Unit 6 Guide - Engineering is Iterative

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

Description
Iterative design allows designers to create and test ideas quickly. Those that show promise can be iterated rapidly until they take sufficient shape to be developed; those that fail to show promise can quickly be abandoned. It's a cost-effective approach which puts user experience at the heart of the design process

Key Concepts
Explain the differences between prototype and model
Compare and contrast the use of different construction materials in the development of prototypes.

Develop testing plans that identify and assess the effectiveness of the prototype.

Students will apply teamwork, evaluation and debrief feedback to build a project management plan and improve their prototype.

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.

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	a
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	a
Identify and analyze issues when bringing a solution to scale.	S.E	a
Engineering Professional Skills		
Apply strategies to collaborate effectively as a team.	P.A	a
Use various forms of communication (oral, written, visual).	P.B	a
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	a
Engineering Design		
Uncover a problem that can be solved with a potentially new product or process.	D.A	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	a
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	a
Use and recognize when to use computational tools.	D.F	a
Create a prototype.	D.G	a
Create and implement a testing plan to evaluate the performance of design solutions.	D.H	a
Apply iteration to improve engineering designs.	D.I	a
Key: (a) assessed during learning progression		

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
Don’t feel bad about failing

Lesson and Content Overview

Lesson Name	Lesson Description	Activity	Assessments
6.1: Where and how do we start the build phase? (vary)	Project planning and prototyping	Prototype	Formative team feedback on S.M.A.R.T. goals Prototype of design concept
6.2: What did we make? (2.5 hrs)	Prototype evaluation	Students will review their progress in selecting and designing a prototype	Observations of teamwork, iteration, and prototype
Sections 6.3, 6.4 and 6.5 are not necessarily a linear flow, but may overlap with each other. Sections 6.3 and 6.4 cover testing of the student-designed solution, and 6.5 covers iteration, or how to make improvements based on the results of testing.			
6.3: Does it work? (2.0 hours, may vary)	Milestone - Unit, System Test Unit testing approach to help students test their prototype.	Students will work in teams to design a testing plan and implement it to determine if their prototype works.	Testing plan and test results
6.4: How does it fit together? (optional) (2.0 hrs)	Rube Goldberg activity to illustrate systems testing	Teams investigate "Rube Goldberg" systems to understand system-level thinking	Observation of teamwork and iteration
6.5: How can we make it better? (2.25 hrs)	Teams review the testing data and feedback and make a plan for iteration.	Identify iteration focus Refine the problem definition Select changes to implement Justify chosen changes and predict effects	Written iteration proposals

6.6: What did we learn? (1.25 hrs)	How did we do in creating a solution?	Reflection on the teamwork and design / test / iteration experience	Teaming reflection Design reflection