Title of Lesson Plan

This is a template for a Teacher’s Guide at the Middle School Level for lessons that are based on Engineering Design in Oregon Science Classrooms program. Throughout this template, you will find loads of blue text, just like this. These are notes to help you better understand the features found in our lessons and create your own lessons. As you fill in material in a template, be sure and remove the corresponding blue text.

*Lesson Summary:*

**Grade Level**: **Preparation Time**:

**Cost**: **Suggested Time**:

**Key Vocabulary**: **Clean Up Time**:

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# 1—Lesson Overview

## 1.1—Introduction

The lesson introduction will give a summary of the lesson’s premise and how it integrates the Engineering Design Process (EDP). It will explain briefly how the students’ learning of core science standards is supplemented by the EDP integration, and will then break the lesson down into its three component parts:

* **Part 1**—Students will use a *reading activity* to familiarize themselves with key vocabulary and scientific concepts behind the lesson, and develop a context for the following activity.
* **Part 2**—The teacher will facilitate an *exploration activity*, highlighting what the students probably need to know to successfully engage in the design activity that follows. ….
* **Part 3**—In this *design activity*, students will go through the EDP themselves.

## 1.2—Lesson Breakdown with Engineering Design

| **Engineering Design Step** | **Related Activity** | **Relevant Documents** | **Product/Assessment** |
| --- | --- | --- | --- |
| 1. Define a problem or a need | **Part 1:** Read Aloud–Think Aloud | Vocab Alert Handout  Reading Handout  Read Aloud–Think Aloud | Class discussion |
| **Part 3:** Engineering | Engineering Design Handout | Engineering Design Handout |
| 2. Propose a potential solution | **Part 1**: Read Aloud–Think Aloud | Vocab Alert Handout  Reading Handout  Read Aloud–Think Aloud | Class discussion |
| **Part 3:** Engineering | Engineering Design Handout | Engineering Design Handout |
| 3. Design a prototype | **Part 2:** Exploration | Exploration Handout | Exploration Handout |
| **Part 3:** Engineering | Engineering Design Handout | A design |
| 4. Design and construct a possible solution | **Part 3:** Engineering | Engineering Design Handout | Prototypes |
| 5. Describe the cost, safety, appearance and environmental impact of the solution as well as what will happen if the solution fails. | **Part 3:** Engineering | Engineering Design Handout | Evaluation questions |

## 1.3—Pre-Requisite Knowledge

Here, the lesson will briefly summarize what students must already know in order to be successful in this lesson.

# 2—Teacher Background Information

## 2.1—Glossary of Terms

Below will be a list of general EDP vocabulary, along with lesson-specific vocabulary, with definitions intended for teachers. You should insert additional words (in alphabetical order) that are associated with the new lesson and drop any that don’t apply to the specific lesson. Anything updated here must also be updated in the **Vocab Alert Handout**.

**Constraint**: In engineering, constraints are limits on possible solutions. For example: cost is a constraint; “must fit in someone’s pocket,” is too.

**Note:**

Sometimes lessons require additional information in order to be properly understood. You can use boxes like this clarify and explain common misconceptions, recommend a specific practice or procedure , or otherwise provide supplemental information in order to help a teacher be more successful.

**Criteria**: In engineering, criteria describe what a solution should do or be.

**Engineer**: A person who solves problems with existing tools, using the Engineering Design Process.

**Engineering Design Process (EDP)**: A process used to solve problems and develop technologies. The process as described by the Oregon Standards for eight-grade students is the following:

* Define a problem that addresses a need, and using relevant science principles investigate possible solutions given specified criteria, constraints, priorities, and trade-offs.
* Design, construct, and test a proposed solution and collect relevant data.
* Evaluate a proposed solution in terms of design and performance criteria, constraints, priorities, and trade-offs.
* Identify possible design improvements.
* Explain how creating a new technology requires considering societal goals, costs, priorities, and trade-offs.

**Problem Statement**: In engineering, the declaration and definition of a need which needs to be solved.

**Prototype**: In engineering, a first model of the solution to be tested or otherwise reviewed as one approaches the solution.

**Solution**: In engineering, the final result of one’s work.

**Test**: Some way of determining whether a possible solution meets all criteria and fits all constraints, and/or deciding whether it is the best possible solution.

## 2.2—Scientific Concepts and Disciplinary Core Ideas

This section provides an overview of the standards met by this lesson, explained with explicit connection to the lesson itself. (For example: “Students will meet *x* standard of mechanical physics by building their own gravity-powered coaster car, and *y* standard of engineering design by testing its success and coming up with a redesign based on their results”). It is intended to be brief, with a complete of the lesson’s alignment with the standards in Appendix 1.

**Note:** You can inject notes directly into the lesson text starting with “Note:”. They should have no indentation, in order to be easier to find. These notes have more integral information for the lesson, such as: “For a complete list of scientific concepts and disciplinary core ideas covered in this lesson, see **Appendix 1**.”

## 2.3—Lesson Timeline

### 2.3.1—Overview Timeline

The overview timeline breaks the lesson into its three activities, and give an estimate of total in-class time needed, as well as the number of class sessions needed. It gives a recommendation for how to schedule the lesson during your week, if needed, with justification based on the lesson itself.

