

# Engineering Design Thinking

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### Abstract

Solutions, opportunities and possibilities are everywhere! Many people don't realize that there's always more than one way to solve a problem. The ability to critically think through human-centered design for challenges is an invaluable skill in all industries. This lesson plan exposes students to a strategic method of problem-solving that they may have never encountered or considered. Students will have the opportunity to interact directly with guest speakers and engage in hands-on design projects to explore their own skills and interests. Challenges include personal, school-wide, national, and even global challenges. Finally, students will develop their own solutions to these problems to hone their own design thinking and problem-solving skills!

STEM areas: science, technology, engineering, and mathematics.

**Budget:** Varies

### Lesson 1: Design Thinking 101

**Suggested Time:** 60 minutes

#### Overview

Students will learn about each component of the Design Thinking process while applying these principles to solve relevant problems. It should be performed by teams of 2 in which each student provides a challenge to the other and they individually come up with a solution for their partner while utilizing the Design Thinking process. Ensure that students understand that the challenges they pose can be solved by a system, a process, or an object.

#### Vocabulary

- Empathy
- Pain Points
- Objectives
- Ideation
- Prioritize

- Prototype
- Test

### **Objectives**

- Students will learn about a range of methods for defining and solving problems.
- Students will learn about how to approach personal challenges through applying the Design Thinking process.
- Students will gain exposure to critically thinking through prototyping and testing.

### **Next Generation Science Standards**

- MS-PS-1, MS-PS-4. Developing and Using Models.
- MS-PS1-3. Obtaining, Evaluating, and Communicating Information.
- ETS1.A, B, and C. Defining and Delimiting Design Problems, Developing Possible Solutions, and Optimizing the Design Solution.

### **Required Project Materials**

- Construction Paper
- Markers
- Pen
- String
- Scissors
- Tape
- Large Sticky Notepad
- Post-It Notes

### **Multimedia Resources**

- “What is Design Thinking?”. Sean VanGenderen. <https://www.youtube.com/watch?v=a7sEoEvT8l8>
- “What is Design Thinking?”. David Terrar. EnterpriseIrregulars. <https://www.enterpriseirregulars.com/125085/what-is-design-thinking/>

### **Optional Multimedia Resources**

- “The Design Thinking Process.” Sprouts. [https://www.youtube.com/watch?v=\\_r0VX-aU\\_T8](https://www.youtube.com/watch?v=_r0VX-aU_T8)

### **Before the Lesson/ Background Information**

- Print out the infographic on “What is Design Thinking?” article titled “Stanford d.school Design Thinking Process.”
- If possible, contact an architect, engineer, designer, or businessman to assist with the lesson. Ask them to bring an example of their design projects.

### **The Lesson**

#### **Part 1: What is Design Thinking? (20 mins)**

1. Ask the students about some of the challenges that they are facing today and how they might go about seeking a solution. Discuss, then play “What is Design Thinking?”

2. Discuss importance of each component of the Design Thinking process. It can be useful to pass out the picture of the Design Thinking process from the Enterprise Irregulars website in class.
3. Using the “What is Design Thinking?”, go through the steps for completing each of the components of Design Thinking. Define empathy, pain points, ideate, test, and prototype.

### **Part 2: Design Thinking Activity (40 mins)**

1. Each student should pick a partner so that there are teams of 2. Pass out required project materials[MK1] to each group.
2. Next[MK2], students will pose a challenge that they deal with in their day-to-day life (i.e., a phone locator for lost phones) to their partner as their partner asks several “Why” questions. Each partner gets 5 minutes for questioning and they must take down notes.
3. Then, students are given 3 minutes to define the problem using their notes and 2 minutes to check to see if their definition aligns with their partner’s perceived problem.
4. Each student is given 5 minutes to ideate and write down their ideas on post-it notes and place them on the large sticky notepad with no judgement.
5. Afterward, the partners will provide each other with feedback on what idea/solution is or is not a feasible for their respective challenge for 5 minutes each.
6. Students will then spend 5 minutes creating an idea of their solution[MK3].
7. Finally, their partner will provide feedback on the idea.

### **Homework Due Next Class**

- Students reflect on how they utilized the Design Thinking process. What did they do well and what do they need to[MK4] improve upon?

## **Lesson 2: Design Thinking in Engineering**

**Suggested Time: 80 minutes**

### **Overview**

Students will learn about applying design thinking in engineering. They will practice using Design Thinking to create solutions for engineering grand challenges.

### **Vocabulary**

- Engineering Design Process
- Engineering Grand Challenges
- Evaluation

### **Objectives**

- Students will learn about the methodology behind the engineering design process.
- Students will learn about a range of engineering challenges that impact the future of society.
- Students will practice using the engineering process to find possible solutions utilizing their imagination and ingenuity.

### **Next Generation Science Standards**

- MS-PS-1, MS-PS-4. Developing and Using Models.
- MS-PS1-3. Obtaining, Evaluating, and Communicating Information.

