Ozobot Meets 3-D Printing (Art Challenge)

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Target Grade Level: 6-9, Science

Time Required: 2-90 minute class periods (180 total minutes)

Standards:

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

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.

Objectives:

Students will

- Use the engineering design process and 3-D printing to create and evaluate a tool that allows an Ozobot to draw its path.
- Utilize computer coding to write and execute a code that can be used in conjunction with the tool created by the 3-D printer in order to create a unique piece of artwork.

Materials Needed:

- Ozobots (ideally 1 per pair of students, however, if resources are limited, lesson can be completed with only 1 Ozobot for the entire class)
- Computers with internet access (ideally 1 per student, 1 per pair/group could also suffice if individual parts of lesson were completed as group work)
- 3-D printer with filament
- Attached Handout – 1 per pair of students
- Pencils/Pens

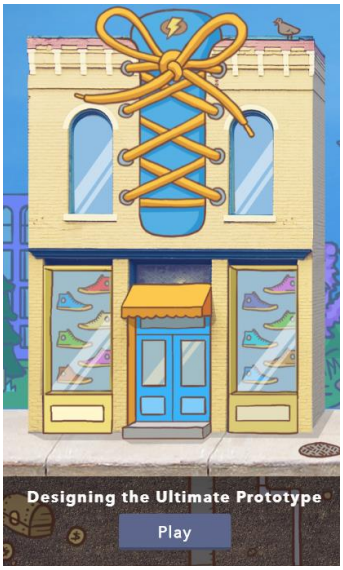
- Scratch Paper
- Free Everfi Account – www.everfi.com
- Free Tinkercad Account - www.tinkercad.com

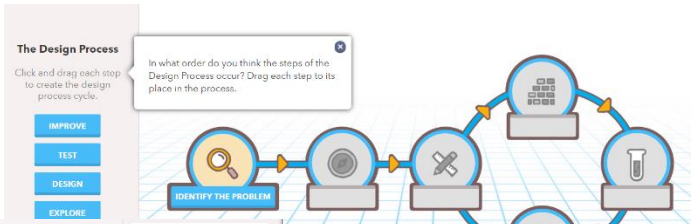
Prior Knowledge: This lesson is best for a class that has already worked some with Ozobots in the classroom and understands the basics of coding with the Ozobot. This lesson is an introduction to 3-D printing not Ozobot coding.

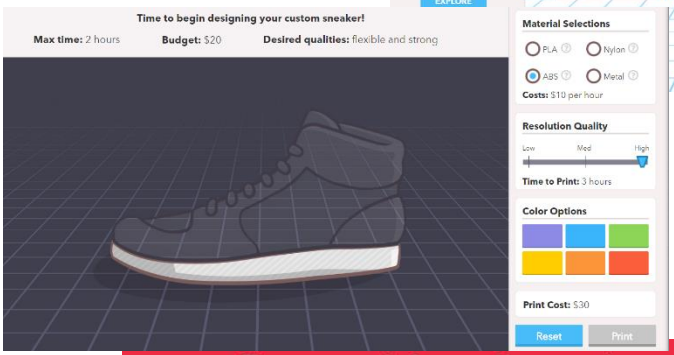
Introduction: (Approximately 20 Minutes/Alternately Could Be Completed Outside of Class As A Prerequisite):

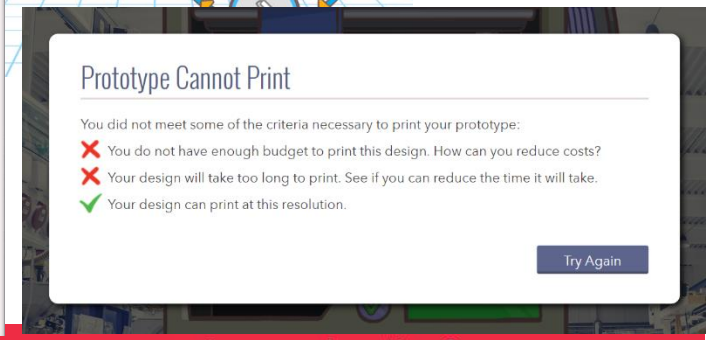
Teacher informs students that they will be completing a challenge that requires them to use the engineering design process and 3-D printing. She specifically introduces them to the challenge (**Challenge:** Use your Ozobot to create a unique piece of artwork. Step 1: With your partner create and print an Ozobot accessory that allows Ozobot to hold a pen, pencil, or marker that can draw the path of the Ozobot. Step 2: Individually create a unique code for the Ozobot to follow while holding the pen that makes a piece of art.) but lets them know that to get a refresher on engineering design process and an introduction to 3-D printing they will have to design their own sneaker! They will individually complete a 20 minute online course (Endeavor-STEM Career Explorations - https://everfi.com/offerings/listing/endeavor-stem-career-exploration/) on a website called Everfi. This program has students design their own sneaker while paying attention to limitations and criteria such as cost, material structures, and print time. It also introduces students to the parts of a 3-D printer.

Below are a few snapshots from that program.









