PLASTIC OCEANS: ADRIFT IN A SEA OF PLASTIC

Lesson 3: Engineering 101

AUTHOR

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DESCRIPTION

This lesson is designed for three 50-minute sessions. The students will engage in multiple mini-engineering challenges to develop their understanding of structures and how to build models. The students will also learn to use the 3D pens to create a 3D object.

GRADE LEVEL(S)

5^{th} – 8^{th} grade

SUBJECT AREA(S)

Engineering, 3D pen, PLA, building, tinkering, newspaper challenge,

ACTIVITY LENGTH

3, 50-minute sessions

LEARNING GOAL(S)

1. Students will understand some basics of engineering.
2. Students will become familiar with 3D pens and how to use them.

CONTENT BACKGROUND

STUDENT BACKGROUND

Students will have completed the TinkerCAD tutorials and boat project. This will give them an understanding of how 3D plastic material is built on itself to create structure.

Students should have some background in the engineering design process. If they do not, you may want to consider extending Days 1-2 by one day in order to engage in a discussion of engineering design. See Extensions below for details.

EDUCATOR BACKGROUND

Educator will want to be familiar with the Galloping Gurdy story. Also, the educator will want to play with the 3D pens and be familiar with troubleshooting and other technical difficulties that may arise.

MATERIALS NEEDED

Classroom Supplies

- Computers with USB to power the pens or power strips for plugging in 10-15 3D pens.
- 3D pens (at least 1 for every pair of students) and filament
- Newspaper
- Spaghetti noodles
- Masking tape
- String
- Marshmallows (large)
- Participation Quiz: Available on the CE Online Educator Library https://drive.google.com/file/d/1hQmOFsYpF6xs0hBiQWONZVNRdFZ6vwb9/view?usp=sharing

Handouts/Paper Materials

- Galloping Gertie video: https://youtu.be/j-zczJXSxnw?si=KYJHFIsDiGglTjtD
- Engineering Challenges handouts: Available on the CE Online Educator Library and at https://drive.google.com/file/d/1w_OxN8lVhmXPuekTdiaEcQ-qr7ARYWuM/view?usp=sharing

Activity Supplies

- Video of 3D pen in use: https://youtu.be/chq9NiQ86NI
- Templates for 3D pens for inspiration and practice: https://www.mynt3d.com/blogs/projects/beach-themed-projects-made-with-a-3d-printing-pen
- Stencils for 3D pens: https://learn.the3doodler.com/stencils/

LESSON PROGRESSION

PLANNING AND PREP

This lesson is designed to last 3 days.

Day 1: **Intro to lesson phenomenon (engineering disaster),** watch video of Galloping Gurdy crashing down. Take the newspaper challenge and reflect on success and failures.

Day 2: **Spaghetti and marshmallow challenge,** students will work in small groups to complete several spaghetti and marshmallow challenges.

Day 3: **3D Pen Challenge,** Students will work in pairs to create 3D objects using stencils/templates with the 3D pens. The challenge will be to create one object each.

LESSON SEQUENCE

Day 1: Background Information and Newspaper challenge

1. (10 min) Warm-up: Students will watch a short video and explanation of Galloping Gurdy (The original Tacoma narrows bridge that famously failed). This is a good time for introducing/re-introducing the engineering design process and briefly assessing student understanding of the design process.
2. (5 min) Pass out instruction sheet for newspaper engineering challenge and put students in small groups. Set expectations for work time using the participation quiz guidelines and Engineering Design principles.
   (5 min) Design time: have each group draw a design for what they are going to build
3. (15 min) Build time to build newspaper stools.
4. (5 min) Test stools
5. (10 min) Redesign stools and retest

   Note: add a second day if needed to complete the challenge.

Day 2: Spaghetti and marshmallow challenges

1. (5 min) Put students into small groups and pass out directions. Set expectations for work time using the participation quiz guidelines and Engineering Design principles. This is a good opportunity to scaffold engineering techniques by expanding time for identifying the problem and designing.
2. (25 min) Have supplies portioned out for each group and have groups get right to work on the spaghetti and marshmallow challenge.
3. (10 min) Have students share out successes and failures and reflections on their work in terms of the Engineering Design process
4. (10 min) Have students redesign based on other team's successes and failures.

Day 3: 3D pens

1. (5 min) Students will watch a short video of children using the 3D pens, and get into pairs (noted above).
2. (5 min) Teacher will pass out 1 pen and PLA material to each pair of students
3. (35 min) Students will work together to create a 3D object each using a template.

4. (5 min) Students will share out their 3D pen created objects. Ensure that there is discussion around the idea of varying types of models and prototypes during an engineering design process.

ASSESSMENT AND EXTENSIONS

FORMATIVE ASSESSMENT

- The teacher should evaluate teamwork using participation quizzes throughout the 3 sessions.
- The end product of the newspaper challenge will be a good formative assessment at the end of day 1 as well as the end products from the spaghetti challenge on day 2.

SUMMATIVE ASSESSMENT

The completed 3D pen challenge.

LESSON EXTENSIONS

- More engineering challenges can be found on the Internet and use similar or the same materials. The 3D pen challenge could also be adjusted to be more difficult or less challenging depending on the formatives from the previous lessons.
- If your students need more exposure to engineering more sessions may be in order, including extending Day 1 and 2 to be a scaffolded intro to engineering design and an intro/discussion of the engineering design process to assess/activate student knowledge, define expectations and address misunderstandings.