2010-2011 ACE Curriculum

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* The footballs provided by CAP to the sixth-grade students should be used with physical fitness lesson #5, “From Football to Flight.”
Topics: airplane surface controls, motion, design, probability
(science, math)

Length of Lesson: 30 - 60 minutes


Objectives:
- Students will define and demonstrate roll, pitch, and yaw.
- Students will experiment with surface controls to adjust flight paths.
- Students will convert fractions to decimals.
- Students will calculate percentages and determine probability from data.

National Standards:

Math
- Number and Operations
  - work flexibly with fractions, decimals, and percents to solve problems
- Understand and apply basic concepts of probability
  - use proportionality and a basic understanding of probability to make and test
    conjectures about the results of experiments and simulations
- Communication
  - Organize and consolidate their mathematical thinking through communication
- Connections
  - Understand how mathematical ideas interconnect and build on one another to
    produce a coherent whole
  - Recognize and apply mathematics in contexts outside of mathematics
- Representation
  - Create and use representations to organize, record, and communicate
    mathematical ideas

Science
- Content Standard A: Science as Inquiry
- Content Standard B: Physical Science
  - Motions and forces
  - Transfer of energy
- Content Standard E: Science and Technology
  - Abilities of technological design
**Background Information:**
(The information and picture below are from http://spaceday-cert.donet.com/media/documents/SpaceDayToolkit.pdf)

Pilots use different terms to describe the particular ways an aircraft moves forward:

- **Pitch:** Aircraft nose moves up or down
- **Roll:** One wing of aircraft tips up while the other tips down
- **Yaw:** Nose of airplane moves left or right while remaining level with the ground

Pilots use several control surfaces (movable sections on the aircraft's surface) to better direct an aircraft's movement. These include:

- **Elevator:** Section on horizontal part of tail that controls pitch
- **Aileron:** Section at rear edge of wing near tip that controls roll
- **Rudder:** Section attached to vertical part of tail that controls yaw

![Diagram of aircraft with control surfaces labeled](image)

**Materials:**
- 5 pieces of green construction paper
- 5 pieces of blue construction paper
- 5 pieces of yellow construction paper
- 5 pieces of orange construction paper
- 1 piece of red construction paper
- tape
- Target Data Sheet (included)

**NOTE:** For this lesson, students need to have knowledge of converting fractions to decimals and decimals to percents. This motivational lesson provides practical practice and application of these math skills.

For homework, prior to teaching this lesson, ask students to make their best paper airplane. If they do not know how to make a paper airplane, you may suggest that they research designs, or you may provide the instructions on how to make the “Simple Paper Airplane” included in this lesson. Tell students that they will need their paper airplane during class tomorrow.

Have 5 target areas set up prior to the beginning of class the next day. To assemble the target areas, join 4 different colored pieces of construction paper together using tape. Place a reasonably sized red circle (or square) in the middle of the 4 pieces of construction paper to represent the bulls-eye. Label the colored squares as A, B, C, and D, as illustrated.
Lesson Presentation:

1. Ask students to take out their paper airplane and a pencil. Tell students that they will use math and science to determine how well they can hit a target.

2. Prior to target practice, inform students that they will learn or recall a few things about airplanes. (A fifth-grade ACE lesson provided instruction on pitch, roll, and yaw.) First of all, airplanes can travel forward, but they can also roll, pitch and yaw. Demonstrate roll, pitch, and yaw with a paper airplane.
   - **Roll:** Tell students to imagine an imaginary horizontal line running through the nose of the airplane to the back end of the plane. If the airplane rotates left or right on this imaginary line, it is rolling. Demonstrate roll by tipping one wing down (the other wing automatically goes up), keeping the body of the airplane (the fuselage) in the same place. (You may wish to use a straw to represent the imaginary axis.)
   - **Pitch:** Tell students to imagine a line running through the plane from wingtip to wingtip. If the airplane rotates up or down on this imaginary line, it is pitching. Holding the wings level, pitch the nose up (move the nose up and the tail goes down). Tell students when the nose goes up, the plane is pitching upward. Tip the nose down, and tell students that when the nose of the plane goes down and the tail is up, the plane is pitching down.
   - **Yaw:** Tell students to imagine a vertical line stabbing the plane right in its mid-section. If the plane twists left or right along this imaginary axis, it is yawing. Tell students to think of a swivel chair. Turn the nose of the airplane to the left and tell students that this is an example of the plane yawing to the left. Then, demonstrate a yaw to the right.

3. (optional) To reinforce or help students better understand roll, pitch, and yaw, have the students kinesthetically demonstrate roll, pitch, and yaw. Tell them to roll by leaning at their waist to their left or right. Tell them pitch by bending forward at their waist and raising their back and head up and down (like bowing to a king or queen). Tell them to yaw by spinning to their left or right on one foot (like being in a swivel chair).