- ETS1.A, B, and C. Defining and Delimiting Design Problems, Developing Possible Solutions, and Optimizing the Design Solution.

### **Required Project Materials**

- Computers
- Markers
- Large Sticky Notepads
- Tri-Fold Poster board

### **Multimedia Resources**

- “The Engineering Process: Crash Course Kids #12.2”. Crash Course Kids. <https://www.youtube.com/watch?v=fxJWin195kU>
- “NAE Grand Challenges for Engineering”. National Academy of Engineering. <http://engineeringchallenges.org/challenges>

### **Optional Multimedia Resources**

- “The Engineering Design Process: A Taco Party”. KQED QUEST. [https://www.youtube.com/watch?v=MAhpfFt\\_mWM](https://www.youtube.com/watch?v=MAhpfFt_mWM)

### **Before the Lesson/ Background Information**

- Review the student reflections of Design Thinking.
- Print out an overview from the “NAE Grand Challenges for Engineering” website link for each student.
- Locate an engineer to do a presentation for the class. Ask them to bring visual demonstrations or fun interactive props on related to what they do.

### **Homework from Previous Session:**

- Assignment on how to improve their Design Thinking skills.

### **The Lesson**

#### **Part 1: What is the Engineering Design Process? (15 mins)**

1. Review the assignment from the homework.
2. Discuss how engineers may incorporate Design Thinking when creating solutions. Play “The Engineering Process: Crash Course Kids #12.2.”

#### **Part 2: Engineer Presentation (25 mins)**

1. Introduce the professional speaker to the class.
2. Reserve some time at the end of presentation for questions.

#### **Part 3: The Engineering Design Process Activity (50 mins)**

1. Split the class into groups of four and distribute materials. Have each group choose an Engineering Grand Challenge to develop a solution utilizing the Engineering Process and Design Thinking.
2. Have each group assess their challenge and design a solution. Then have students present their design process for their solution.

### **Homework Due Next Class**

- Research current problems in the U.S. and outline how they may go about creating a solution for the problem.

### **Lesson 3: Engineering Design in the Real-World**

**Suggested Time: 60 minutes**

#### **Overview**

Students will quickly present their own research about current problems in the U.S. and create a solution to a real-world problem that engineers must solve. (For example, the Florida pedestrian bridge collapse)

#### **Vocabulary**

- Research
- Evaluation
- Analysis
- Iterate

#### **Objectives**

- Students will learn about relevant problems in the U.S. that require solutions and are applicable to their lives.
- Students will learn how to research, analyze, and evaluate how to create a sustainable solution.

#### **Next Generation Science Standards**

- MS-PS-1, MS-PS-4. Developing and Using Models.
- MS-PS1-3. Obtaining, Evaluating, and Communicating Information.
- ETS1.A, B, and C. Defining and Delimiting Design Problems, Developing Possible Solutions, and Optimizing the Design Solution.

#### **Required Project Materials**

- Computers
- Markers
- Large Sticky Notepads
- Notecards (200 per group)

#### **Multimedia Resources**

- “Florida bridge collapse caught on dashcam video from the highway”. Nicole Darrah. Fox News. <http://www.foxnews.com/us/2018/03/21/florida-bridge-collapse-caught-on-dashcam-video-from-highway.html>
- “Evaluating and Analyzing Data From Primary Research”. Write Content Solutions. <http://www.write.com/writing-guides/research-writing/research-process/evaluating-and-analyzing-data-from-primary-research/>

#### **Optional Multimedia Resources**

- None

#### **Before the Lesson/ Background Information**

- If possible, contact a subject-matter expert who can serve as a consultant/advisor to your students for the problem that they will be working on.

#### **Homework from Previous Session:**

Students should investigate a current U.S. problem that requires an engineering solution. They will write a 300-word essay about how they would utilize the engineering design process to come up with a solution for this problem. They should also be ready to share their problem & solution with the class.

### **The Lesson**

#### **Part 1: A World of Problems (30 mins)**

1. Allow students to share their research on current problems in the U.S. and what they believe may be a viable solution.
2. Read and discuss a news article regarding the relevant problem with the class.
3. Teach students about the research process. Have students read “Evaluating and Analyzing Data from Primary Research.”

#### **Part 2: Real-World Problem-Solving Activity (30 mins)**

1. Have students split up in groups of 4 and research further about posed problems from their homework and possible solutions via the internet.[\[MK5\]](#)
2. Allow groups to choose a posed problem that they all have an interest in solving. Have them create a materials lists to build a prototype of a system, process, or object that they believe will solve the problem.[\[MK6\]](#)

### **Homework Due Next Class**

1. Students should reflect on how they could apply the engineering design process to challenges within their home, school, and/or community.
2. Students will have a week to build a prototype as a team. Their prototypes will be tested, and students will provide constructive feedback on what they believed worked and could be improved.