It will then include at least two suggested timelines, if needed, which will help a teacher plan logistics for executing this lesson. The rest of section 3.1 is filled with a description of the materials needed for the lesson:

**Note**: In this example Lesson Timeline, parts two and three are both conducted over two days. In the table below, they are listed in the order in which they are intended to be executed.

| **Activity** | **Suggested Timeline 1** | **Suggested Timeline 2** |
| --- | --- | --- |
| *Part 1: Reading Activity* | Friday, first half of class | Monday, first half of class |
| *Part 2: Exploration Activity* | Friday, second half of class | Monday, second half of class |
| *Part 3: EDP Activity* | Monday | Wednesday |

### 2.3.2—Part 1 Timeline (30 minutes)

This activity will take an estimated total of thirty minutes, during which the teacher will do the following:

1. Distribute materials to all students
2. Vocab Alert exercise, part 1
3. Read Aloud–Think Aloud activity
4. Vocab Alert exercise, part 2

### 2.3.3—Part 2 Timeline (50 minutes)

This activity will take an estimated total of fifty minutes; that total is over two days. During this time, the teacher will do the following:

#### Day 1 (25 minutes)

1. Demonstrate the first part of the EDP activity that the students will do
2. Distribute materials to all students
3. Give students time to hypothesize the performance of demonstration bricks

#### Day 2 (25 minutes)

1. Demonstrate the second part of the EDP activity that the students will do
2. Discuss results and answer discussion questions

### 2.4.4—Part 3 Timeline (60 minutes)

This activity will take an estimated total of sixty minutes; that total will be split over two days. During this time, the teacher will do the following:

#### Day 1 (30 minutes)

1. Distribute materials to all students
2. Discuss the Engineering Design Handout
3. Have students work on the Engineering Design Handout in groups
4. Clean up

#### Day 2 (30 minutes)

1. Distribute materials to all students
2. Test the solution
3. Clean up
4. Discuss results of the test

## 2.5 —Lesson Materials

In this section you will find a breakdown of materials, to help a teacher plan logistics for executing this lesson. Materials will be broken down into “Printed Materials,” which are printed materials used by the teacher or the students, and “Activity Materials,” which will be used by the students during the activity associated with the lesson.

Materials are listed again at the beginning of each part of the activity. Below is a listing of all materials needed for all parts of the activity:

### 2.5.1—Printed Materials

* Reading Handout (one per student)
* Read Aloud–Think Aloud Resource (one for the teacher)
* Exploration Handout (one per student)
* Engineering Design Handout (one per student)
* Vocab Alert! Handout (one per student)
* All other materials needed for any part of the lesson, which can be prepared ahead of time.

### 2.5.2—Activity Materials

All materials needed for any part of the activity associated with the lesson. **Note:** For a complete listing of materials with important notes, and common places at which they can be purchased, see **Appendix**

# 3—Preparation

## 3.1—Part 1: Reading

### 3.1.1—Materials

This activity-specific materials listing contains only the materials used in this activity, in exactly the same manner as section 3.2.

#### Printed Materials

* Reading Handout (one per student)
* Read Aloud–Think Aloud Resource (one for the teacher)
* Other materials prepared before this activity.

#### Activity Materials

* Materials used in this activity.

### 3.1.2—Preparation Steps

1. For the sake of redundancy and clarity, the first step in any activity will always be to make necessary copies of any lesson materials: “Make a *Reading* booklet and the *Vocab Alert!* handout for every student. Make a copy of the *Read Aloud – Think Aloud* resource for yourself.”
2. Any other steps required to prepare for this activity.

## 3.2—Part 2: Exploration Activity

**Note**: If you do not have the time for a class demonstration, as an optional alternative you can give your students a copy of the *Information for Design Activity* handout. It contains information that they would have received during the Exploration Activity and will be useful to them during the Engineering Design Activity. Walk your students through this handout.

### 3.2.1—Materials

#### Printed Materials

* Exploration Activity Handout (one per student)
* Other materials prepared before this activity.

#### Activity Materials

* List the materials needed for this activity

### 3.2.2—Preparation Steps

1. Make a copy of the *Exploration Activity* handout for every student. Make a copy of the *Tested Results* handout for every student.
2. Any other steps required to prepare for this activity.

## 3.3—Part 3: Engineering Design

### 3.3.1—Materials

#### Printed Materials

* Engineering Design Handout (one per student)
* **Optional**— Information for Design Activity Handout (one per student) – provide this handout if the students did not do Part 2 – Exploration Activity.
* Other materials prepared before this activity.

#### Activity Materials

#### Materials used in this activity.

### 3.3.2—Preparation Steps

1. Make copies of the *Engineering Design* handout for every student.
2. Any other steps required to prepare for this activity.

