Engineering in the Elementary Classroom: Adapting Engineering Activities to Fit the Needs of Your Students

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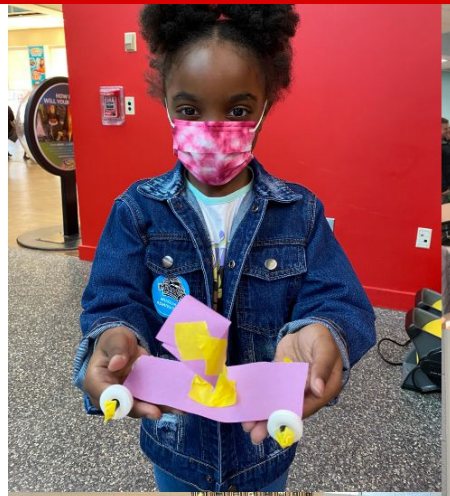
go.ncsu.edu/build-engineers-2026

Engineering Challenge!

Work with a partner to build a structure to hold a book at least **1 inch** off the table using **1 sheet of paper** and **4 paper clips**.

The Engineering Place for K-20 Engineering Outreach

- Summer Engineering Camps
  - 51 camp offerings including Partner Camps
- On Campus Programs
  - e.g. EB&B, Boys & Girls Club
- Family STEM Nights
- The Solar House
  - Tours and Renewable Energy Programs
- Outreach into the community/Schools
- Teacher Professional Development
- The Engineering Lab
- Researcher Broader Impact support



Agenda

- Introduction & Icebreaker
- Hands-on engineering challenges
- Discussion
- Adapting engineering challenges
- Wrap-up

Session Learning Objectives

- Participate in a hands-on engineering challenge you can incorporate into your classroom
- Discuss and plan for how activities can be adapted to your needs
- Learn about the engineering design process and engineering habits of mind

Introductions

At your table, please share:

- Your name, your role/what you teach, and where you are located
- Something you are hoping to learn today

Group Norms

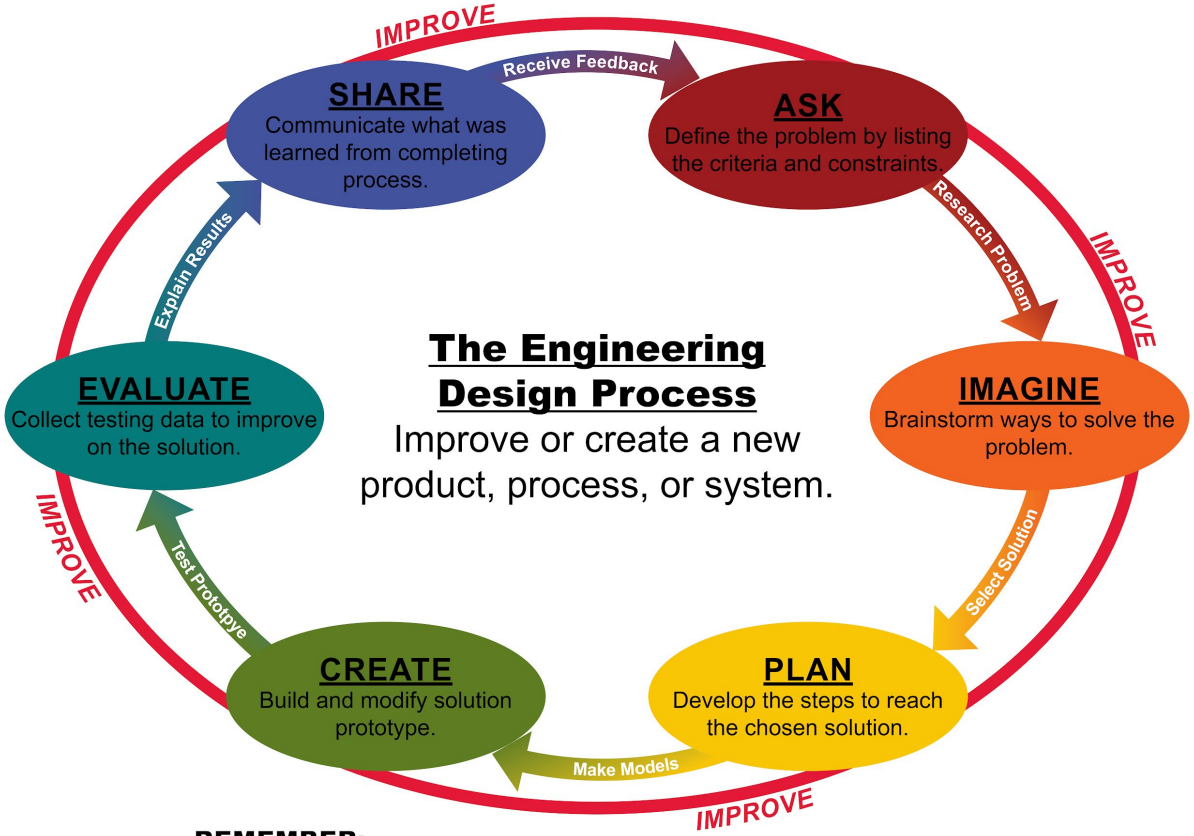
- This is a collaborative environment where everyone's expertise and ideas are valued.
- Everyone is expected to contribute
- Be courteous and respectful of your teammates as you work to complete today's challenges.
- Today is your chance to "Think and Do" just as real engineers do. Work together as you design, create and build prototypes (models) for the engineering challenge.
- There are no silly or stupid questions - questions are welcome at any time.
- Have fun!

