HEALTH IN SPACE:
PROBLEM SOLVING THROUGH ENGINEERING

INTRODUCTION

In this lesson, students are divided into small groups and tasked with finding a solution to fix a broken bone in a space (microgravity) environment. This requires a general understanding of bones and their structure, as well as significant problem solving skills utilizing the basic materials available to repair the situation.

LESSON OVERVIEW

Subject & Grade Level: Science, 5 – 8 Grade

Length: 45 minutes (1 full class session)

Objectives

At the conclusion of this lesson students will be able to:

- Describe basic bone structure and functionality in space and on Earth.
- Determine class-wide best practices of how to fix a broken bone in both a space and Earth environments.
- Demonstrate a basic knowledge of orthopedics, and compare and contrast bone care as it relates to a space or Earth environment.

Key Questions

- What is the basic anatomy of bones in the arm?
- What are the key differences between bone growth in space and on Earth?
- How do you problem solve when you do not have all necessary materials?
- Can materials be used in ways that differ from their primary function to help solve problems that have occurred due to an emergency or accident?

Standards

- NGSS MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- NGSS MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- Common Core MP.2: Reason abstractly and quantitatively.

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Materials Needed

Depending on the class size and how many different groups of student you form (*we recommend groups of about 4 to 5*), each group will need the following to complete this lesson (*it may be easier to provide students with a box/basket that contains all of the needed and prepared materials*).

- HIS Reproducible 1
- HIS Reproducible 2
- 1 meter stick (ruler or dowel rod)
- 1 roll of duct tape
- 10-15 unsharpened wooden pencils
- 2 pieces of 8” x 11” construction paper
- 2-3 bandanas or a small throw blanket or a pillow case
- 2-3 balloons
- 1-2 plastic soda bottles
- 1 roll of masking tape

Background Information: Teacher Knowledge

As we continue to branch out of our own orbit through space exploration, different situations will undoubtedly present themselves. Astronauts go through intense preparation, complete with a number of health and physical fitness checks. However, we can never truly be prepared for the types of emergencies that may present themselves during space travel or how astronauts will problem solve and use what they have at their disposal to ensure the safe return of all those involved.

In this lesson, students focus on a “what if” scenario. During this scenario, a fellow astronaut (one in their group) has broken a bone in space (specific bone location is up to the teacher, but we recommend the arm). The students must problem solve to create a method to stabilize the bone until they can return to their home base.

What makes this situation interesting and slightly more difficult is that most astronauts suffer from loss of bone mass in space. Therefore there is a larger risk of broken bones as time passes in space. Although there has never been a broken bone in the microgravity environment, problem solving is an efficient way to find the best solution to deal with the situation if it were to arise.

Resources

Bone Mass in Space
http://science.nasa.gov/science-news/science-at-nasa/2001/ast01oct_1/

http://www.nbcnews.com/id/3077393/ns/technology_and_science-science/t/why-do-bones-weaken-space/#.U6LWTPldWSo

Medical History on the ISS
http://www.nasa.gov/mission_pages/station/research/experiments/1025.html

How to provide first aid for a broken bone
http://www.wikihow.com/Provide-First-Aid-for-a-Broken-Bone

Additional Resources

Muscle Atrophy in Space
http://www.nasa.gov/mission_pages/station/research/experiments/245.html

LESSON STEPS

Teacher Preparation

To prepare for this lesson, teachers must have reviewed the basic bone mass materials and understand how bones themselves are repaired in the short term using splints. They must also have a basic working knowledge of space and microgravity situations. Teachers also must gather the necessary materials for everything to work well.

Note: It may be easier to provide students with a box/basket that contains all of the needed and prepared materials.

Warm-up

Ask the students what they know about basic human anatomy to gather their understanding. This could include things such as:

What is a bone? What do bones do?

They support and protect the various organs of the body.

They produce red and white blood cells and store minerals.

The structure of bones provides shape to your body. This can determine your height or body type.

Bones work hand-in-hand with muscles and ligaments to create movement.

Show students two images (HIS Reproducible 1) individually and then have the students compare and analyze both images. Ask the students to write down what they think they see and list any possible similarities or differences (one is an image of a normal bone, the other is a bone that suffers from osteoporosis).

Engage the students in a classroom discussion about the differences between the two images and what they wrote down. Have this discussion lead to a few more minutes of lecture-based instruction where students learn about how living in space affects bone mass.

ACTIVITY

Divide the class into several small groups of "astronauts" who are based in a space station similar to the ISS. These students are tasked with trying to fix a broken bone with limited resources (which bone is broken is up to the teacher, but we recommend working with the arm). Tell the students they have about 20 minutes to utilize the materials in front of them and apply what they recently learned to decide how to best secure the broken bone. (OPTIONAL: If it is possible, have students "secure" the unused items using Velcro or masking tape to mimic the idea of being in space/no gravity).

Remind students that bones can be bound in various ways; however a good solution should be to keep the bones secure and immobile. Also remind students that they are in a microgravity environment and to think about how securing a bone in that environment might be easier or more difficult.

After 20 minutes, have one student from each group describe their design to the other groups and explain why they believe it is the best solution to fix the broken bone. In addition, have them describe how they came to their decision. If students are hesitant to share, ask pertinent questions about their decision making process. Examples: I listened to one leader/assumed expert, voted as a group, arrived at general consensus, tried several options, etc.

The lesson ends with a teacher-led class-wide recap and discussion of what they liked about the activity, other group's designs, and a final summarizing point about broken bones in space.

http://img.webmd.com/dtmcms/live/webmd/consumer_assets/site_images/articles/health_tools/osteoporosis_overview_slideshow/webmd_rm_photo_of_porous_bones.jpg

STUDENT INSTRUCTIONS

You and your teammates are in a space station orbiting the Earth. Due to an unexpected accident, one of your teammates now has a broken arm. This is unprecedented for your team and you all now must design a way to set and fix the broken bone in the microgravity atmosphere. There are limitations and parameters for this situation. Here are a few things to keep in mind as you are working on finding a solution.

- You have limited resources. Only the resources provided by your teacher can be used for this activity.
- There is no right or wrong answer for this exercise. Since this has never been done before no one is prepared for the current situation.
- The only other requirements for the project are the following:
  - The broken arm must be secure (it cannot move at all)
  - The broken arm has to be in a place where it cannot be further injured.
  - The broken arm will continue to be in a microgravity environment for several days. Take this into consideration when finding your solution.

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