Engineering Design Process

Teach 1	Names of student(s) teaching:
Teach date: Teach time: Teach length:	Title of lesson: Engineering Design Process (cont'd.) Source (Kit, Lesson, Page #):

Concept statement/Main idea:
Student teams are challenged to navigate a table tennis ball through a timed obstacle course using only the provided unconventional "tools." Teams act as engineers by working through the steps of the engineering design process to complete the overall task with each group member responsible to accomplish one of the obstacle course challenges. Inspired by the engineers who helped the Apollo 13 astronauts through critical problems in space, students must be innovative with the provided supplies to use them as tools to move the ball through the obstacles as swiftly as possible. Groups are encouraged to communicate with each other to share vital information. The course and tool choices are easily customizable for varied age groups and/or difficulty levels. Pre/post assessment handouts, competition rules and judging rubric are provided. https://www.teachengineering.org/activities/view/ucd_derbytool_activity1

Standards for the lesson:
Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Objectives	Evaluation
Write objectives in SWBAT form	Write at least one question to match the objective you listed or describe what you will look at to be sure that students can do this.
SWBAT **apply** the engineering design process to their obstacle course that will successfully allow the ball to roll through it.	1. Which of the following is NOT a part of the engineering design process? A) Redesign as needed B) Build a prototype C) Research the problem

	D) Develop one solution
SWBAT **discuss** changes that were made to their engineering design.	2. What changes were made to your engineering design plan after your initial run?

Engagement

Estimated time: 5 minutes

Description of activity: The teacher will have the students recall the Engineering Design Process and will demonstrate a video of Apollo 13 and the problem it had onboard.

What the teacher does	What the student does	Possible questions to ask students — think like a student and consider possible student responses
The teacher will have the students recall the engineering design process from Tuesday's lesson. After the students recall the engineering design process, the teacher will introduce Apollo 13 and the incident that occurred onboard. The teacher will ask questions about Apollo 13 and how the Engineering Design Process plays a role in how the issue was fixed.	The student will recall the Engineering Design Process and will answer the teacher's questions.	You may have heard of the Apollo 13 mission, do you know what happened on board the space shuttle? How important was it for the people at Mission Control and onboard Apollo 13? Do you think they agreed on everything they were saying? How do you think the Engineering Design Process played a role in how the issues aboard Apollo 13 was resolved?

Resources needed:

Powerpoint

Safety considerations:

Exploration

Estimated time: 25 minutes

Description of activity: Students will work in groups, with each member assigned to a specific obstacle, and will work together as a team to try to get their tennis ball to the end of the obstacle. Students are not allowed to touch the tennis ball with their hands and can only use the given “tools’” that are provided.

What the teacher does	What the student does	Possible questions to ask students — think like a student and consider possible student responses
The teacher will demonstrate the obstacle to the students and will give them 10 minutes to design their plan and to determine which tools will be utilized to complete their obstacle challenge. At the 10 minute mark, students will test their design idea and will have a minute and thirty seconds to complete their obstacle course with the help of their “tools”. At the end of the explore, students will be told that they will have the opportunity to redesign. They will have 5 minutes for the redo and will have another 5 minutes to test out their final design. *NOTE: The competition rules will need to be changed depending on what supplies	The students will discuss their plans and write it out on their worksheet, and will determine which tools will be utilized.	Why did you pick those specific tools? What tools will you use in your redesign? What tools won’t you use in your redesign? What worked well in your initial design? What did not work well in your initial design?

are used and how the obstacle is set-up. *NOTE: You, as the teacher, will have the opportunity to design the obstacle course PRIOR to your teach. However, for each mini obstacle within your lesson there will have to be one person assigned to said obstacle. Ex. If there is an incline, a ramp, a maze, and a drop then there will be four people in the group with each person assigned a specific mini obstacle.		

Resources needed:

- Pre-set up obstacle course
- Tools
- Worksheet

Explore Worksheet Link
Explore KEY
Competition Rules

Safety considerations:
Be careful with any sharp objects.
Be careful with any heavy objects.