Hands-On Engineering Challenge

What is Engineering?

Creatively solving problems to help people.

Engineering Design Cycle



REMEMBER:

FAILURE IS ALWAYS PART OF THE PROCESS... WE LEARN FROM FAILURE!

Scenario

The North Carolina Zoo has hired you to design a playground for their new star of the zoo… a Blue Death Feigning Beetle!!! The complexity of the new playground should be interesting for the beetle. In order to be hired for the job, the engineer must gain the most points with their prototype

Tools & Materials

- Scissors
- Ruler
- 1 nanobot

- Cardboard pieces
- Cardstock
- Index cards
- Straight straws
- Bendy straws
- Craft sticks
- Aluminum foil
- Masking tape
- Wax paper

CONSTRAINTS

Limitations on the design, such as available funds, resources, or time

1. You must only use the materials provided for this challenge.
2. You have a budget of $5 for your design.
3. Your nanobot must navigate the maze independently (no touching!), but you may start the nanobot over one time.
4. The nanobot should take less than 3 minute to navigate the maze.

Item	Price Per Item
Cardboard	$0.60
Index Card	$0.10
Cardstock	$0.40
Craft sticks	$0.50
Straws	$0.75
Aluminum foil	$0.40
Wax paper	$0.40
Tape	$1

CRITERIA

Rules or directions that must be followed for a successful design

Your maze should contain a variety of features to entertain your beetle:

- A tunnel - 10 pts
- A 90 degree turn - 10 pts
- A 180 to 360 degree turn - 40 pts
- A sound change - 20 pts
- A door - 10 pts
- An incline - 40 pts/cm
- A decline - 20 pts/cm

How many points can you design your maze to include?

Scenario + Challenge

The North Carolina Zoo has hired you to design a playground for their new star of the zoo… a Blue Death Feigning Beetle!!! The complexity of the new playground should be interesting for the beetle. In order to be hired for the job, the engineer must gain the most points with their prototype

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- Straight Straws
- Bendy Straws
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- Wax paper
- Tape

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How many points can you design your maze to include?

Discussion

1. What elements of your design do you think had the largest impact on its performance?
2. What makes your design similar to other designs?
3. What makes your design different from other designs?
4. If you had more time, what would you do next ….?
5. How did you work with others to solve the problem?
6. How do failures help us improve the next iterations of our designs?