1. Once both students in student pair have completed their individual Everfi course, they will begin step 1 of the challenge discussed in the intro. Students will complete this process by following the procedure outlined in the attached handout. Here are the basic steps.
   a. Search "Ozobot" on thingiverse.com to determine what accessories have already been created (1-2 minutes)
   b. Find an accessory that would be easy to modify for the purpose described in the challenge (5 minutes)
   c. Upload the file to tinkercad.com (3-4 min.)
   d. Modify the file in tinkercad (45 min.)
   e. Submit file to teacher for printing or begin printing with teacher permission (5 min.)

   (Note: teacher may need to stop and model a few aspects as the lesson progresses. For example, teacher may show students how to download and upload files needed. Teacher may also show a quick demonstration of how to modify objects in tinkercad.)

2. While students wait for item to print, they may begin writing their code to create a piece of art. Students will go to https://ozoblockly.com/editor?lang=en&robot=bit&mode=4 and write a code (individually) that makes the Ozobot move in a unique way.
3. They may upload their program to the Ozobot at any time to test out their code and modify as needed. (Approximately 30 minutes. Timing will vary, students who claim to be "done" should be encouraged to test out and add more)
4. Once their 3-D accessory has printed (probably the next class period) students will test out their new accessory and evaluate its effectiveness. They will also complete the questions 9-10 on their handout. (Approximately 10 minutes)
5. Students will run their code with their newly created accessory to create their piece of art and potentially tweak their code until they are satisfied with the outcome. (30 minutes)

Closure: Students groups will reflect on how they used the engineering design process and coding to create the accessory and unique piece of artwork by presenting the following to their class: their new accessories, the challenges and successes in the process, modifications they would make in future designs, and how they made their artwork. Following presentations, they will answer the final two questions on their handout (20 minutes)

Assessment

Individual – Students will be given a 10 question pretest and posttest during their Everfi (Introduction) course. These both serve as a **formative assessment** specifically focused on the engineering design procedure and 3-D printer vocabulary and processes that will be important for them to complete the rest of the lesson. Students will be required to score at least 80% on the post test in order to move to the next assignment. Students will be able to retake however 10 questions are chosen at random from a bank of 30 so the retake will not be the exactly same. A list of the questions and answers are available for anyone who signs up for an Everfi teacher account.

The coded art work will serve as an individual **summative assessment** of coding ability and creativity for each student.

Team- The Ozobot Art Student Handout will serve as a **formative assessment** that leads student through the engineering design process. It will be graded question by question.

The 3-D printed accessory will serve as the **summative team assessment** for this lesson. It will be graded using the rubric below.

	Below Expectations	Meets Expectations	Exceeds Expectations
Design (80pts)	Students' 3-D printed accessory doesn't fit Ozobot or in unable to hold the pencil and draw even after modifications in the classroom. 0----------27----------55	Students' 3-D printed accessory fits Ozobot and correctly holds the pencil to make art AFTER some modification made post printing (ex. Students had to make the pencil bigger by wrapping tape around it) 56----------63----------70	Students' 3-D printed accessory fits Ozobot and correctly holds the pencil to make art WITHOUT additional modification after printing. 71----------75----------80
Teamwork (20pts)	Some team members didn't contribute their fair share. Team required much intervention/redirection from teacher. 0----------7----------14	All team members contributed to project in a meaningful way. Team required minimal redirection from teacher. 15----------16----------17	Team members took on appropriate rolls and contributed equally toward the success of the project. No teacher redirection needed. 18----------19----------20

Differentiation Strategies: This lesson can be modified in a number of ways to tailor to classes at different skill levels and for individual students with different skill levels.

- Everfi "Sneaker" introductory lesson could be done as a whole class as a teacher demo either to save time or for a class that may need extra guidance in navigating through the program.
- Advanced classes and/or students comfortable with the Everfi program could complete the "Sneaker" lesson as homework the night before.
- ELL students can be provided with a glossary of key terms from the Everfi program which they can refer back to as needed.
- When students complete their individual Everfi assignment and are waiting for their partner to finish to start Step 1 of the challenge, the finished student should be encouraged to start exploring/creating/doing free tutorials in tinkercad in order to get a handle on how that program works.
- All students will be given an opportunity to redo their Everfi assessment. However, if a student is still having difficulty they may be given extended time outside of class to complete the assignment. This may be particularly beneficial for some students in Special Education or ELL students.
- Additionally, students are grouped so that students with greater skill in technology are paired with students who are weaker in technology.
- Teacher should stop and explain points of confusion to whole class when relevant.
- Teacher should have a printed accessory that works made ahead of time to show students who need the extra support.
- For the coding, students can use any of the levels of ozoblockly coding from beginner to masters based on the classes or individual students coding ability. Students could self select the appropriate code level or teacher could assign based on ability. (Ex. Mark's art code needs to use code level 3, while Jared

should incorporate aspects of code level 4)

Integration of STEM + Art = STEAM

S – Students will be using computer science to complete their coding

T – Students will be using 3-D printers, Ozobots, and online learning modules in this lesson.

