

Introduction

This lesson will give students the skills and confidence to develop design ideas and bring them to life. Students will learn how to apply essential steps in a design & engineering process to produce creative, collaborative solutions to STEM challenges.

[Click here](#) to explore the entire Kid Spark Curriculum Library.

NGSS Learning Dimensions

This Kid Spark lesson engages students in the following learning dimensions of the Next Generation Science Standards:




Scientific/Engineering Practice:

Planning and carrying out investigations

Crosscutting Concept:

Systems and system models

Learning Objectives

-  Understand and use the Kid Spark design & engineering process to solve a challenge.
-  Become familiar with the use of design briefs: define the challenge presented and understand the required specifications.
-  Understand how a grading rubric is used to evaluate a project or challenge.

Resources

The following resources will be used to complete this lesson.

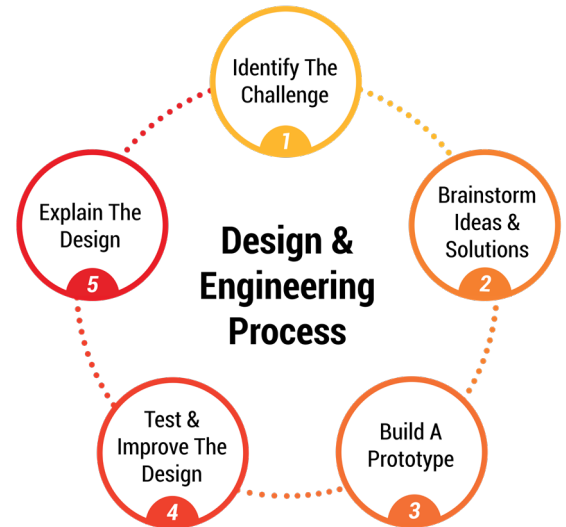
1. Kid Spark Curriculum

The Design & Engineering Process

- a. Teacher Lesson Plan
- b. Curriculum Packet (1 per team)
- c. Student Engineering Workbook (1 per team)

2. Kid Spark Mobile STEM Lab (Pictured Right)

Activity Time: 120 Minutes



Educational Standards

NGSS

K-5-ETS1-3 Engineering Design
 MS-ETS1-4 Engineering Design

ITEEA

STL8- Attributes of Design
 STL9- Engineering Design
 STL10- Invention and Innovation
 STL10- Applying Design Process

Resources



ROK Blocks Mobile STEM Lab
 *Up to 4 students per lab

Procedure

Complete the following steps to teach students about the design & engineering process.

1. Grouping

Before class, arrange students in teams of up to 4. Group students that will work effectively together.

2. Disperse Materials (2 Minutes)

Provide teams with correct Kid Spark Mobile STEM Lab, curriculum packet, and student engineering workbook. Instruct students to fill out appropriate information in student engineering workbook as they progress through the lesson.

3. Review Learning Objectives (1 Minutes)

Review learning objectives with students.
(Curriculum Packet - Page 1)

4. Review Key Terms (6 Minutes)

Instruct students to review key terms in curriculum packet and write definitions in student engineering workbook. These key terms will be used throughout the lesson.
(Curriculum Packet - Page 1)
(Student Engineering Workbook - Page 1)

5. The Kid Spark Design & Engineering Process (10 Minutes)

Instructor and students work together to learn about the Kid Spark Design & Engineering Process. Review the purpose of the process and each of the five steps. Instructor will walk teams through each of the steps later in this lesson.
(Curriculum Packet - Page 3)
(Student Engineering Workbook - Page 2)

Tip: Have teams write down each step in the student engineering workbook, then have each student discuss and share their own understanding of what each step means with the other members in their team.

6. Building the ROK Blocks Tree (8 Minutes)

Instruct students to follow the graphic instructions to assemble a ROK Blocks tree.
(Curriculum Packet - Page 4)

Tip: Have a model of the ROK Blocks tree built as a reference for students.

