Access Your Potential®
Essential Eight Tech Experiences

3D Printing – Lesson plan
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**Objective:**
Students will explore the emerging technology of 3D printing. They will use innovative thinking and teamwork to imagine how 3D printing might be used to improve our lives.

Learn more about the Essential Eight [here](#) or check out the E8 Technologies Introductory Video linked in the Materials section below.

**Audience:**
High school and older.

**Essential question:**
How can 3D printing be used to improve our lives?

**Materials:**
- “3D Printing” visual handouts – 1 copy per student
- “Solving Problems Using 3D Printing” team design challenge handouts – 1 copy per small team of 3-4 students
- Whiteboard markers
- Mystery bags with 3-5 samples of 3D printed items (see below in Pre-Visit Prep for setup). Each bag will have only one item in it, so you’ll need one bag per item. Suggestions include:
  - Tesseract Hypercube
  - Mechanical Gear Heart Toy
  - Cuttlefish Toy
  - Augmented Reality Mars Model
- A laptop and portable 3D printer set to print a sample item during the lesson
  - Set the laptop and printer up on a table at the front of the room, and have the printer working on the sample item when the students come into the classroom. This will help them immediately begin to form a concrete understanding of the technology and will also build excitement and anticipation
- Various example YouTube videos showing how 3D printing works and its applications. (Note: Provide video links to the teacher ahead of time and ask the teacher about school video policies. See the “On showing videos in class” callout in Activity 1 for more information):
  - Consider sharing this [introductory video](#) on the Essential Eight Technologies (5:03 in length)  
    Password is ‘E8”
  - “What is 3D Printing and How Does it Work?” – (2:21 in length. A good quick overview of the technology)
  - “How Does 3D Printing Work?” – (7:36 in length. A longer overview video that goes into more depth on different printing materials, technologies, and applications)
Pre-visit prep:

• **Note:** It is highly recommended that you spend time learning to set up and use the portable 3D printer before working with students

• Set up the **Mystery Bags**. You’ll need one opaque bag for each sample item – so if you have four sample items you’ll need four mystery bags. The bags need to be large enough for the item to comfortably fit and for a student to put their hand in the bag and feel the item. Reusable shopping bags can work well for this. Place one item into each of the bags

• Work with the teacher ahead of time to **figure out a room arrangement** where the students can gather into groups of 4-5. These groups will carry out the group brainstorming work together in Activity 3. Knowing their students, the teacher may also want to pre-compose the groups in order to get the most out of the activity and minimize disruptions

• Gather a few interesting **stories of 3D printing use or technology developments from the news** in case there is time to share them during the lesson

• Print necessary **handouts**

Lesson length:

45 minutes
Considerations for facilitating virtually (via Google Hangout, WebEx, or Skype)

Much of this lesson can be delivered virtually via Google Hangout, WebEx, or Skype. The educator you are working with may have a preference on technology, so defer to them. Benefits of this include schedule flexibility for both the classroom and facilitator and elimination of travel time. Keep in mind the following elements when transitioning this lesson to a virtual format:

- Start off with a clear personal introduction - share with the students where you are (generally) geographically and some detail about your job and career journey. This will help develop a personal and engaging connection with the classroom. Consider teaching the class with a colleague as well!
- Make sure the video/sound is working well up-front!
- Share the printable handouts with the teacher in advance, as they will need to print and distribute on your behalf. Discuss with the teacher in advance what you will need and the timing on when to distribute the materials
- Edit Activities 1 and 2 – Since the students will not be able to see the portable 3D printer in person or peruse the sample objects, share both YouTube videos in order to expand their understanding of the technology. It can also be helpful if the teacher gathers 3D printed sample objects prior to the lesson. You can provide the teacher with this list of suggestions:
  - Tesseract Hypercube
  - Mechanical Gear Heart Toy
  - Cuttlefish Toy
  - Augmented Reality Mars Model
- Don’t be afraid to engage with the students by asking questions as you talk through the material!

Lesson outline

Introduction: (1 minute)
- As the students come into the room, encourage them to stop by the table at the front of the room and briefly watch the 3D printer at work
- Once they are seated, greet the students and introduce yourselves. Explain that you’re from [Company]. [Insert quick sentence or two about the Company]. Explain that you’re here to talk with them about some of the incredible emerging technologies that are changing our lives.

Activity 1: “What is 3D printing?” (12 minutes, Large group activity)
- Overview: Before telling the students what 3D printing is, get them thinking and talking right away by exploring what they currently know about 3D printing. Then add to their knowledge with further information
- Point to the 3D printer and ask the students, “Does anyone know what this thing is?” Most likely some if not most of them will know that it is a 3D printer. Follow up by asking questions like, “What’s this contraption doing?” “How does it do what it’s doing?” “How does it know what to print?” “What are these things used for?” In essence, you’re beginning the lesson by exploring what the students currently know about 3D printing rather than going straight into imparting information onto them. After each thought that a student offers, simply say, “Thank you!” Don’t affirm or disapprove of any suggestion so as not to increase students’ concerns about being wrong or making a contribution to the conversation
– Now have the teacher show a **3D printing overview video** from YouTube. Sharing these types of videos with students is key to helping them form a concrete, real-world understanding of what these devices are and can do.

### On showing videos in class:

Video policies vary from school to school. Check with the teacher ahead of time to make sure showing videos and using a channel such as YouTube are allowed at their school. Have the teacher preview and approve the videos ahead of time. Then have the teacher queue up the videos and play them on their equipment (rather than you showing them).

Also be mindful of ads and popups. Encourage the teacher to mute and block the video during any ads and turn off any popup ads as soon as they emerge or use a popup blocker.