Explanation

Estimated time: 10 minutes
Description of activity: Students will explain what worked well and what did not work well in their design and redesign.

What the teacher does	What the student does	Possible questions to ask students — think like a student and consider possible student responses

The teacher will have each group explain what ”tools” worked well in their design and re-design. The teacher will also ask what was the most difficult part of the Engineering Design Process.	The student will explain their Engineering Design Process and their design and redesign.	What changes were made in order to successfully complete the obstacle course? How many “tools” did you switch out for the redesign? Why did you not make any changes to your “tools”?

Resources needed:
The groups design and redesign processes, along with their results.

Safety considerations:

Elaboration

Estimated time: 10 minutes
Description of activity: The teacher will connect the Engineering Design Process to situations that are used in everyday life.

What the teacher does	What the student does	Possible questions to ask students — think like a student and consider possible student responses
The teacher will ask the students to connect their design and redesign to everyday situations. Other than the Apollo 13 incident where else would the Engineering Design Process be a crucial factor with various people working together?	The students will connect the Engineering Design Process to real-life situations.	What common design and redesign concepts can you think of? How important is a design and redesign concept? How many more redesign attempts do you think you would need to have successfully completed the obstacle course?

		Why do things have to be redesigned?

Resources needed:
Power Point

Safety considerations:

Evaluation

Estimated time: 5 minutes
Description of activity: Students will complete the evaluation quiz on their own and will turn it in when finished.

What the teacher does	What the student does	Possible questions to ask students — think like a student and consider possible student responses
The teacher will distribute the evaluation quiz and have the students complete the quiz on their own.	The students will complete their evaluation quiz on their own and turn it in when they are finished.	

Resources needed:
Evaluation Quiz
KEY

Safety considerations:

Name: _____ Date: _____ Class: _____

Engineering Derby: Tool Ingenuity

1. Prior to beginning the obstacle list out which member of your team is in charge of what obstacle.

2. List out what "tools" you will be using for each part of the obstacle and explain why you will be using it.

3. After you completed the obstacle course for the first time, what did you talk about during your post-trial meeting? Did the meeting help your team or not? How did it help (or not help) your team? What did you do differently during your second attempt at the course? =

4. Explain, sketch and label a new obstacle course for the Engineering Derby. What challenges does the obstacle course have?

5. Susan and José disagree about which tool to use for the first obstacle. How would engineers resolve the disagreement?
   A. Whoever speaks the loudest wins the argument.
   B. José should be polite and not argue.
   C. Make a list of the pros and cons for each tool.
   D. All of the above.
6. Engineers who design projects and invents must consider many constraints. A constraint is a type of requirement, restriction or limitation. Name three constraints you faced during the activity.

Name: _____ Date: _____ Class: _____

Engineering Derby: Tool Ingenuity
Post-Assessment

Answer Key

1. Prior to beginning the obstacle list out which member of your team is in charge of what obstacle.

2. List out what "tools" you will be using for each part of the obstacle and explain why you will be using it.

3. After you completed the obstacle course for the first time, what did you talk about during your post-trial meeting? Did the meeting help your team or not? How did it help (or not help) your team? What did you do differently during your second attempt at the course? (***max 5 points***)

   Expect students to summarize what was discussed during the post-job meeting. The ideal response relates the meeting topics to the obstacle course trial performance and identifies subsequent changes the group decided to make as a result of the meeting discussion.

   Give 2 points for a summary.
   Give 1 point if it was stated that the meeting was either helpful or not helpful.
   Give 2 points for describing a change made during the next obstacle course run.

4. Explain, sketch and label a new obstacle course for the Engineering Derby. What challenges does the obstacle course have? (***max 5 points***)

   Expect students to act as engineers and provide clearly labeled drawings (schematics) of a proposed obstacle course, along with explanatory text.
   - Give 2 points for explaining the obstacle.
   - Give 2 points for a sketch.
   - Give 1 point if the sketch is labeled.