Six Engineering Habits of Mind

- **Optimism –** Having the attitude that every failure is an opportunity to create an improvement. “I CAN DO THIS!
- **Persistence –** Failure is expected.
- **Collaboration –** Leverage the perspective, knowledge, & capabilities of team members through effective communication to create MORE than the sum of the parts.
- **Creativity –** Key component in Engineering Innovation
- **Ethics –** Understanding the impact of engineering design on all people & the environment. Doing the right thing!
- **Systems Thinking –** See the “Big Picture” & realize how the effect of one system can impact another through cause & effect

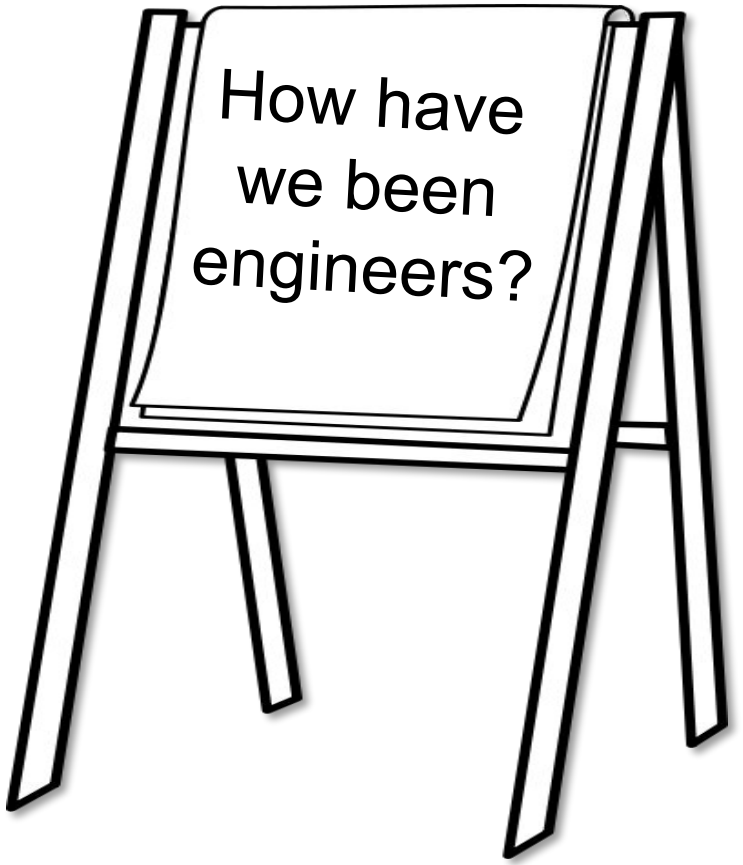
Source: Committee on K-12 Engineering Education, National Academy of Engineering and NRC

Discussion

Reflection

1. How could this challenge be adapted for different grade levels?

2. What teaching strategies are effective when implementing engineering into the classroom?



Criteria - What to put in your maze?

For **grade level K-2**, your maze should have:

- One entrance and one exit
- A tunnel to go through
- One left or right turn

For **grade level 3-5**, your maze should have:

- One entrance and one exit
- 2 right turns
- A tunnel
- A loop
- A hill
- A sound

For **grade level 6-8**, your maze should have:

- One entrance and one exit
- 90 degree turn
- 360 degree turn
- Incline
- Decline
- Door
- Movable obstacle

Engineering In Action!

Six Engineering Habits of Mind

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Six Engineering Habits of Mind

- **Optimism –** “I CAN do this!”
- **Persistence –** Working through Failure!
- **Collaboration –** Teamwork!
- **Creativity –** Idea Generation
- **Ethics –** Doing the right thing
- **Systems Thinking –** Seeing the “Big Picture”

Adjust the Complexity

Younger Grades

- Focus on single-step tasks or concepts (e.g., build a parachute that allows a payload to land safely).
- Use fewer or simpler materials (e.g., craft sticks, tape, pipe cleaners)
- Provide clear templates or examples.
- Incorporate guided instruction and step-by-step scaffolding.

Older Grades

- Introduce multi-step problems requiring iterative testing and improvement.
- Use a broader range of materials and allow more open-ended designs.
- Add complex goals (e.g., build a parachute that must achieve the longest descent time while protecting the payload)
- Encourage independent exploration and decision-making.