7. Understanding a Design Brief (8 Minutes)

Instructor should explain what a design brief is.
(Curriculum Packet - Page 5)
(Student Engineering Workbook - Page 2)

Tip: Have students read through the design brief. Ask them to identify the scenario, the specific challenge and sub-challenges, and specifications the design must meet.

8. The Design & Engineering Process - Step 1: Identify the Challenge (5 Minutes)

After each team has assembled one ROK Blocks tree, review the specific challenge, sub-challenges and design specifications with them.

(Curriculum Packet - Page 6)

(Student Engineering Workbook - Page 3)

Tip: *Instruct students to keep hands off engineering materials during step 1. This will help to insure they are truly experiencing every step in the process and understanding the value of each.*

Tip: *Ask groups to identify the design challenge and sub-challenges that have been outlined in the design brief.*

- Design Challenge:** Build a treehouse
- Sub-Challenge:** Build a ladder system
- Sub-Challenge:** Build a trap door
- Sub-Challenge:** Build a roof system
- Sub-Challenge:** Keep cost under \$120



9. The Design & Engineering Process - Step 2: Brainstorm Ideas & Solutions (10 Minutes)

After teams understand the design challenge and sub-challenges, they need to get familiar with how to brainstorm potential design ideas and solutions to the challenges.

(Curriculum Packet - Page 6)

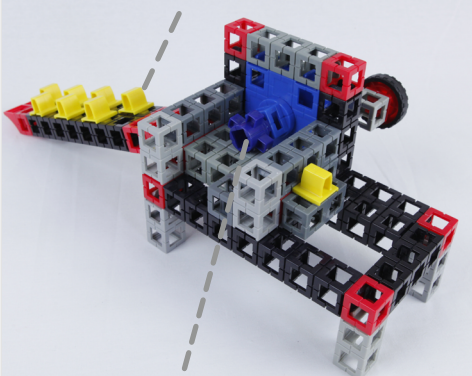
(Student Engineering Workbook - Page 3)

Tip: *Instruct students to pass the ROK Blocks tree around the team. Each member should spend one minute explaining design ideas and possible solutions to the challenge and sub-challenges. Build some examples of ladders, roof systems, and trap doors to show the students. Students should understand it is important to brainstorm ideas and solutions as a team while they identify each sub-challenge or problem in a design. Also, remind students that they are working with a budget of \$120, so it is important to consider building components and cost as they develop their design.*



Example: Ladder System

Retractable Ladder

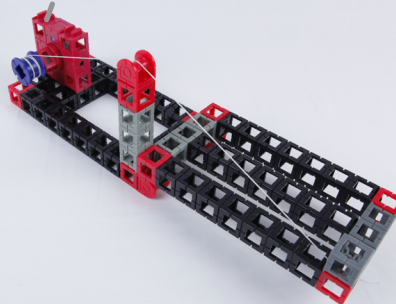


Featuring: Bearing Module and Cog

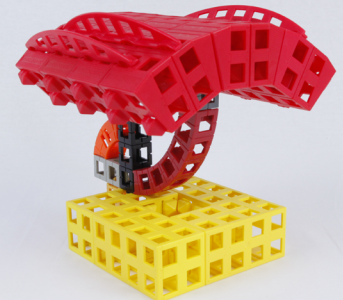
Example: Trap Door

Motorized Trap Door Featuring: Motor Module & Spool

*Bearing module can be used in place of motor module, if motor module is not available.



Example: Roof System



10. Review Grading Rubric (5 Minutes)

Review the grading rubric with the class. Have teams read through the rubric and review how their projects will be evaluated. It is important to know how a project will be evaluated to develop a high quality design.

(Curriculum Packet - Page 7)

(Student Engineering Workbook - Page 4)

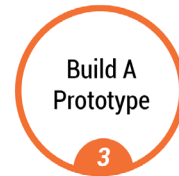
11. The Design & Engineering Process - Step 3: Build a Prototype (20 Minutes)

Once students have brainstormed ideas and possible solutions, they can begin to build a prototype.

