

Learning Progression: Engineering Design Process

Materials: FOSS Variables

Grade level: 5

Prerequisite skill:

Define:
 Defining and delimiting engineering problems involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or criteria.

Develop Solutions:
 Designing solutions to engineering problems begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem.

Optimize:
 Optimizing the design solution involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important.

Big Idea:
 Engineers use the engineering design process to solve human problems.

Learning Target: A problem needs to be solved.

Success Criteria: I can identify and clearly understand the problem.

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: A problem's solutions will have constraints or criteria.

Success Criteria: I can specify the constraints and criteria of a successful solution to a problem.

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: A problem may have more than one solution.

Success Criteria: I can research in order to refine the solutions. *Gain prior knowledge?*

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: A problem's solution needs to address real world constraints.

Success Criteria: I can evaluate successful solutions based on criteria and constraints.

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: Generate multiple solutions to a problem.

Success Criteria: When given a problem, I can generate multiple solutions.

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: Evaluate your solution designs to ensure they meet the criteria and constraints.

Success Criteria: I can choose solutions that meet the criteria and constraints.

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: Design and/or develop models of possible solutions.

Success Criteria: I can create models of my solutions.

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: Test:
 • Systematic
 • Check criteria & constraints
 • Record data

Success Criteria: I can design a process to systematically test the solutions.

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: Analyze:
 • Which solves the problem?
 • Looking at the data
 • Communicate other ideas

Success Criteria: I can evaluate the data from testing to determine how well it met the criteria or constraints of the problem.

Formative Assessment:
 Lifeboats
 Plane Sense
 Flippers

Learning Target: Refine:
 • Change the designs to solutions
 • Best meet criteria
 • Trade off less important features

Success Criteria: I can change my solution using the information we gathered to better meet the criteria or know that the optimal solution has been found.

Formative Assessment:
 Lifeboats
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 Flippers

Later big ideas that build on this big idea include:



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Variables

Teacher Instructions: Implementation Support

Timing of the task: *please indicate the best time during the course of the kit to do this activity*

Required additional materials (not included in the kit): *please list any materials needed for the design challenge that are not included in the kit*

Teacher Instructions: *describe how to implement this task with students, include any helpful hints or other information a teacher will need to do this task with students*

Challenge Title: Lifeboats

Targeted Engineering Practices

- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem
- Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Connected Scientific Content Ideas

Description of Student Success Criteria:

At the completion of this task students will be able to:

The student will be able to design a system that will support the most passengers possible without sinking.

Lifeboats Engineer Design Challenge

Challenge: Design a system that will support the most passengers possible

Criteria: Modify the standard system (the 3 cm cup) by only one variable at a time to hold the most passengers possible without sinking

Constraints: Time limit on construction time (20 min) System uses these materials from the kit:

Corks, paperclips, sponges, rubber stoppers, aluminum foil, duct tape, straws, craft sticks, paper cups, rubber bands

Have available: Design challenge graphic organizer; tape, scissors, staplers, glue etc for construction

TEACHER TIPS:

1. Students need lots of practice with two coordinate graphs and making trend lines to predict outcomes.
2. Teacher needs to limit materials students are using, as material options are too many.



Variables

Challenge Title: Plane Sense

Targeted Engineering Practices

- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem
- Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Connected Scientific Content Ideas

Description of Student Success Criteria:

At the completion of this task students will be able to:

Students will be able to design a transport system for an airplane that carries the greatest amount of passengers at least one meter on the flight path.

Plane Sense Design Challenge

Challenge: Design a transport system for your air plane.

Criteria: Transport the greatest amount of passengers at least one meter on the flight path.

Modify the plane system by only one variable at a time to carry the greatest amount of passengers at least one meter on the flight path.

Constraints: Use the plane system and 4 meter flight path from previous investigations, pennies (passengers), one 8.5 x 11 paper, string, scotch tape, 2 paper clips, and a meter tape. Time constraint: 30 minutes.

- Record your team's brainstormed (tested or not) solutions:
- Draw and label a diagram of your basic solution.
- How did you optimize your new system? What failure points did you encounter? What modifications did you make to your initial design?



Variables

Challenge Title: Flippers

Targeted Engineering Practices

- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem
- Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Connected Scientific Content Ideas

Description of Student Success Criteria:

At the completion of this task students will be able to:

The student will be able to build a new flipper system that propels the foil ball the greatest distance.

Build Your Own Flipper

Design Brief

Problem:

Create a new flipper system.

Specifications:

Success Criteria: Build a new flipper system that propels the foil ball the greatest distance.

Constraints: Final design may use any of the following materials:

- (1) plastic spoon*
- (1) Foil ball (10cm or 20cm)
- (4) Craft sticks
- 1 yd. masking tape*
- (1) cork (rubber or wooden)
- (2) straws (jumbo or super jumbo)
- (1) plastic cup
- (1) yard string
- (5) large paperclips
- (5) small paperclips
- (3) rubber bands
- Use of table or desktop is allowable
- (1) 12" ruler*
- scissors*



Record your team's brainstormed (tested or not) solutions:

Draw and label a diagram of your basic solution.

How did you optimize your new system? What failure points did you encounter? What modifications did you make to your initial design?



Teacher tips:

- 1) Students need to be given a time limit for this design challenge, as there are no listed time constraints.
- 2) All supplies available were not utilized so it is suggested to modify supply list.
- 3) Information needs to be added about whether or not the flipper system should be free standing.