4. Call out roll, pitch, and yaw positions to students and have students orient their paper airplane appropriately.

   - pitch up
   - pitch down
   - yaw left
   - yaw right
   - roll left
   - roll right
5. Tell students that an airplane’s control surfaces (moveable sections on an airplane’s surface) such as a rudder, aileron, and elevator, affect how the plane rolls, pitches, and yaws. (See background information.)

6. Have students make 2 small cuts a few centimeters apart at the back of each wingtip if they have not done so. State that these movable parts are called elevons and that an elevon is a combination of an aileron and elevator. (See background information.) Tell students that they can bend the elevons slightly up or down, and this will change the flight path of their airplane. (Teachers: You may want students to experiment with the elevons to find out on their own how adjusting the elevons affects flight, or if time is an issue you may want to provide instructions. For example, if their plane is flying too low, they can slightly bend both elevons up slightly, and the plane will move up. If their plane is flying too high, they can lower the elevons to bring the plane down. If students have one elevon up and one down, it affects roll to the left or right.) Tell students that their paper airplane does not have a rudder (the moveable piece on the vertical tail of the aircraft), so they cannot control yaw.

7. Distribute a “Target Data Sheet” to each student, and divide students into 5 groups. Tell students that they will line up in front of a target area (the colored pieces of construction paper taped to the wall). They will take turns tossing their plane toward the red bull’s-eye. After their toss, they will move to the back of the line and make a tally mark on their data sheet in the correct box to indicate where the nose of their airplane hit the target area. For example, if they toss it and it hits the “A” piece of construction paper, they should put a tally mark in the “A” box on their data sheet. Tell students they have 8 times (or other amount determined by the teacher) to toss their plane at the target. Once they have completed all tosses, they should answer the remaining questions on the data sheet. Discuss how to complete the chart by putting an example on the board if necessary.

8. Direct each group to their target area and allow them to begin.

9. As time permits, allow students to share some results from their data sheet. Determine who has the best aim.

10. Ask students to explain how they used math and science to determine how well they can hit a target with a paper airplane. (Possible discussions: Newton’s laws of motion help explain why the plane moves: inertia, F=MA, action/reaction. Also, students used the scientific method by asking, “What will happen if I toss it like this?” They hypothesized, analyzed, drew conclusions, and made adjustments. They were able to count and create a percentage to describe their accuracy in hitting a target. It is more specific to say, “I can hit the bull’s-eye 70% of the time,” rather than saying, “I am good at hitting a bull’s-eye with a paper airplane.”)
Summarization:
Ask students to summarize what they learned from today's lesson. In sharing lessons learned, ensure that someone explains pitch, roll, and yaw. Remind students that science and math help to explain and provide a better understanding and description of events.

Ask students what would happen if they practiced these skills (tossing airplanes at a target, converting fractions to decimals, and converting decimals to percents) every day. In theory, they should become better and better. Remind students that while practice may not make perfect, it does make one better. Encourage students to practice good character skills daily and work on being the best person they can be.

Assessment:
- teacher observation
- “Target Data Sheet”

Additional activity ideas to enrich and extend the primary lesson (optional):
- Have students determine the overall percentage of hitting a target for girls versus boys.
- Complete the “Flight Direction Challenge Point Worksheet.” (a NASA worksheet)
- Have students use their own personal data from their “Target Data Sheet” to create a page that provides information like that on the “Flight Direction Challenge Point Worksheet.”

Source: NASA at http://www.ueet.nasa.gov/StudentSite/dynamicsofflight.html
SIMPLE PAPER AIRPLANE

1. Fold up
2. Fold up
3. Fold up
4. Fold sides down (in opposite directions)
5. Complete airplane

NAME ____________________________________________

1. How many total times did your teacher say that you are to toss the plane for this activity? ______

2. Each time after you toss your paper airplane, place a tally mark in the target picture below to indicate where your airplane struck the target area.

3. Complete the chart below:

<table>
<thead>
<tr>
<th># of times it hit this area</th>
<th>Total # of times you threw the plane</th>
<th>Write a fraction indicating how many times you hit this area.</th>
<th>What % of the time did you hit this area?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>C</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bull’s-eye</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
McINTOSH STUDENTS’ FLIGHT DATA

Flight Results

<table>
<thead>
<tr>
<th>Section A</th>
<th>Section B</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Create a pie graph to represent the flight results on the left.

| Section A—Green | Section B—Red | Section C—Yellow | Section D—Blue |

1. Which section of the target did the McIntosh Team’s planes hit the most? The least?
MOST: Section __________ LEAST: Section __________

2. What patterns do you notice in the data for their airplane?

3. Of the 10 landings, how many were in section A? In section B? In section C? In section D?

   Section A: ______  Section B: ______  Section C: ______  Section D: ______

4. Discuss how the number of landings in a section can be expressed with either a fraction or decimal. Organize the data in the displayed table.

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of Landings</th>
<th>Total Flights</th>
<th>Fraction</th>
<th>Decimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section A</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section B</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section C</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section D</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Color the circle graph to summarize landing results for each section of the sample data.