(Page 6 - Curriculum Packet)

(Page 3 - Student Engineering Workbook)

Tip: *Instruct students to work as a team to build a prototype treehouse that includes a ladder system, trap door, and roof system. Encourage them to use steps 1 and 2 in the design & engineering process for each part of the design.*



12. The Design & Engineering Process - Step 4: Test & Improve The Design (15 Minutes)

As students are building prototypes, they will need to test them to make sure everything is functioning consistently. As students test their prototypes, they will identify new challenges to improve the design and functionality. Students should return to steps 1-4 in the design & engineering process for each new challenge that is presented.

(Curriculum Packet - Page 6)

(Student Engineering Workbook - Page 3)

Tip: *After students have spent time building and testing prototypes, have them pause for a minute. Ask the teams to explain what new challenges were identified as they tested their prototypes. Ask them how they brainstormed ideas and possible solutions to improve the design and functionality.*



This process of steps 1-4 should be repeated for each new challenge that is presented, until the design is of high quality and is functioning consistently.

Tip: *Remind students to review the grading rubric and design specifications as they are testing and improving the design. Also, encourage teams to find ways to reduce the overall cost of the design.*

13. The Design & Engineering Process - Step 5: Explain The Design (20 Minutes)

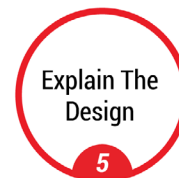
After teams have completed their designs, they should prepare to explain all aspects of the design to others. This includes a detailed description and demonstration of the design, how it functions, and how each team member contributed to the design. Teams should also discuss the process they went through to develop the design and a description of how they overcame new challenges that were discovered during testing.

(Curriculum Packet - Page 6)

(Student Engineering Workbook - Page 3)

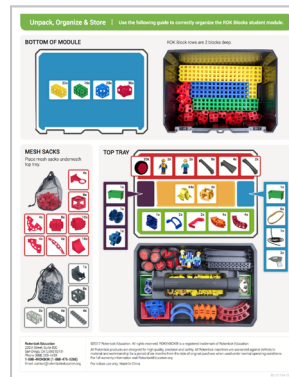
Tip: *Give students five minutes to prepare presentation/demonstration. Then, give each team two minutes to present their designs to the class.*

Tip: *Have teams hand in their student engineering workbook before they present to the class. Instructor can use the grading rubric to assess each team project as they are presenting.*



14. Cleanup (10 Minutes)

To keep the ROK Blocks Lab clean and organized, students should have an understanding of how to correctly pack the lab once they are finished using it. Have students locate the ROK Blocks Inventory and Organization Guide that was included in the lab. Instruct students to pack the lab back exactly as shown in the guide.



15. Lesson Review (2 Minutes)

Use the last few minutes of class to review the lesson.

Guiding Questions:

1. What are the five steps in the Kid Spark Design & Engineering Process?
2. What is a design brief?
3. What is a grading rubric?
4. What was challenging about innovating as a team?

Team Members:

