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

Discover Engineering		
Iterate and evolve the definition of what it means to engineer and be an engineer.	E.A	
Awareness of changing perspectives on one's current identities with respect to engineering through regular reflection.	E.B	
Recognize the value of engineering for all regardless of one's potential career.	E.C	
Explain and apply ethical considerations when exploring an engineering problem.	E.D	
Engineering in Society		
Explore the impacts of past engineering successes and failures on society as a whole.	S.A	
Use systems thinking to propose and analyze the relationship between inputs, intention, and impacts of technology in society.	S.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.).	S.C	
Integrate diverse disciplinary thinking and expertise to inform design solutions that add value to society.	S.D	
Identify and analyze issues when bringing a solution to scale.	S.E	
Engineering Professional Skills		
Apply strategies to collaborate effectively as a team.	P.A	
Use various forms of communication (oral, written, visual).	P.B	
Recognize when to use various communication tools based on audience.	P.C	
Develop, implement, and adapt a project management plan.	P.D	
Contribute individually to overall team efforts.	P.E	
Engineering Design		
Uncover a problem that can be solved with a potentially new product or process.	D.A	
Identify appropriate stakeholders and evaluate stakeholder input.	D.B	
Plan and conduct research by gathering relevant and credible data, facts, and information.	D.C	
Model physical situations using mathematical equations.	D.D	
Evaluate solution alternatives and select a final design by considering assumptions, tradeoffs, criteria, and constraints.	D.E	
Use and recognize when to use computational tools.	D.F	
Create a prototype.	D.G	
Create and implement a testing plan to evaluate the performance of design solutions.	D.H	
Apply iteration to improve engineering designs.	D.I	

Misconceptions

LIVE

Engineers work in isolation, without input from others; stakeholders, team members.
Engineers focus on the technology and do not need to learn how to write.

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	Lesson Description	Activity	Assessments
2.1: How do engineers collaborate? (2.5 hrs)	Introduce teamwork and characteristics of a high functioning team.	Create a fort using materials provided and rate team effectiveness using a rubric.	A document explaining the unique features of their team.
2.2: Who needs potable water? (1 hr)	Investigation of access to clean water, both as an Engineering Grand Challenge and for some areas, a local community issue.	Investigation and discussion of the access to the clean water crisis, to include challenges faced by different situations and communities.	Water treatment map illustrating how clean water gets to students' school
2.3: How is water filtered? (1.5 hrs)	Investigation of water filtration process.	Activity: Exploration of the water filtration process. (Materials provided)	None - Observation notes from the instructor of teamwork
2.4: What is engineering design? (0.75 hrs)	Recognizing multiple models exist for the engineering design process (EDP), the class creates their process of engineering design activities.	Create a classroom display that enables the components of the EDP to be moved around based upon the different design activities.	Classroom visual display of EDP with movable components
2.5: What is a personal	Students are presented an access to clean water problem and asked to	Students are presented a problem for them to	None - Observation

portable water device? (0.75 hrs)	design a solution.	research, discuss, and benchmark specifications, criteria, and constraints.	notes from the instructor
2.6: How many ideas do we have? (0.5 hrs)	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.	Students will work through the previous lesson's problem to practice effective brainstorming techniques.	None - Observation notes from the instructor
2.7: Which design do we select? (1 hr)	Class decides on a solution design using specified criteria and a justified scoring system.	Students will review and generate methods for narrowing solution choice ensuring the selection is tied to design decisions.	
2.8: How can we represent our design? (3.5 hrs)	Learn to sketch.	Tools: sketching	Design representation
2.9: How do we make our design? (3.5 hrs)	Prototype 1.0 Teams (3 or 4 members) will take different construction approaches/methods to one design agreed upon in lesson 2.6.	Design exploration (materials given) Construction includes learning and using different types of tools/techniques/materials as available	Recorded re-iteration to document justification for changes. Prototype
2.10: Does your design work? (1.5 hrs)	Does this "work"? An important part of the design process is to test whether the design works as expected.	Teams create a testing plan. Teams test out other team's prototype based upon testing plan and document testing results.	Observation notes of instructor.
2.11: How do we improve our design? (1.5 hrs)	Testing data improves design iteration.	Using testing result data, teams evaluate their design and identify needed changes to address feedback.	Written test plan, Data from testing

2.12: Can I share my progress? (2.5 hrs)	Share results of design process with classmates. Discuss design process, effectiveness of design, team effectiveness.	Communicate designs, test results, propose iteration of design based on feedback	Presentation / poster / web page
2.13: How do we debrief? (1 hr)	Discuss the processes, ethical implications, and performance of the solution and the teamwork.	Discuss and Debrief session for students to share their feedback regarding their solution design, areas for improvement, and teaming processes.	Debriefs of engineer reflection: (design process, ethics)