Unit 2 Guide - Engineering is Creative

Driving Questions

- Who do engineers design for and how does the product impact the user?
- How do engineers go from problem to product?
- How do we know our design works?

Description

The students will engage in a guided whole-class engineering challenge tethered to a global issue in which they are provided a related local problem. The students will design, construct, test and evaluate their product(s) to address a need e.g. water filtration.

Key Concepts

(Design) Design is a process that requires us to test how well we meet our initial goals which are often established through stakeholder inputs.
(Engineering Discipline) The role of civil engineers in providing clean drinking water will be highlighted.
(Teamwork) Students will be introduced to teamwork.
(Ethics and Society) Engineering design can impact society and choices/decisions may not occur in isolation.

Learning Outcomes*

Connect with Engineering

CE.A	Iterate and evolve the definition of what it means to engineer and be an engineer.	

Engineering in Society

ES.A	Explore the impacts of past engineering successes and failures on society as a whole.	
ES.B	Recognize and investigate the world's greatest challenges and the role that engineering plays in solving these challenges (e.g., Engineering Grand Challenges, UN sustainability goals, etc.).	
ES.C	Integrate diverse disciplinary thinking and expertise to inform design solutions that add value to society.	

Engineering Professional Skills

PS.A	Use various engineering communication methods.	
PS.B	Collaborate effectively in a team.	

Engineering Design

ED.A	Identify and describe a problem that can be solved with a potentially new product or process.	
ED.C	Plan and conduct research by gathering relevant and credible data, facts, and information.	
ED.D	Articulate appropriate STEM practices and principles in the design	
ED.E	Evaluate solution alternatives and select a final design by considering assumptions, tradeoffs, criteria, and constraints.	
ED.F	Create a prototype.	
ED.G	Create and implement a testing plan to evaluate the performance of design solutions.	
ED.H	Apply iteration to improve engineering designs.	
ED.I	Articulate and reflect on how an engineering design process could be applied to solving a problem.	

Misconceptions

- Engineers work in isolation, without input from others, such as stakeholders, team members.

- Engineers focus on technology and do not need to know how to read or write
- Water that looks, smells, and tastes good is safe to drink (potable) and water that does not look, smell, or taste good is not.
- All design is engineering design; there's no difference between engineering and, say, artistic design.
- Engineering design is only the part where you come up with an idea and build it (and does not inherently include research, delimiting the problem, testing and/or improving).
- Engineering design is making a plan on paper or on the computer.
- Engineering design is essentially trial and error.
- Contributing to a team's success at the beginning of a project means having great ideas (as opposed to offering all ideas); that bad ideas are not valuable; that individuals are more or less naturally creative and will be the ones to come up with ideas (as opposed to team members helping each other).
- Students may think that there is always one best design, or that the most creative and innovative designs are best, or ones that use high tech materials are best, etc.
- Voting is the best way to decide on an idea for a team to pursue.
- Using objective analysis means that people are not swayed by their own preference or the preferences of others.

Teaching Challenges

- Using Tools (Technical Drawing and Computer Aided Design)
- Teaching teaming and how to support multiple groups during the design process
- Teaching Engineering
- Failing is still learning / Failure is necessary

Lesson and Content Overview

Note: this unit will be a whole-class project with some parts being done in small 3-4 person teams and the rest done in the whole-class "team"

Lesson Name (duration)	Lesson Description	Activity (duration)
2.1 Introduction to Teaming [90-95 min] Video: Lesson 2.1	Introduce teamwork and characteristics of a high functioning team.	Activity 2.1.1 Rain Shelter Design [77 min]
2.2 Community Based Problems [90-95 min] Video: Lesson 2.2	Investigation of access to clean water, both as an Engineering Grand Challenge and for some areas, a local community issue.	Activity 2.2.1 Potable Water in the Community [60 min]

2.3 Introduction to the Engineering Design Process [50 min] **Video: Lesson 2.3-2.6**	Recognizing multiple models exist for the engineering design process (EDP), the class creates their process of engineering design activities.	Activity 2.3.1 Engineering an Engineering Design Process [45 min]
2.4 Problem Definition [135 min]	Students are presented with an access to clean water problem and asked to design a solution. Students research the science behind water quality and safety as well as filtration.	Activity 2.4.1 Personal Potable Water Device Problem [95 min] Activity 2.4.2 Research the Science [35 min]
2.5 Ideation [50 min]	Innovative ideas and solutions are often created through brainstorming. Brainstorming requires team synergy to build upon one another and to promote an environment that allows for the sharing of thoughts and ideas.	Activity 2.5.1 Brainstorming [45 min]
2.6 Design Selection [143 min]	Class decides on a solution design using specified criteria and a justified scoring system.	Activity 2.6.1 Mathematical Modeling [60 min] Activity 2.6.2 Design Selection [80 min]
2.7 Sketching a Design [95-215 min] **Video: Lesson 2.7**	Learn to sketch. Optionally, learn to do computer aided drawings.	Activity 2.7.1 Sketching a Design [90-200 min]
2.8 Prototype Creation [110-115 min] **Video: Lesson 2.8-2.10**	Prototype 1.0; Teams (3 or 4 members) will build their own prototypes.	Activity 2.8.1 Prototype Creation [95-100 min]
2.9 Prototype Testing [100 min]	Does this "work"? An important part of the design process is to test whether the design works as expected.	Activity 2.9.1 Prototype Testing [90 min]
2.10 Design Iteration [85-90 min]	Testing data improves design iteration.	Activity 2.10.1 Design Iteration [80-85 min]
2.11 Design Communication Through Posters [130 min] **Video: Lesson 2.11-2.12**	Share results of the design process with classmates. Discuss design process, effectiveness of design, team effectiveness.	Activity 2.11.1 Gallery Walk [125 min]
2.12 Product, Process and Team Evaluation [130 min]	Discuss the processes, ethical implications, and performance of the solution and the teamwork.	Activity 2.12.1 Product and Team Evaluation [125 min]
2.13 Introduction to the MyDesign Portfolio [100 min]	Introduce the MyDesign Portfolio.	Activity 2.13.1 Introduction to the MyDesign Portfolio [90 min]