1. _____ 3. _____
2. _____ 4. _____

Total Points

Workbook: /11 pts

Design

Challenge: /30 pts

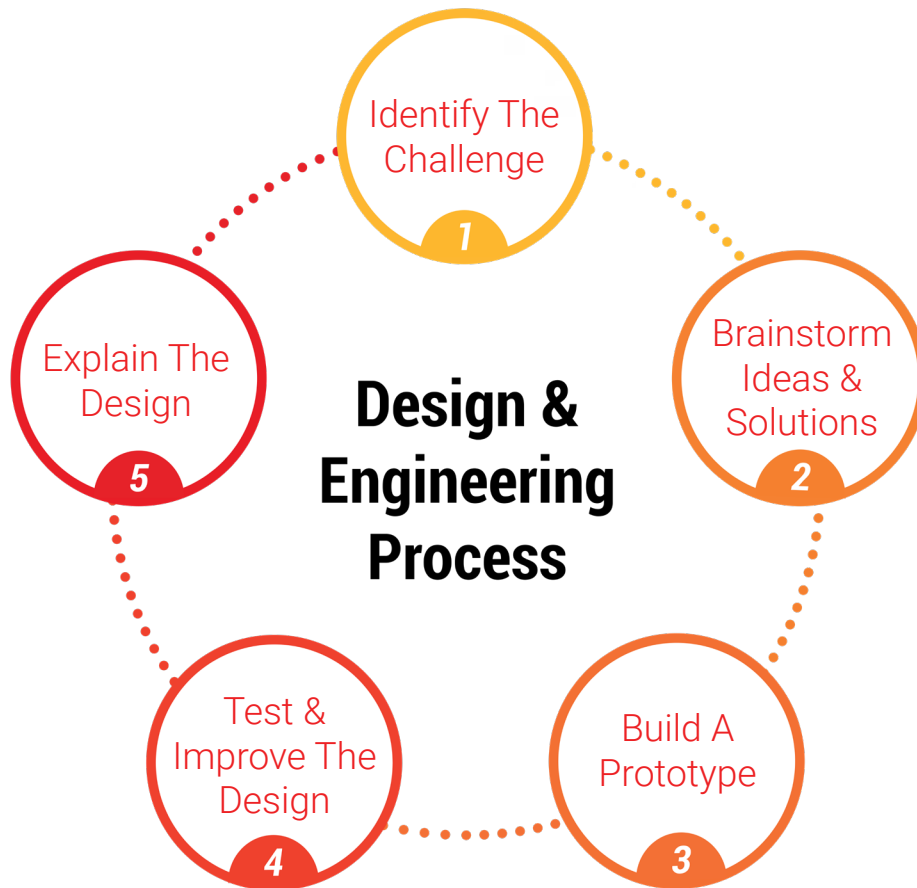
Key Terms

Write the definitions of each key term in the space provided.

1. **Design & Engineering Process:** A series of steps that designers and engineers use to develop solutions to problems or challenges.
2. **Design Brief:** A written document for a project that outlines what needs to be designed and what specifications it must meet.
3. **Brainstorm:** A group discussion to produce ideas and ways of solving problems.
4. **Prototype:** An original, working model of a design that is used for testing.
5. **Empathy:** The ability to understand and share the feelings of another.
6. **Grading Rubric:** A guide listing specific criteria for grading or scoring projects or challenges.

The Design & Engineering Process

7. Fill in each step of the Kid Spark Design & engineering Process in the image below.
8. Discuss the purpose of each step with members in the team.



Build a ROK Blocks Tree

9. Complete all four steps to assemble a ROK Blocks Tree.

Understanding a Design Brief

Fill in the correct answer in the spaces provided below.

10. A Design Brief serves as the guiding document for a project.
11. What is the specific design challenge on page 5? Design & engineer a custom treehouse

Design & Engineering Challenge

Follow each step in the design & engineering process to develop a solution to the problem. Place a check in the box as each step is completed. Fill in the blanks when necessary.

1. Identify The Challenge

- Challenge: Design & engineer a custom treehouse
- Sub-Challenge: Build a ladder system
- Sub-Challenge: Build a trap door
- Sub-Challenge: Build a roof system
- Sub-Challenge: Keep cost under \$120
- Review specifications

2. Brainstorm Ideas & Solutions

- Discuss design ideas.
- Consider engineering materials and cost.