Modify the Constraints

Younger Grades

- Allow unlimited materials
- Provide premade components or partial designs
- Extend the time for building and testing
- Allow students to work in larger groups for collaborative problem-solving

Older Grades

- Limit the number or type of materials available.
- Add constraints, like limiting the size of the parachute or requiring it to fit into a launcher and deploy.
- Introduce external challenges (e.g., wind, rain)
- Shorten the time for design and iteration
- Partway through the working time, “recall” one of the materials

Modify the Criteria

Younger Grades

- Use binary criteria (e.g., did the payload land safely).
- Accept designs with minimal performance to build confidence.
- Offer simpler, more specific goals

Older Grades

- Introduce multiple performance criteria (e.g., the parachute must land in the target zone and stay afloat for at least 10 seconds).
- Evaluate efficiency
- Emphasize aesthetics, creativity, or sustainability.

Add a Cost and Material Constraint

Younger Grades

- Assign a set number of tokens or play money to purchase materials (e.g., straws = 1 token, tape = 2 tokens).
- Keep pricing simple and materials affordable to encourage creativity without frustration.
- Offer "free" materials to ensure all students can complete the challenge.

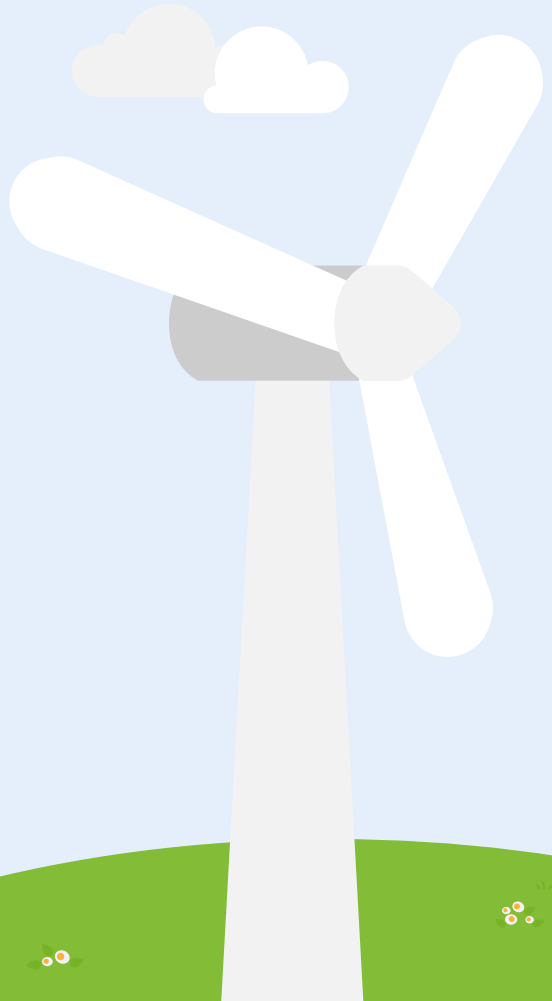
Older Grades

- Use more detailed pricing to simulate trade-offs (e.g., more substantial materials cost more).
- Introduce "bonus" costs for extras (e.g., extra time, additional testing).
- Incentivize using fewer materials or staying under budget (e.g., "Unused tokens = extra points).

Adapting Engineering Challenges

Let's Discuss

- How can I adapt this engineering challenge for my classroom?
- What elements of this activity would work well with my students?
- What elements of this activity might be too easy for my students?
- What elements of this activity might be too difficult for my students?
- What might make this activity more interesting for my students?



Goal:

Design and build something that can harness the power of the wind

Scenario + Challenge

Your school is looking to start using wind energy to help reduce energy costs. Can you design a device that will use the power of the wind to lift a cup of marbles, helping to deliver materials to the second level of your school?

Tools

- Scissors
- Fan
- Tape

Materials

- Large cup (1)
- Small cup (1)
- Skewer stick (1)
- Straw (1)
- Pool noodle piece (1)
- Popsicle sticks (5)
- Index cards (5)
- Rubber bands (10)
- Paper clips (5)
- String (15 inches)

Constraints

- You can only use the material provided to build your design.
- You have 30 minutes to complete your device.

Criteria

- Your device should lift a cup of marbles using the power of the wind (fan).