# 4—Activity Instructions

This section will break down specific, executable instructions for a teacher to use as reference during class. A few steps will typically be the same for all lessons, such as in the reading activity:

## 4.1—Part 1: Reading

1. Pass out the *Reading* booklet to each student. Pass out the *Vocab Alert!* worksheet to each student.
2. Explain to students that the words on this page are the important words to know for the upcoming story. Ask student to rate their knowledge of each word by circling a number in the “Before” column for the word.
3. Read each word aloud and have the class repeat the word aloud.
4. Explain the following rating system to the students:

**1** — I have never heard of this word before now.

**2** — I recognize this word, but I don’t know what it means.

**3** — I sort-of know what this word means, but I would have a hard time explaining what it means.

**4** — I can explain what this word means and use it in a sentence.

1. Give students a chance to rank the word before moving on to the next word and repeating the process
2. Read the storybook with the class using the *Read Aloud–Think Aloud* resource, following the prompts in it.
3. After you read and discuss the story with your students, have them re-rate each vocabulary word in the “After” column on the *Vocab Alert!* page at the front of the book using the process from **Step 2**.
4. Have students draw a picture of each word in the space provided on the *Vocab Alert!* page.

## 4.2—Part 2: Exploration Activity

**Note:** As an optional alternative for teachers short on time, one can skip the exploration activity. Instead, you can hand out the *Information for Design Activity* handout and walk your students through it either as a very short Part 2 or as preface to Part 3.

If activities are split into multiple days, they will be separated and organized like so:

### 4.2.1—Part 2, Day One

In front of the students, as a class demonstration, go through the following steps and explain what you are doing to students.

Sometimes these steps will involve students by having you ask them to help, which will increase attentiveness and learning.

1. The steps for executing this part of the activity go here.
2. These steps will commonly include prompts to stop and explain certain concepts to students.
3. They can also include prompts start discussions with the class, to evaluate their knowledge of what is going on.

### 4.2.2—Part 2, Day Two

1. The steps for executing this part of the activity go here.
2. Some lessons will include reflection questions for further evaluation. They will be listed like this.
   1. Which prototype was the most successful, and why?
   2. Which prototype was the least successful, and why?
   3. How did your predictions compare to your results?

## 4.3—Part 3: Engineering Design

If activities are split into multiple days, they will be separated and organized like so:

### 4.3.1—Part 3, Day One

1. The steps for executing this part of the activity go here.
2. These steps will include recommended group sizes and structures (designating group responsibilities, etc.) as well as procedure to monitor the success of groups.
3. They can also include tips for helping groups which are struggling.

### 4.3.2—Part 3, Day Two

1. The steps for executing this part of the activity go here.
2. Some lessons will include reflection questions for further evaluation. They should be listed like this:
   1. Which prototype was the most successful, and why?
   2. Which prototype was the least successful, and why?
   3. How did your predictions compare to your results?

# Appendix 1A: 2009 Standards that Relate to this Lesson

In this appendix you will find a listing of the standards with which the lesson aligns. Under the cited standards you can add bullets phrased as “Students will be able to …”

### General Science

In this section, list the science content standards addressed by your lesson.

### Engineering Design

In this section, select from the following list engineering design standards addressed by your lesson.

**K.4D.1** Create structures using natural or designed materials and simple tools.

**2.4D.1** Use tools to construct a simple designed structure out of common objects and materials.

**2.4D.2** Work with a team to complete a designed structure that can be shared with others.

**2.4D.3** Describe an engineering design that is used to solve a problem or address a need.

**3.4D.1** Identify a problem that can be addressed through engineering design, propose a potential solution, and

design a prototype.

**4.4D.1** Identify a problem that can be addressed through engineering design using science principles.

**4.4D.2** Design, construct, and test a prototype of a possible solution to a problem using appropriate tools,

materials and resources

**5.4D.1** Using science principles, describe a solution to a need or problem given criteria and constraints.

**5.4D.2** Design and build a prototype of a proposed engineering solution

# Appendix 1B: 2014 (NGSS) Standards that Relate to this Lesson

## Alignment to Next Generation Science Standards

### Performance Expectations

List the performance expectations that align with your lesson.

### Science and Engineering Practices

List the scientific and engineering practices that align with your lesson.

### Disciplinary Core Ideas

List the disciplinary core ideas that align with your lesson.

### Cross Cutting Concepts

List the cross cutting concepts that align with your lesson.

### Connections to Engineering, Technology, and Applications of Science

List your lesson’s connections to Engineering, Technology and Application of Science.

# Appendix 2: Material Breakdown

For this section, create a complete listing of materials as seen in section 3, with additional notes that will help a teacher or someone else purchase the materials. Also include in this section any important notes you have found through as you developed the lesson and purchased the materials.

In our lessons, most commonly you will find a buyer’s guide which includes expected prices for items not commonly found in the classroom—and the types of stores at which you can find them. You will also find important notes we found throughout our development process.

## Buyer’s Guide:

| Item | Cost | Found In | Notes |
| --- | --- | --- | --- |
|  |  |  | . |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

# Appendix 3: Resources and Extensions

In this section, provide supplementary resources and possible extensions for this lesson. The purpose of this appendix is to better equip other teachers to modify and adapt the lesson to fit their needs, as well as the needs of their students. Note that nothing here will have been directly integrated into this lesson—it will simply be a listing of places to look.