5. Susan and José disagree about which tool to use for the first obstacle. How would engineers resolve the disagreement? (***max 1 point***)
   A. Whoever speaks the loudest wins the argument.
   B. José should be polite and not argue.
   C. Make a list of the pros and cons for each tool.
   D. All of the above.

6. Engineers who design projects and inventions must consider many constraints. A constraint is a type of requirement, restriction or limitation. Name three constraints you faced during the activity. (***max 3 points***)

   Expect students to write down some of the many constraints that applied during the event.
   - Give 1 point per constraint listed, up to a maximum of 3
   - Examples: the time limit, the table tennis ball may not touch the participant's body, a tool can be used for only one obstacle, no more than two tools may be used per obstacle, as well as any other obstacle course rules that resulted in penalties if broken.

Total possible points = 14

Name: _____ Date: _____ Class: _____

PLEASE NOTE: The obstacle course and tools will need to be adjusted according to what materials will be provided for the lesson!!

Engineering Derby: Tool Ingenuity
Competition Rules

Challenge Description
Teammates move a table tennis ball through an obstacle course using only the provided tools.

Materials
Each team receives an envelope filled with the same 12 tools.

Competition Rules

1. Only the 12 provided tools may be used. The tools may not be permanently modified.
2. The table tennis ball must be moved through the obstacle course with 6 challenges in the following order: lifting the ball from the floor to a 3-foot-tall table > moving the ball across a 3-foot-long table > carrying the ball across a 1-foot-wide gap to an inclined table > moving the ball along a 15°-incline 3-foot-long table > moving the ball down a 5-foot-long ramp to the floor > pushing through a 3-foot-long tube. Note: Dimensions are approximate.
3. During the competition, only the active team is permitted in the obstacle course room.
4. The judge walks the participating group through the course, explaining each obstacle.
5. After handing out the tools, the judge starts a stopwatch. The competitors may test the use of the tools (not on the actual obstacle course or table tennis ball) for 1 minute before attempting the course. At this time, the team assigns obstacles to its members. Each competitor must have 1-2 tools. After the competitor receives his/her tools, s/he may not exchange them.
6. Prior to starting the course, the team must line up in order with its respective obstacle, with each competitor holding 1-2 tools. Each obstacle must be cleared by a single competitor. After starting, competitors may not switch tools with their teammates. Each competitor may only use his/her 1-2 tools.
7. If the table tennis ball falls off of the obstacle course, the current obstacle must be restarted.
8. If any competitor touches the ball with anything other than the provided tools, the current obstacle must be restarted and the team is given a 30-second penalty.
9. The judge stops timing when the ball clears the final obstacle. A 10-minute time limit is enforced. If the team has not completed the obstacle course by this time, a 30-second penalty is given for each uncompleted obstacle.

10. After its first trial, the team reconvenes for 15 minutes to discuss how to improve its course performance.
11. Then, each team re-runs the obstacle course a second time.
12. To conclude the competition, the team with the fastest time wins.

Name:_____
Date:_____

Apollo 13 Engineering Design Process QUIZ

1. **Which of the following is NOT a part of the engineering design process?**
   A) Redesign as needed
   B) Build a prototype
   C) Research the problem
   D) Develop one solution

2. **What changes were made to your engineering design plan after your initial run?**

3. **Susan and José disagree about which tool to use for the first obstacle. How would engineers resolve the disagreement?**

A. Whoever speaks the loudest wins the argument.
B. José should be polite and not argue.
C. Make a list of the pros and cons for each tool.
D. All of the above.

Name:_____
Date:_____

Apollo 13 Engineering Design Process

KEY

1. **Which of the following is NOT a part of the engineering design process?**
   A) Redesign as needed
   B) Build a prototype
   C) Research the problem
   D) Develop one solution

2. **What changes were made to your engineering design plan after your initial run?**

3. **Susan and José disagree about which tool to use for the first obstacle. How would engineers resolve the disagreement?**

A. Whoever speaks the loudest wins the argument.
B. José should be polite and not argue.
C. Make a list of the pros and cons for each tool.
D. All of the above.