Introduction to Engineering: 6.A.1
Introduction to the Design Process

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>6</th>
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</table>
| Sessions        | Session 1 – 40 – 60 minutes  
|                 | Session 2 - 40-55 minutes |
| Seasonality     | N/A |
| Instructional Mode(s) | Whole class, Independent Activity |
| Team Size       | N/A |
| WPS Benchmarks  | 06.SC.TE.07  
|                 | 06.SC.TE.08 |
| MA Frameworks   | 6-8.TE.2.1  
|                 | 6-8.TE.2.2 |
| Key Words       | Engineering, Introduction, Design Process |

Summary
This lesson introduces students to engineering and the engineering design process. The students will begin by taking the “Pre-test” individually to assess what they already know about engineering. The class will share ideas of what engineers do as a whole, and then be introduced to the design process of how they accomplish their goals. The activity provided enforces the purpose of the design process and gives them an opportunity to use the strategy of the design process together.

Learning Objectives
2002 Worcester Public Schools (WPS) Benchmarks for Grade 6
06.SC.TE.07 Identify and explain the steps of the engineering design process, e.g., identify the need or problem, research the problem, develop possible solutions, select the best possible design, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.
06.SC.TE.08 Demonstrate methods of representing solutions to a design problem, e.g., sketches, orthographic projections, multiview drawings.

Additional Learning Objectives
1. 6-8.TE.2.1 Identify and explain the steps of the engineering design process, e.g., identify the need or problem, research the problem, develop possible solutions,
select the best possible design, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.

2. 6-8.TE.2.2 Demonstrate methods of representing solutions to a design problem, e.g., sketches, orthographic projections, multiview drawings.

3. Students should have a good understanding that engineering is the use of science and technology to design and create products and processes to aid society.

4. All students should have a clear understanding of the difference between science and engineering, and be able to describe what types of things are created by engineers.

5. At the conclusion of the lesson they should know the steps of the design process, and the importance of following its order.

6. Students should understand how to put the design process to use in order to solve a problem they are faced with.

**Required Background Knowledge**

None

**Essential Questions**

1. What is engineering?
2. What do engineers do (including non-traditional)?
3. What around you in life involves engineers?
4. What is the difference between engineering and science?
5. How do engineers solve problems?
6. What are the steps of the design process?
Introduction / Motivation

Hand out *Pre-test* to students, and display the Engineering Design Process poster in the classroom. The *Pre-test* is intended to act as a reference point to determine how effective the engineering curriculum has been. Administer the same test at the end of the school year as a *Post-test* and compare the two.

Procedure

**Session 1: 40 - 60 minutes**

The instructor will:

1. Have the students take the *Pre-test* to assess what knowledge they already have on the question topics. (10-15 minutes)
2. Address the whole class with the “Essential Questions (1-4)” one at a time and briefly have the students brainstorm ideas (See *Teacher Reference Sheet* for suggest answers.). (10-15 minutes)
3. Direct the student’s attention to the poster of the design process, or if this is not available, map it out on the chalkboard for students to refer to for the rest of the lesson. Go over the importance of each step and give a brief description of what each step consists of for tasks. (See *Steps of the Engineering Design Process* and *Teacher Reference Sheet*) (5 minutes)
4. Hand out *Engineering Design Problem* (See attachments). Tell the students that they must devise a way to get from point A to point B on the picture they were given. Explain that this is the first step to the design process: Identifying the Problem, and that they will be using the design process to solve this problem. (<5 minutes).
5. Remind the students that the second step in the engineering design process is ‘research the need or problem’. Explain to the students that they will be using what they know from experience and studies as their form of “research” to complete the second step. The third step is to ‘develop possible solution(s)’. This is also called brainstorming. Have the students come up with a few possible solutions for the problem. (10-20 minutes – depending on whether they use what they already know or are able to do some research.)
***Can end session one before homework assigned or continue if there is time enough for one long lesson.***

**Session 2: 40 – 55 minutes**

The instructor will:

6. Have the students continue the design process by choosing the best solution out of the options created during the brainstorming session. Have the ideas given by each student out load or list them on the chalkboard. Have the students provide reasons for why they think one idea is better than the others. (If this was assigned as homework, have each student read what he or she wrote aloud.) This is a very difficult task. You may want to end the session without selecting the best design, or have the students put their heads on their desks and objectively vote (by raising their hand) on which idea they think is the best. The votes can simply be tallied up as each design alternative is announced and the students raise their hands to get a final design choice. (15-20 minutes)

7. Depending on time limitations, you may want to draw the students attention to the lack of information given on the *Engineering Design Problem*. How did the students know how big the island was. What is the picture was only a drawing of a mud puddle or what if it was a distant planet with no gravity. During the research stage of the engineering design process you should ask questions about the problem you are trying to solve. (5-10 minutes)

8. Review the final four steps of the design process with the students. Discuss the building, testing, communicating, and evaluating steps by questioning the students for interaction while lecturing. (*See Teacher Reference Sheet*) (20-25 minutes).

