Topic: Super Bowl – field goal kicking

Challenge:
Think like a coach/trainer/engineer/sports scientist and design a solution for a field goal kicking machine that can "kick" a paper football the farthest distance and/or with the most accuracy.

Materials:

Paper Football-
- Scissors
- Paper (various types with different rigidity)
- Tape
- *Optional- markers or colored pencils

Field Goal Posts-

- Popsicle sticks (x5)
- Tape or glue
- Binder clip

Football kicker- *optional
- Varies with design

Real World Connection/Resources:
Templates for making your football and field goal posts can be found here: Solve It STEM Challenges — Office of Maricopa County School Superintendent Steve Watson
Mark Rober Just Built a Robot Capable of Kicking the World's Longest Field Goal: World's Longest Field Goal- Robot vs NFL Kicker - YouTube
Why kicking a field goal is harder than it looks: Why Kicking a Field Goal is Harder Than it Looks | NOVA | PBS
Science buddies- the science behind a perfect kick: Field Goal! The Science Behind a Perfect Football Kick | Science Project (sciencebuddies.org)
PBS Kids- Field goal kicking machine: Build | Kicking Machine . DESIGN SQUAD GLOBAL | PBS KIDS
Explore on-demand interviews with professionals sharing their career journey and talking about their workplace: https://schoolsup.org/stem-pro-live
Connect with professionals to enhance real-world application and bring awareness to college and career pathways: educatorproconnect.org

Sequence of Instruction	
Define the Problem:	
Guided Questions	Teacher Notes
• What do you have available to work with when designing your solution? • What would a successful solution look like? How will you know if your design is successful? • What are your constraints or limitations? **Developing Solutions with Empathy** requires thinking about the problems from the perspective of the user. • **Who** is your solution intended for? • **What** are the challenges they are facing? • **How** is their current experience impacting their physical and emotional life? • Finally, you need to try to understand what is causing them to have this experience. Understanding the **Why** is the most critical step in developing a successful solution.	• Have your students start by building a paper football. • *a template has been provided with instructions. • Have your students attempt "kicking" the football and make observations about the current model. • *field goal posts can be made using materials listed above. • Have them attempt to "kick" for distance and/or accuracy and consider the benefits and challenges of using the model. • Next, have the students make observations and describe their experiences then define what they

	think the problem is with the current models. • *Remember to support developing an empathetic solution. • Establish your parameters (groups, roles, time limit, # of trials, amount of material allowed to use, etc.).
Research the Problem:	
Guided Questions	Teacher Notes

• What is already known about the problem?
• What are some current solutions that can be built upon/improved?
• What technology is available to help you understand the problem better?
• What are some obstacles, challenges connected to your problem?
• Who are you building the solution for?
	• Have students research the location where the testing will take place.
	  • How far does it need to travel?
	  • How high does it need to go?
	• Use the links in the real-world connections to learn more about field goal kicking and the science involved.

Brainstorm Possible Solutions:	
Guided Questions	Teacher Notes
• How many ideas can you come up with individually? • How many ideas can you come up with as a group? • How can you use/build on the groups ideas to refine your own?	• Have students individually come up with at least 2 possible designs that they could use to improve the kick (distance and/or accuracy). • Have students share designs with a group. **Encourage a variety of ideas and a safe environment.* • Encourage reflection and refinement of ideas
Choose the Best Solution:	
Guided Questions	Teacher Notes
• Which solution(s) could you build using the materials/time you have available? • Which solution(s) could you build considering the constraints/ limitations? • Which solution do you think has the best chance to be successful?	• Have students choose a design and make a plan to "build" a new model.

Build a Model or Prototype:	
Guided Questions	Teacher Notes
• What materials will you need? • Does your design meet the lesson objective? • Does your design clearly communicate your selected solution to the problem?	• Revisit the objective and make sure the students design matches their intended solution to the problem. • Is their choice based on thinking empathetically as to what the user would want?
Test your Solution:	
Guided Questions	Teacher Notes
• Did you record your observations? • How will you know if your design worked as intended? • How will you know if your design was successful?	• Have students make and record observations during their trial(s). • Encourage students to stay true to their design and not make modifications while testing without first recording what they are changing and why.
Communicate your Solution:	
Guided Questions	Teacher Notes
• Did your design work as intended? How do you know? • Did it solve the problem that you identified? How do you know? • Do you still think your solution is the best one for the problem? Why or why not? • What would you different if you could do it again? Why?	• Have students reflect individually and then record responses. • Have students share responses with their group then whole class. • To make iterations, you will want to re-enter the Engineering Design Process and begin thinking about defining the problem(s) they had with the initial idea. • The purpose is to provide a process for them to formalize their thinking and not rely on trial and error to merely accomplish a task. • Take a picture or video of your final design and email us at: stem@maricopa.gov