3. Build A Prototype

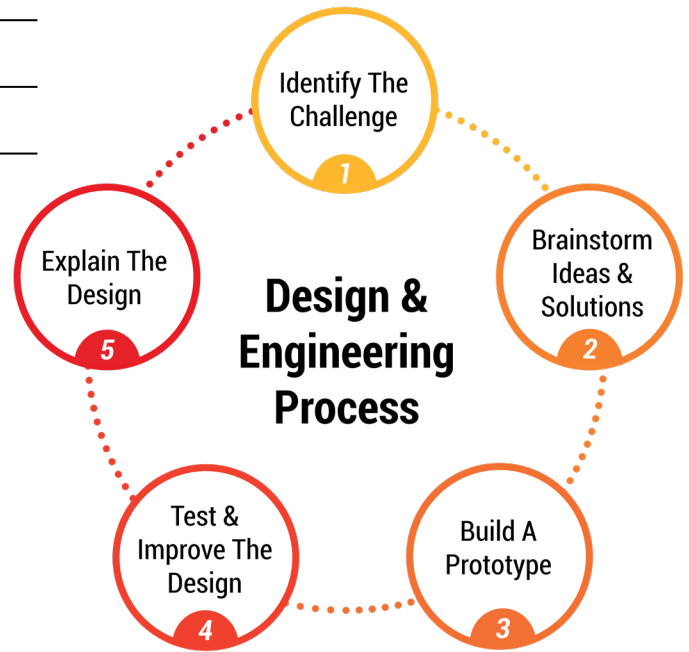
- Build a working prototype of the design.

4. Test & Improve The Design

- Test & improve the design for performance and consistency.
- New challenge discovered: Various new challenges discovered during testing
- Review grading rubric and design specifications.
- Consider ways to reduce cost.







5. Explain The Design

- Prepare to demonstrate and present the design to others.
- Review project grading rubric.
- Explain any unique design features that were included.
- Describe at least one new problem/challenge discovered during Step 4 (Test and Improve The Design) and how the team redesigned a new solution.
- Calculate and share the overall dimensions of treehouse. Length: Various cm Depth: Various cm Height: Various cm



Challenge Evaluation

When teams have completed the design & engineering challenge, it should be presented to the teacher and classmates for evaluation. Teams will be graded on the following criteria:

-  **Specifications:** Does the design meet all specifications as stated in the design brief?
-  **Performance:** How well does the design work? Does it function consistently?
-  **Team Collaboration:** How well did the team work together? Can each student describe how they contributed?
-  **Design Quality/Aesthetics:** Is the design of high quality? Is it structurally strong, attractive, and well proportioned?
-  **Material Cost:** What was the total cost of the design? Was the team able to stay on or under budget?
-  **Presentation:** How well did the team communicate all aspects of the design to others?

Grading Rubric	Advanced 5 Points	Proficient 4 Points	Partially Proficient 3 Points	Not Proficient 0 Points
Specifications	<input type="checkbox"/> Meets all specifications	<input type="checkbox"/> Meets most specifications	<input type="checkbox"/> Meets some specifications	<input type="checkbox"/> Does not meet specifications
Performance	<input type="checkbox"/> Design performs consistently well	<input type="checkbox"/> Design performs well often	<input type="checkbox"/> Design is partially functional	<input type="checkbox"/> Design does not work
Team Collaboration	<input type="checkbox"/> Every member of team contributed	<input type="checkbox"/> Most members of team contributed	<input type="checkbox"/> Some members of team contributed	<input type="checkbox"/> Team did not work together
Design Quality/ Aesthetics	<input type="checkbox"/> Great design/ aesthetics	<input type="checkbox"/> Good design/ aesthetics	<input type="checkbox"/> Average design/ aesthetics	<input type="checkbox"/> Poor design/ aesthetics
Material Cost	<input type="checkbox"/> On Budget (\$120 or Less)	<input type="checkbox"/> Slightly Over Budget (\$120-130)	<input type="checkbox"/> Over Budget (\$130-140)	<input type="checkbox"/> Significantly Over Budget (\$141+)
Presentation	<input type="checkbox"/> Great presentation/ well explained	<input type="checkbox"/> Good presentation/ well explained	<input type="checkbox"/> Poor presentation/ explanation	<input type="checkbox"/> No presentation/ explanation
Points	<u>Column Total</u>	<u>Column Total</u>	<u>Column Total</u>	<u>Column Total</u>
Total Points				<u>Total Points /30</u>