Let's Discuss

- How can I adapt this engineering challenge for my classroom?
- What elements of this activity would work well with my students?
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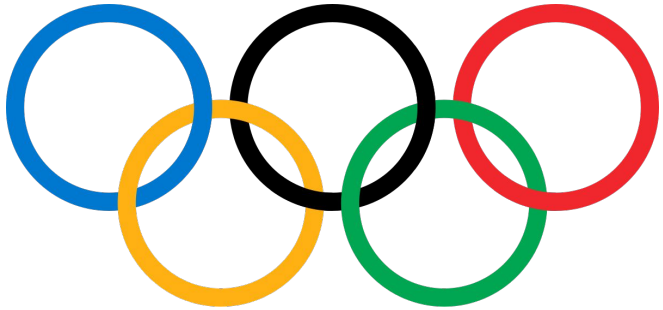
What's our Problem?



Engineering Challenge

The winter Olympics are coming up. You are on the engineering team for the Bobsledding event. Can your team help develop a fast and safe bobsled for the competition?

Tools

- Stop watch
- Race track
- Rider/ passenger

Materials

- Toilet paper roll
- Binder clips (2)
- Fabric strip (1)
- Cardstock
- Pipe cleaners (2)
- Straws (2)
- Tape (2 ft.)

Constraints

1. You must only use the materials provided for this challenge.
2. You must complete the challenge within the given time frame.
3. Your rider should safely make it to the end of the track in the bobsled.

Criteria

1. How many seconds did it take for your bobsled to make it to the end of the track?
2. Did your rider have a fun and safe ride?

Let's Discuss

- How can I adapt this engineering challenge for my classroom?
- What elements of this activity would work well with my students?
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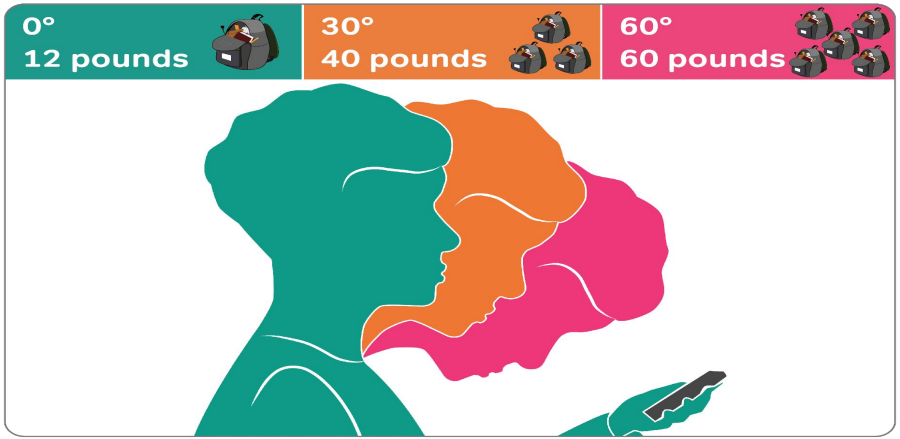
What's our Problem?



Weight on the spine **increases** as you tilt your head forward.

"Text neck" happens when we bend our necks for a long time to look at our phones. This can cause neck pain, headaches, stiff neck, and shoulder blade pain.

- What problem do you notice?
- Have you ever experienced this problem?
- What do you normally do to solve this problem?

Engineering Challenge

Design and build a device to hold our phone so we don't hurt our neck. The stand will also either *a) have adjustable angles, b) hold the phone vertically and horizontally, or c) be durable*

Tools

- Scissors
- Tape
- Model phone

Materials

- Binder clips
- Cardboard
- Cardstock
- Straws
- Craft sticks
- Paper clips

Constraints

1. You must use only the materials provided for this challenge.
2. Use as few materials as possible.
3. Complete your design within 20 minutes.

Criteria

1. The device must hold up the phone when the "play" button is tapped.
2. *The angle of the stand can be adjusted and the stand continues to hold the phone*
3. *The phone can rest on the stand both horizontally and vertically while the "play" button is tapped*
4. *The stand stays intact when pushed off the table*

Let's Discuss

- How can I adapt this engineering challenge for my classroom?
- What elements of this activity would work well with my students?
- What elements of this activity might be too easy for my students?
- What elements of this activity might be too difficult for my students?
- What might make this activity more interesting for my students?

Session Wrap-Up

- What something you learned today that you can use in your classroom?
- How have you adapted engineering activities for your classroom previously?
- Based on these activities, what ideas do you have on how you can integrate engineering into your curriculum?

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Evaluation

go.ncsu.edu/build-engineers-feedback