Unit 6 Guide - Engineering is Iterative

Driving Questions
What is design, iteration and testing?
Why is a final design report important?

Description
Students build and test a prototype of a solution they have designed in teams to address a local problem associated with a global issue. Students use what they learn from testing the prototype to redesign their solution through iteration. Teams culminate this unit by generating a comprehensive engineering design report and presentation.

Key Concepts
Connect with Engineering

Students explore and apply ethics to their designed solutions.

Engineering in Society

As students are designing a solution that could cost up to $1000, they consider what issues they will face as they scale their solution up.

Engineering Professional Skills

Students communicate within and beyond their teams about their engineering design work. Teams update their project management plans as they analyze test results and consider iteration. Students and their teams evaluate their teamwork as individuals and as whole teams.

Engineering Design

Student teams take their design plans and use them to create a prototype. After creating testing plans that are evaluated by content experts, tests are conducted. Data is analyzed and summarized. Iteration is at least planned, if not conducted. External evaluators provide summative feedback to the student teams. Finally, teams review their engineering design process work itself.

Note on lesson times within Unit 6:
Suggested lesson times have been provided in prior lessons, but the nature of teams working on different designs means that the time to finish some steps (such as 'iteration') may vary greatly. The overall time for this lesson is a function of the scope of the designs and the time remaining in the academic session. While some lessons include suggested times, other will 'vary'. Teachers are encouraged to review each lesson and reach out to the community for guidance and suggestions as you begin Unit 6.

Learning Outcomes: specific to Unit 6: learning objectives may vary in Unit 6 as teams go through each step of their design. The best estimates are shown in each lesson, but you may not cover each and may include some not listed.

Connect with Engineering

	CE.A	Iterate and evolve the definition of what it means to engineer and be an engineer.
	CE.B	Recognize the value of engineering for all regardless of one's potential career.
	CE.C	Explain and apply ethical considerations when exploring an engineering problem.

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.
	ES.D	Identify and analyze issues when bringing a solution to scale.

Engineering Professional Skills

	PS.A	Use various engineering communication methods.
	PS.B	Collaborate effectively in a team.
	PS.C	Develop, implement, and adapt a project management plan.

Engineering Design

	ED.A	Identify and describe a problem that can be solved with a potentially new product or process.
	ED.B	Identify appropriate stakeholders and content experts and evaluate their input.
	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
Iterations are a waste of time
Failed prototypes promote discouragement
Testing plans are a waste of time

Teaching Challenges
Establishing comfort with failed design
Students are likely to feel bad about failing

Lesson and Content Overview

Lesson Name	Lesson Description	Activity
6.1 Prototype Planning and Creation [285-295 minutes] Video: Lesson 6.1 - 6.3 and 6.5 - 6.6	Teachers instruct students about all necessary safety issues and skills for prototype construction. Students learn to create S.M.A.R.T. goals and use that skill to create goals for prototype creation. Students make a plan for prototype construction and then implement it.	1.0 Classroom and Laboratory Safety [5-15 minutes] 6.1.1 S.M.A.R.T. Goal Setting [30 minutes] 3.8.1 Prototype Construction Planning [33 minutes] 3.9.1 Prototype Creation [210 minutes]
6.2 Team and Design Check-In [40 minutes]	Teams complete the Team Performance Rubric and the Team and Design Check-in.	6.2.1 Team and Design Check-In [35 minutes]
6.3 Testing [165 minutes]	Teams create a testing plan and then implement that plan.	6.3.1 Test Planning [65 minutes] 6.3.2 Test Implementation [85 minutes]

6.4 System Integration (optional) [170 minutes] Video: Lesson 6.4	Teams learn how to create Activity Diagrams and practice on a Rube Goldberg example. Teams then plan and execute systems integration.	6.4.1 Rube Goldberg Interactions [30 minutes] 6.4.2 Systems Integration [120 minutes]
6.5 Iteration [125 minutes]	Team synthesize and summarize their results and make plans for iteration.	6.5.1 Iteration Planning [120 minutes]
6.6 Reflection [150 minutes]	Teams assess their engineering design decisions. Individuals and teams assess their teaming contributions.	6.6.1 Design Reflection [75 minutes] 6.6.2 Teaming Reflection [55 minutes]