### YouTube overview video:

- **“What is 3D Printing and How Does it Work?”** – (2:21 in length. A good quick overview of the technology. Start with this video, and if there is extra time at the end of the lesson the teacher can show longer video)
  - Video talking points:
    - 3D printing is changing the way we produce objects
    - Additive manufacturing – an object is created by adding material layer by layer
    - Smaller printers are bringing 3D printing into people’s homes and businesses
    - The first step in 3D printing is to make a blueprint of the object. You can create your own or download blueprints
    - Printers can print plastic, food, houses, and someday maybe even body parts and organs
- **“How Does 3D Printing Work?”** – (7:36 in length. A longer overview video that goes into more depth on different printing materials, technologies, and applications)

### Next, pass out the “3D Printing” visual handout and walk through it with the students. Quickly cover:

- Definition of 3D Printing
- Uses of 3D Printing
- Vocabulary examples:
  - Prototypes – Early versions of an idea made to gather feedback and improve the design. Print a car part to make sure it fits and works, print a scale model of a house to see the design in three dimensions, print a toy design to see how it feels to play with it
  - Prosthetics – Mechanical hands, arms, legs, and feet
- As you go over the handout, be sure to point out thoughts that the students already covered, which will help them feel heard and validated
3D Printing

What is 3D Printing?
Called an “additive manufacturing technology,” 3D printing uses digital models and different types of “inks” to print three dimensional objects. These machines build up layer upon layer of materials such as plastic, resin, metal, glass and even living cells until an object is formed.

What is 3D Printing used for?
3D printers can be set up and used in factories, schools, hospitals, construction sites, and many other places.

- Designers print prototypes of their ideas to quickly test them
- Engineers print mechanical parts for cars, airplanes, and space ships
- Astronauts print tools or parts to repair their space station
- Healthcare workers print prosthetics and someday may be able to print human organs, like hearts and lungs
- Aid workers will be able to quickly print homes for disaster areas or to house the homeless
- Someday you may be able to print food in your own kitchen

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Activity 2: “Mystery bag” (10 minutes, Large group activity)
• Overview: Engage the students by having volunteers guess what sample objects are by touch only
  – Bring out the 4 or 5 bags that you’ve prepared with one example 3D printed item in each bag. One bag at a time, ask for a volunteer to come up, put their hand in the bag, and try to use their tactile senses to tell the class what the item is by touch only. After they guess it correctly or after a few tries, have them pull the item out of the bag and show the class
  – Point out key features of the 3D printed sample items, such as the visible lines that are indicative of the additive printing process, or interacting parts like gears, or the use of different colored inks
  – Display the items on the table at the front of the room for the students to peruse at the end of the lesson

Activity 3: “Solving problems using 3D printing” – Team design challenge
(13 minutes, Small group activity)
• Overview: Have the students work to brainstorm innovative uses of 3D printing to help solve problems
  – Remind the students that, as we saw before, 3D printing can be used for many different things. Tell the students that it’s now time to put their innovative thinking and creativity skills to the test. Tell them that their challenge is to work in small teams to quickly brainstorm innovative uses of 3D printing on a space station crewed by astronauts
  – Read the challenge out loud to the teams. Let them know that they will have only 8 minutes to brainstorm their ideas and develop their pitch presentations
  – Pass out the “Solving Problems Using 3D Printing” handout (see below) as well as sheets of paper (or space on their whiteboard) and markers for them to create their presentations. Then have them get to work!

Activity 4: “Ideas presentations” (7 minutes, Large group activity)
• Overview: Have the students share their ideas for using 3D printing to help solve problems
  – Have the teams quickly deliver their presentations
  – After each presentation, quickly highlight particularly innovative thinking and problem solving
  – Tell them that their ideas are creative and worthy of being made a reality
Wrap up and supplemental activity (2 minutes)

- Point out that innovative companies are working with clients to combine 3D printing technology with other emerging technologies (the rest of the Essential Eight – Drones, Virtual Reality, Augmented Reality, AI, Blockchain, Robotics, The Internet of Things) to solve big problems around the world. This is called convergence when you’re using more than one of these technologies together to solve a problem.

- Remind the students that 3D printing is already a part of their lives. Some of them may even have 3D printers at home. Tell them that 3D printers can often be found around their communities in makerspaces, hands-on museums, and schools.

- Remind them that the world of 3D printing is only getting bigger, and it will need clever designers and developers like them.

- Also encourage them to share at least two things they learned or figured out today about 3D printing with friends or family.

- Thank the students contributing and working with you to explore the exciting world of 3D printing. Tell them that you’re impressed by their ideas, their creative problem solving, and their teamwork.

- If you have extra time, you can:
  - Have students come up and peruse the sample 3D printed objects
  - Have the teacher show whichever YouTube overview video that was not shown earlier
Solving problems using 3D printing

Team design challenge

Your team’s challenge:

1. Imagine that you are the crew of astronauts on a space station. You have a 3D printer on the station.

2. Identify one key problem that might occur on the station that you think 3D printing could help solve. Think about:
   - Emergency situations where something needs to be repaired or replaced quickly
   - Medical care needs
   - Scientific research needs
   - Ways to make the living conditions better or more comfortable
   - Entertainment needs

3. Work together to brainstorm how you could use 3D printing to help solve that problem. Think about:
   - Printing using different materials such as plastics, metal, glass, living cells, etc.
   - Printing small and large items

4. Create a presentation to share your 3D printing ideas. Be sure to include the following:
   - Tell us what problem you’re solving
   - Tell us your 3D printing ideas
   - Create at least one drawing to bring your ideas to life

5. You will have only 1 minute to give your presentation, so be brief!
Thank you