E – Students will be using the engineering design process to create a novel product

A – Students will write a program that creates a unique piece of art.

M - Students will be using math in the tinkercad program to create the correct scale for accessories. They will also have to position their object on the coordinate plane.

Names: _____

Ozobot Art Student Handout

Challenge: Use your Ozobot to create a unique piece of artwork.

Step 1: With your partner create and print an Ozobot accessory that allows Ozobot to hold a pen, pencil, or marker that can draw the path that the Ozobot follows.

Step 2: Individually create a unique code for the Ozobot to follow while holding the pen that makes a piece of art.

Work with your partner to follow the procedure and answer the questions below to guide you through Step 1 of your Ozobot Art challenge.

1. ID the Problem: Restate the challenge you have been given in your words.

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2. ID the Problem: What are the limitations and constraints you need to consider when trying to solve this problem?

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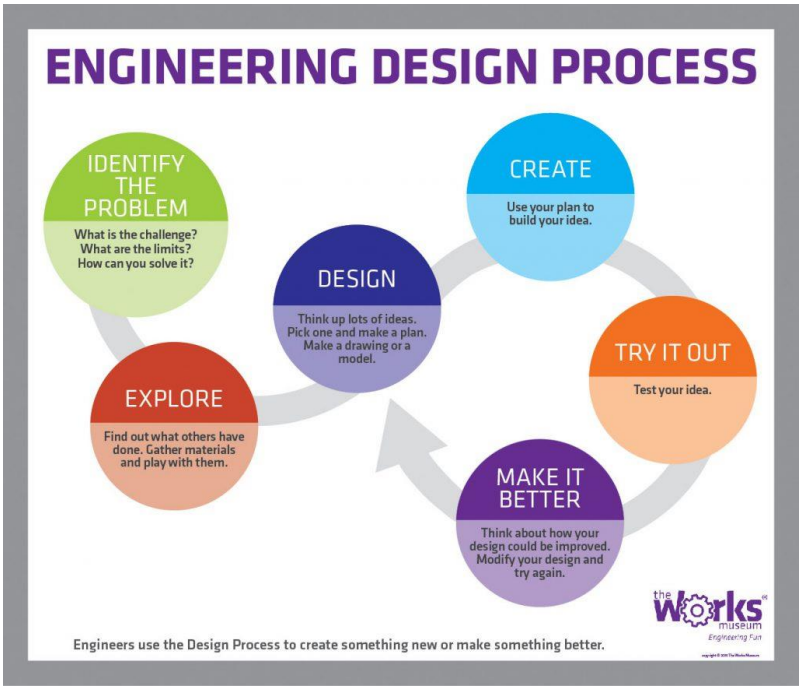

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3. Explore: Go to thingiverse.com and search "Ozobot" to see if others have already invented device that solves your problem. Describe what you found when you did your search.

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4. Design: Choose one of the accessories already created on thingiverse that you think you could modify in order to allow it to hold a pen. What is the name of the design that you have chosen to modify?

   _____

5. Design: Describe why you think the design you listed above is the best option for modification.

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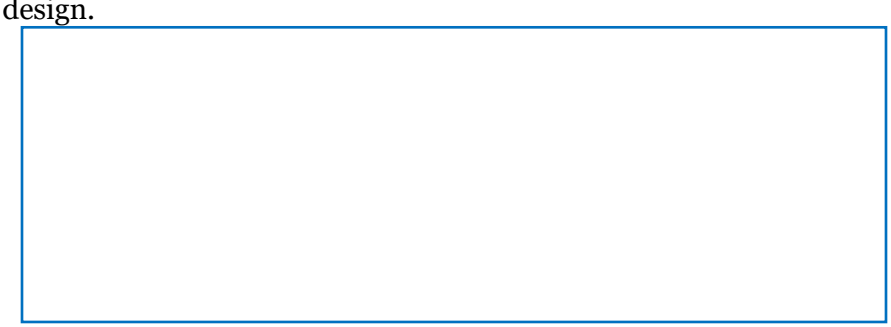
6. Design: Draw a picture below of the Ozobot accessory that you plan on creating by modifying this existing design.



7. Create: Download the files from thingiverse of the accessory that you plan on modifying. Then, open up tinkercad.com and upload your file/files. How will you determine that you have the correct size for your pencil holding mechanism?

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8. Try it out: Print your 3D model. See if it will hold and write with your writing utensil.
9. Make it better: Was your design a success? Provide evidence for your assessment.

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10. Make it better: What could you do to improve you design? (even it worked well, how can you make it even better?)

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11. Make it better: Based on your classmates presentations, what are some of the similarities and differences in the designs created by different groups?

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12. Make it better: Based on your classmates presentations, describe how different aspects of your

classmates designs could be combined to make an even better design.

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Resources:

https://theworks.org/educators-and-groups/elementary-engineering-resources/engineering-design-process/

www.ozoblockly.com

www.tinkercad.com

www.thingiverse.com

www.everfi.com