Lesson Title	6. Using a Pugh Matrix- An Engineer's Tool
Lesson Designer	Catherine Piscitelli
Standards	☐ CCSS ☑ NGSS ☐ ASCA ☐ Other
	HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
	HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
	HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
Learning Objectives	Students will be able to: • Identify what a Pugh Matrix is and what it is used for • Explain the elements of a Pugh Matrix • Create and use a Pugh Matrix to determine which solution would be best to fulfill an engineering need.

Timeline	Duration
Opening Activity Revisiting the engineering process, Teaching the Pugh Matrix Application Activity	Four to six 60-minute lessons

Teaching Strategies/Student Actions	Monitoring
1. Opening Activity: chart comparison and students create list of common characteristics 2. Revisit the engineering process 3. Teaching the Pugh Matrix: Slides Presentation/ Students listen and take notes 4. Application Activity: Students create a criteria and constraints list, design 3-4 solutions, and create a Pugh Matrix	• Teacher orchestrates whole group instruction. Teacher facilitates final list compilation. • Teacher questioning during review. • Teacher questioning and checking for note taking during slides presentation. • Teacher monitors each group's progress; final grading of solutions and Pugh Matrix using rubric.

Product Description	Students will use their application skills to create a Pugh Matrix for solutions to a given need.
Evaluation	Teachers will use the rubric provided to assess the Pugh Matrix making sure the product includes all of the elements reflective of a good Pugh Matrix

Resources and Materials	Additional Notes
• Four chart examples • Internet access needed • Pugh Matrix slides presentation • Criteria and constraints chart • Pugh Matrix rubric	

Teacher Resource Guide

Introduction
One of the key tools an engineer uses during their design process is a Pugh Matrix. We use Pugh Matrices in our everyday lives even though we may have different names for them. A more common name might be a merchandise comparison chart, a pros and cons list, or in general, a decision making tool.

Opening Activity- What is a Pugh Matrix?
1. Have students look at the following four charts:
   Merchandise comparison:
   - Apple watch series comparison
   - Amazon beach chair comparison

   Pros and cons:
   - College visit Pros and Cons Worksheet
   - Pros and cons of technology

2. Ask students to make observations. What are some similarities and differences among these charts? When might they use something similar?
3. Have students work in small groups to make a list of common factors in the charts. Give them 5-8 minutes to work. Then have each small group or pair share one of their answers. Continue whole group discussion until all possibilities are mentioned. Compile the factors into a list either on the board or in a shared document.

Revisit the Engineering Process
Use the following website and diagram to discuss the engineering and design process.
- https://www.sciencebuddies.org/science-fair-projects/engineering-design-process/engineering-design-process-steps
- https://www.teachengineering.org/PDF/edp/TE_EDPTeacherMaterials_8.5x11.pdf

Teaching the Pugh Matrix
Explain to students that the Pugh Matrix would be used during the "imagine" stage. Go through this slide presentation with students to teach them what a good Pugh Matrix looks like.

Application
5. *Introduce the problem.* In today's world, society has taken steps to reduce germ transmission. One of these steps is to increase the amount of "self" check-outs at grocery stores. However, customers still have to use a touch screen to complete their transaction. Your task is to create a "touchless" interface for grocery store "self" check-outs.
6. *Describe.* Have students work in their small groups to determine the criteria and constraints of the project using the Chart. Review the lists together to make sure everyone is on the same page. (You can collect these and score them if you wish.)
7. *Develop Solutions.* Have students develop possible solutions.
   - Students can draw sketches of possible solutions or use the computer to design the image. They should come up with 3-4 solutions. These should be submitted along with the Pugh Matrix.
4. *Create the Matrix.* Finally, have students make a Pugh Matrix detailing the various aspects of their designs. Remind them to use their criteria list from earlier. Use the following grading rubric. Give the rubric to students ahead of time as a reminder of what makes a good Pugh Matrix. *Note.* Students can use Excel or Google Sheets to create their Pugh Matrix.

https://docs.google.com/document/d/1wpE18EqJ7GAq8YywVU4eHzYIDeb2gotZrxx6MiaztkM/edit?usp=sharing

Criteria and Constraints Chart

Criteria	Constraints

Pugh Matrix Rubric

Element	Value	Earned
Three to five appropriate solutions are represented that target the problem/need.	6	
Several criteria are listed and are accurate and applicable to engineering need.	4	
Rating system makes sense and is easy to follow.	4	
KEY is present and clearly explains the rating system.	4	
Summative calculations are correct.	3	
Choice solution is clearly identified.	3	
Total	**24**	