STEM Lab Lesson Plans

3rd- 5th Grade Introduction to Engineering Design Process

Standard: Science & Engineering Practices: 3.S.1, 4.S.1, 5.S.1

Objective: Students will explore the steps of the Engineering Design Process by applying them to a challenge

Ignite Curiosity: What do you think an engineer is or what is engineering? (Think / pair/ share) in small groups; groups share, then debrief characteristics of engineers

Investigate: Show class a picture of a picnic scene. Small groups identify (grade 3) or classify (grades 4&5) 5-10 items that have been engineered in the picture. Share ideas. Discuss many types of engineering.

The Engineering Design Process (Powerpoint)

Engage with video: NASA Engineering Design Process (grades 3&4) or Engineering a Taco Party (grade 5), while students fill in Graphic Organizer

Apply the EDP:

ASK: Create a boat that will hold ten passengers and float (grades 3&4) or Create a flinker that will not float or sink (grade 5)

Identify criteria and constraints as a whole group

IMAGINE: Students independently brainstorm ideas for solving the challenge. They draw diagrams of ideas, labelling materials outlined in the constraints.

PLAN: Groups collaborate to put their ideas together into a clear plan, labelled with materials and amounts.

CREATE: Members of groups fulfill roles to collect materials and build prototype according to their plan.

TEST: Test boats or flinkers and record data on floating time, passengers held, and/or flinking time.

IMPROVE: Groups revise plans and devices and retest. Evaluate the impact that the improvements had on the results.

Invite Connections: Students reflect on the design process, how well their changes improved the results, or what changes they would make if given more time

Assessment: Written aspects of EDP evaluated for consistency with challenge, and written reflections evaluated for application of results, Graphic organizers recording the steps of EDP in introduction are also evaluated for accuracy.

1st Grade "Punkin Chunkin" Catapult Challenge using the Engineering Design Process

Standard: Science & Engineering Practices:1.S.1B.1 Construct devices or design solutions to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the devices or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem, and (6) communicate the results.

Objective: Students will create catapults to launch pumpkin.

Ignite Curiosity: Introduce the Punkin Chunkin Challenge by watching a video clip of the real annual Punkin Chunkin Contest.

Investigate: Introduce the STEM challenge using a teacher created flipchart.

ASK: Present challenge - Who can make a catapult to launch a pumpkin the farthest?

IMAGINE: Students work independently to brainstorm ideas for creating a catapult using the materials available.

PLAN: Students synergize to develop a plan for their collaborative catapult.

CREATE: Members of groups fulfill roles to create catapults.

TEST: Each student completes a trial test on his/her team's catapult. Record data about how far the pumpkin was launched.

IMPROVE: Groups make changes for any necessary changes needed and retest to see whether changes improved results.

Invite Connections: Groups compete to find the class winner, whose catapult travels the farthest distance. Students reflect on the design process, how well their changes improved the results, or what changes they would make if given more time.

Assessment: Observation of participation in steps of EDP, and student reflections.

2nd Grade Wind Sail Challenge using the Engineering Design Process

Standard: 2.S.1A.2 Develop and use models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.; 2.E.2A.3 Develop and use models to describe and compare the effects of wind (moving air) on objects.

Objective: Students will explore models and materials to research how to make a wind sail that will harness the wind.

Ignite Curiosity: Video: “Always On-Flying on the World’s Fastest Sailboat”

Debrief on what mechanical engineers are, and students' previous knowledge of ways we use the wind.

Investigate:

ASK: Create a windsail that will go the farthest during a 10-second time period.

IMAGINE: Using the “Be the Mechanical Engineer” sheet, students will break into groups of 4 to experiment with the materials to determine what would work best as a wind sail. Groups will discuss what shapes they feel will work best for the sail.

PLAN: Groups will draw and label their plans for creating a wind sail.

CREATE: Students fulfil roles (materials manager, speaker, timekeeper, recorder, etc.) to create wind sail according to their plan.

Invite Connections:

TEST: A group-appointed speaker from each group will explain their reasoning for choosing their materials and shapes. Groups will then test their sails.

IMPROVE: Groups will have 15 mintues to discuss modifications and make improvements to their sails. Groups will then test again to see if their sail design improved from the first test.

Regroup, and students reflect on their observations, what they would do differently if given more time, and what real-life connections can be made to these observations.

Assessment: Student reflections in relation to Engineering Design Process

3rd Grade Explorer Ship (Product) Challenge using the Engineering Design Process

Standard: Science & Engineering Practices: 3.S.1, 3rd Grade Social Studies 3-2 (understand exploration and settlement of South Carolina)

Objective: Students will use common materials to float a ship across the "Atlantic Ocean."

Ignite Curiosity: Review previous knowledge of five explorers; review where explorers came from, how they traveled, and what their goals were

Investigate: Present challenge (slides)

ASK: How can we create a boat to carry an explorer from his home country across the Atlantic Ocean to South Carolina?

IMAGINE: Students work independently to choose an explorer, determine why he is their choice and his home country, and brainstorm ideas for creating a ship that will be wind powered.

PLAN: Students synergize to combine their ideas into one clear plan, labelled with materials and amounts of each.

CREATE: Members of groups fulfill roles to collect materials and build prototype according to their plan.

TEST: Test boats and record data on whether it held explorer, had flag of home country, and traveled across the Atlantic Ocean in under 30 seconds.

IMPROVE: Groups revise plans and devices and retest. Evaluate the impact that the improvements had on the results.

Invite Connections: Students reflect on the design process, how well their changes improved the results, or what changes they would make if given more time.

Assessment: Written aspects of EDP evaluated for consistency with challenge, and written reflections evaluated for application of results.

5th Grade Assembly Line (Process) Challenge using the Engineering Design Process

Standard: Science & Engineering Practices:5.S.1, 5th Grade Social Studies 5-3.1 (technologies during the Industrial Revolution) and 5-4.1 (standard of living improvement post-WWI)

Objective: Students will compare individual manufacturing speed for a catapult to manufacturing speed using an assembly line process. “How does using an assembly line affect production speed?”

Ignite Curiosity: Demonstrate creation of catapults and how they use forces and mechanical advantage to propel projectiles farther; Present challenge - to make as many of these as quickly as we can.

Investigate: Students watch BrainPop video about Assembly Lines to review the process that was developed during the Industrial Revolution. Students share ideas about what assembly lines were used to create and how they were beneficial.

ASK: How can we make the most catapults possible (to quality standards) within a given amount of time?

IMAGINE: “Control” test - Students work independently to create as many catapults as possible, start to finish, in 5 minutes. Immediately after 5 minutes ends, they reflect on which steps were easiest and which were most time-consuming.

PLAN: Students synergize to develop an assembly line plan, assigning particular steps in the building process to each student.

CREATE: Members of groups fulfill roles in the assembly line to create catapults, again within 5 minute time limit.

TEST: Record data about how many catapults were created using assembly line process, and compare to the number of catapults made by the same number of students when working independently.

IMPROVE: Groups revise plans for assembly line process (which student has which role), and try process one more time for 5 minutes. Compare data and whether process has made catapult-making more efficient.

Invite Connections: Students reflect on the design process, how well their changes improved the results, or what changes they would make if given more time. Also, application is made to a factory setting, and how more catapults made in the same amount of time would drive costs down, allowing goods to be produced less expensively.

Assessment: Written reflections evaluated for application of results.