and how to solve it with said items

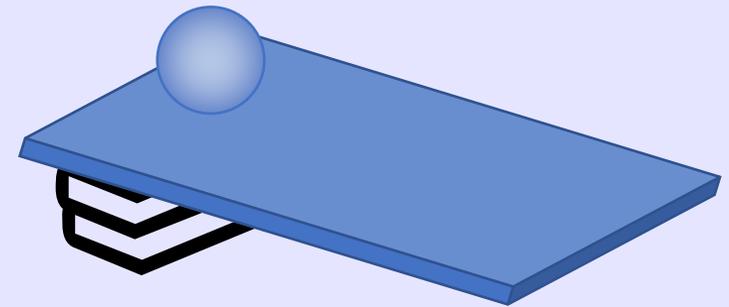


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Students step behind line after setup

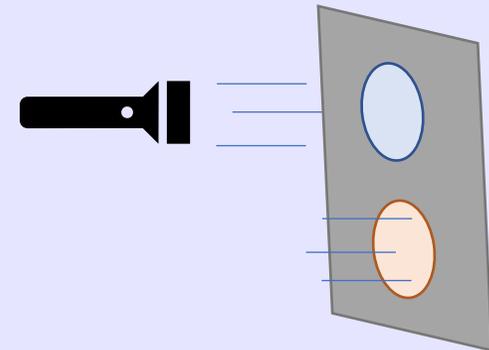
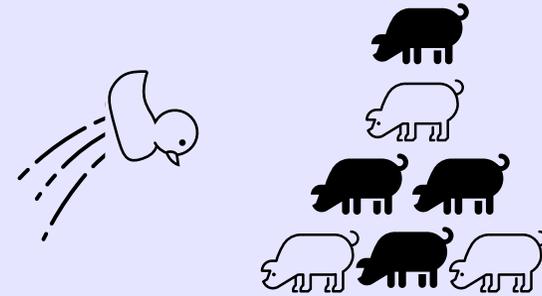
# Marble on a Sloped Surface

- There are a lot of physics experiments with rolling spheres and streams of water.
- Could be used with tracks as well
- Depending on how many books are used to prop up the board, the slope will be different and cause very different solutions.
- Again, random items can be used to keep the sphere above a line when dropped or in place when released.
- Depending on the rules that you define, students could:
  - Remove books
  - Add books
  - Reposition board
  - Use Magnets and magnetic wire or steel ball
- There are many variations on balls in goal area activities that can generate some true Rube Goldberg designs.



# Video games

- Study how free video games are designed and simulate classroom activities based on those concepts.
- Have the students recreate their favorite games with a random assortment of items in a set time window.
- There are many ball rolling games and water flow games that could be replicated in a classroom.
- The use of a Raspberry pie and light sensors/emitters could be used to simulate the popular game Portals.



# Additional Options

## ➤ KiwiCo

- If a parent, alumni, or donor want to provide resources to increase the STEM offerings in a program for relatively cheap, KiwiCo has some very unique kits.

## ➤ Arduino

- Robotics is not for everyone, but there are a lot of really good resources that have projects already put together or close to the desired outcome.

## ➤ Taskmaster – British TV show

- Very funny show that has activities from the simple to complex for ideas.

## ➤ 3D Printing Assemblies

- Thingiverse has many assemblies ready to go and if teachers are demonstrating the use of CAD, a print-modify-print approach may be interesting.

## ➤ Matchstick puzzles

- This gets into Mensa games and could be used with craft sticks as well

## ➤ Reach out to an industry professional or tradesperson.

## ➤ Contact me. We can schedule some time to talk thru some ideas.

# Questions?

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