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**Materials List**

<table>
<thead>
<tr>
<th>Materials per class</th>
<th>Amount</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poster board or chalkboard</td>
<td>One</td>
<td>Supermarket or Office Supply Store</td>
</tr>
<tr>
<td>Markers or Chalk</td>
<td>One</td>
<td>Supermarket or Office Supply Store</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials per student</th>
<th>Amount</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
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4
Vocabulary with Definitions (in alphabetical order)

1. **Brainstorming** – A technique for generating ideas and solutions to problems.

2. **Engineer** – An engineer is a person who designs something to satisfy a need or want; constructs new things using the engineering design process; assembles known parts to make a whole object.

3. **Engineering Design Process** – A process used to solve problems through research, brainstorming, and critical thinking. Engineers as well as many other people use the engineering design process to solve different types of problems including engineering problems.

4. **Scientist** – A scientist is a person who looks closely at the world around him/her to draw conclusions; performs experiments with the scientific method; studies a whole object to identify the parts.

5. **Test** – The process of proving that a conceptual design actually works.

**Assessment / Evaluation of Students**

The instructor may assess the students in any/all of the following manners:

1. Look over the **Pre-test** to see what the students knew before starting the lesson to compare their participation and efforts during the class lesson.

2. Check for participation in the individual brainstorming activities.

3. Make note of which students actively participated in the whole class participation sessions.

4. Check the homework assignment (if applicable).

**Lesson Extensions**

The instructor might use this lesson as an introduction to the other lessons in this unit.

**Attachments**

1. Pre-Test

2. Teacher Reference Sheet

3. Steps of the Engineering Design Process

4. Engineering Design Problem

**Troubleshooting Tips**

None
Safety Issues

None

Additional Resources

None

Key Words

Engineering, Introduction, Design Process
Pre-Test

1.) What is an engineer?

2.) What is a scientist?

3.) What is the difference between science and engineering?

4.) Identify the following and write about what they are used for:

   Name: ______________________
   Use: ______________________

   Name: ______________________
   Use: ______________________

5.) Have you ever heard the following term (please circle one answer)?

   a.) Astronomy 
      YES  NO
   b.) Biology
      YES  NO
   c.) Geology
      YES  NO
   d.) Mechanical Engineering
      YES  NO
   e.) Electrical Engineering
      YES  NO
   f.) Civil Engineering
      YES  NO

6.) Define two of the terms in number 5.

   a.) ______________________
   b.) ______________________

Additional Comments:
Teacher Reference Sheet

The following includes possible responses to either help or add on to the class discussions:

Essential Questions 1-4:

1. What is engineering? *Engineers use science to design products and processes to aid society.*
2. What do engineers do?
   - Design bridges
   - Get power to your house
   - Design cars
   - Design computers and software
   - Develop cures to diseases
   - Non-traditional: lawyers, teachers, and business people
3. What around you in life involves engineering? *Most things that you can think of.*
4. What is the difference between engineering and science? *Science happens in nature and engineering is “man-made”.*

Reviewing Design Steps #4-8:

- **What is a prototype?** A design that is intended to be tested and demonstrate that the product functions properly in the environment it is supposed to act in. It is produced before the final design is created.
- **How could we go about building it? How could we test it?**
- **What tools or methods could we use to present what we found?** This is the communication step of the design in which the results of a prototype and the test performed on it are presented to other through the use of “Power Point” presentations or posters.
- **What would we do with the results?** You would use the results to see what aspects of the design failed and what aspects worked well. For example, the transportation designs brainstormed in class may include some that might be tested unsafe, and would need to be fixed in order to become a safer mode of transportation. They would then be evaluated and lead into the final step of design: Redesign.
- Talking about how some products are redesigned such as vehicles, appliances, and computers, may help the students understand the purpose of the design process and the importance of evaluating test results.
Steps of the Engineering Design Process

1. Identify the need or problem
2. Research the need or problem
   - Examine current state of the issue and current solutions
   - Explore other options via the internet, library, interviews, etc.
3. Develop possible solution(s)
   - Brainstorm possible solutions
   - Draw on mathematics and science
   - Articulate the possible solutions in two and three dimensions
   - Refine the possible solutions
4. Select the best possible solution(s)
   - Determine which solution(s) best meet(s) the original requirements
5. Construct a prototype
   - Model the selected solution(s) in two and three dimensions
6. Test and evaluate the solution(s)
   - Does it work?
   - Does it meet the original design constraints?
7. Communicate the solution(s)
   - Make an engineering presentation that includes a discussion of how the solution(s) best meet(s) the needs of the initial problem, opportunity, or need
   - Discuss societal impact and tradeoffs of the solution(s)
8. Redesign
   - Overhaul the solution(s) based on information gathered during the tests and presentation

Engineering Design Problem

Problem: Devise a way to get from point A to point B on the island below.

Brainstorming ideas (may include sketches):