STEM CAREER ADVENTURES

Aerospace Physician: 3D Printing a Rib For Astronauts

Adventure Description:

In this adventure, students will think like an aerospace physician and learn how to use a 3-D printer to print human body parts for space exploration.

Activity

Step One: Background Information on Aerospace Physicians, Astronauts, and 3D Printing (15 minutes)

- Explain to students that aerospace physicians specialize in studying the effects of prolonged time in space on the human body. Astronauts are often sent on missions that last upwards of 6 months. While the astronauts are in space, many changes can occur to the astronaut, both physically and mentally. Show Handout: Mental and Physical Changes in Space. Discuss how astronaut's bodies can change in the absence of gravity and how an astronaut's mental state can change after being in close quarters with a team of other astronauts.
- Next, discuss how one risk of space travel is developing a serious medical condition. Without access to the medical care they can receive on Earth, astronauts facing serious medical issues in space could die. For example, when a body part of an astronaut in space or on another planet fails, they do not have access to a replacement part. On Earth, doctors can replace a diseased kidney in one patient with a human kidney donated by another person. If a patient needs their knee replaced, they can replace it with an artificial knee made from metal.
- Next, explain to students that NASA is planning on sending astronauts to work and live on Mars by 2025. When they get there, they will need to be self-reliant. They will bring a lot of things from Earth to help them survive, but they can't bring everything. If they send a message to Earth that they need a specific tool, it could take 2 years to get a delivery from Earth. One of the things that astronauts can't just keep a supply of is human body parts. Here on Earth, if a person needs a replacement body part they can often get one. For example, if a person needs a new kidney, a close relative can donate one of theirs.
- Explain to students that aerospace physicians have conducted research on the value of using 3-D printers to print body parts for astronauts. Show Handout: 3-D Printing a Human Rib.

Step Two: Creating a 3-D Model in Tinkercad (20 – 30 minutes)

- Explain to students that they will think like an aerospace physician and create a 3-D printed rib for an astronaut in space. First, students will create a 3-D computer model of a rib using Tinkercard software (or any other design software you have).
- Teacher Note: If students do not have experience working with this software, we suggest giving them 10-15 minutes to explore and play with different features in Tinkercard.

Please contact Allison Bischoff, Director of Teacher Support, at allison@rozzylearningcompany.com or 314-272-2560 with questions.

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- Divide students into pairs or small groups. Provide students with Handout: 3-D Printing a Replacement Rib. Walk through the steps together as a class.
- Discuss step 1 on the handout. Explain that there are specific angles and lengths that must be used to print the body parts. Ribs have a special angle in the front and back of the body, which is what offers protection to the internal organs.
- Have students open Tinkercard on their computer and follow the instructions to create the computer model under Step 2.

Step Three: Figuring Out Scale (10 minutes)

- Next, discuss scale: When using a computer modeling software, projects are usually scaled down, much like a building blueprint. This means that each measurement is divided by the same number, called a scale factor. For example, if a book is 16 inches long, but we want to draw it 4 inches long on a piece of paper, we have divided by a scale factor of 4.
- Guide students through their calculations in step 3 of the handout.

Step Four: Printing the 3-D Rib Model (30+ minutes) (OPTIONAL IF YOU HAVE A 3-D PRINTER)

- Explain to students that they will now print their 3-D rib using the 3-D printer.
- Instruct students to print 3-D rib, following directions under Step 3 on the handout.
    - Before printing, make sure that students have changed their scale to 500%. This will print a model that is 5 times bigger than the 3-D computer model of the rib.
- Depending on your printer it may take 30 minutes or more to print your 3-D rib. While your model is printing, keep an eye on the printer begin figuring out how to improve your 3-D model as described in the next step.

Step Five: Improving the 3-D Rib Model and Concluding Discussion (15-20 minutes)

- Explain to students that they will now complete step 4 and experiment with the computer software and printer to improve their 3-D rib model.
- Have students follow the instructions on Step 4 on the handout. Give students time to experiment with different shapes and combinations in Tinkercard, and to print different shapes with the 3-D printer.
- Have a concluding class discussion about how 3-D printers could be used by astronauts and aerospace physicians to print 3-D models of body parts.
- Extra time? Discuss ethical concerns about creating 3-D body parts to be used in space (e.g., Some people are concerned that 3-D printing working body parts could some day lead to 3-D printing a complete human! Another concern is the use of embryonic vs. adult stem cells to 3-D print human body parts.).

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Materials List

Provided online:

- Handout: Mental and Physical Changes in Space
- Handout: 3-D Printing a Human Rib
- Handout: 3-D Printing a Replacement Rib

Not provided (Each group needs):

- Computer to access Tinkercad
- Human rib model (skeleton, anatomy model, etc.)
- Ruler
- Protractor
- 3-D Printer
- 3-D Printing Filament

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