CAP’s ACE Program (2010)
1. Which section of the target did the McIntosh Team's planes hit the most? The least?
   MOST: Section B
   LEAST: Section D

2. What patterns do you notice in the data for their airplanes?

3. Of the 10 landings, how many were in section A? In section B? In section C? In section D?
   Section A: 3   Section B: 5   Section C: 2   Section D: 0

4. Discuss how the number of landings in a section can be expressed with either a fraction or decimal. Organize the data in the displayed table.

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of Landings</th>
<th>Total Flights</th>
<th>Fraction</th>
<th>Decimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section A</td>
<td>3</td>
<td>10</td>
<td>3/10</td>
<td>.30</td>
</tr>
<tr>
<td>Section B</td>
<td>5</td>
<td>10</td>
<td>5/10</td>
<td>.50</td>
</tr>
<tr>
<td>Section C</td>
<td>2</td>
<td>10</td>
<td>2/10</td>
<td>.20</td>
</tr>
<tr>
<td>Section D</td>
<td>0</td>
<td>10</td>
<td>0/10</td>
<td>.00</td>
</tr>
</tbody>
</table>

5. Color the circle graph to summarize landing results for each section of the sample data.

Topics: scientific method, motion, force, design, safety, technology, economics (science, math)

Length of Lesson: 60 minutes

Objectives:
- Students will define payload.
- Students will design a cost-effective package to safely deliver payload.
- Students will use critical thinking and problem solving skills.
- Students will use teamwork skills.

National Science Standards:
- Content Standard A: Science as Inquiry
- Content Standard B: Physical Science
  - Properties and changes of properties in matter
  - Motion and forces
  - Transfer of energy
- Content Standard C: Earth and Space Science
  - Earth in the solar system
- Content Standard D: Science and Technology
  - Abilities of technological design
- Content Standard G: History and Nature of Science
  - Science as a human endeavor
  - History of science

Background Information: (from http://www.jpl.nasa.gov/news/fact_sheets/mars03rovers.pdf)
Mars came closer to Earth in August 2003 than it had in thousands of years. NASA decided in the summer of 2000 to take advantage of this favorable planetary geometry to send two rovers to Mars: Spirit and Opportunity.

Both rovers were launched from Cape Canaveral Air Force Station on central Florida’s Space Coast. Spirit ascended in daylight on June 10, 2003. Opportunity followed with a nighttime launch on July 7. Each rover made the trip tightly tucked inside its folded-up lander, which was encased in a protective aeroshell and attached to a disc-shaped cruise stage about 2.6 meters (8.5 feet) in diameter. The cruise stage was jettisoned about 15 minutes before the spacecraft reached the top of Mars’ atmosphere.

With the heat-shield portion of the aeroshell pointed forward, the spacecraft slammed into the atmosphere at about 5.4 kilometers per second (12,000 miles per hour). Atmospheric friction in the next four minutes cut that speed by 90 percent, then a parachute fastened to the backshell portion of the aeroshell opened about two minutes before landing. About 20 seconds later, the spacecraft
jettisoned the heat shield. In the final eight seconds before impact, gas generators inflated the lander's airbags, retro rockets on the backshell fired to halt descent speed, and transverse rockets fired (on Spirit's lander) to reduce horizontal speed. The bridle was cut to release the lander from the backshell and parachute. Then the airbag-encased lander dropped in free fall.

Spirit landed on Jan. 4, Universal Time (at 8:35 p.m. Jan. 3, Pacific Standard Time). It bounced about 8.4 meters (27.6 feet) high. After 27 more bounces and then rolling, it came to a stop about 250 to 300 meters (270 to 330 yards) from its first impact. Spirit had journeyed 487 million kilometers (303 million miles).

Opportunity landed on Jan. 25, Universal Time (at 9:05 p.m. Jan. 24, Pacific Standard Time). It traveled about 200 meters (220 yards) while bouncing 26 times and rolling after the impact. It came to rest inside a small crater. One scientist called the landing an “interplanetary hole in one.” Opportunity had flown 456 million kilometers (283 million miles) from Earth and landed only about 25 kilometers (16 miles) from the center of the target area.

The design for the two rovers began with some basics from Sojourner, the rover on NASA's 1997 Mars Pathfinder mission. Some of the carried-over design elements are six wheels and a rocker-bogie suspension for driving over rough terrain, a shell of airbags for cushioning the landing, solar panels and rechargeable batteries for power, and radioisotope heater units for protecting batteries through extremely cold martian nights. However, at 174 kilograms (384 pounds), each Mars Exploration Rover is more than 17 times as heavy as Sojourner. They are also more than twice as long (at 1.6 meters or 5.2 feet) and tall (1.5 meters or 4.9 feet). Pathfinder's lander, not the Sojourner rover, housed that mission's main communications, camera and computer functions. The Mars Exploration Rovers carry equipment for those functions onboard. Their landers enfolded them in flight and performed crucial roles on arrival, but after Spirit and Opportunity rolled off their unfolded landers onto Martian soil, the landers' jobs were finished.
NOTE:
The goal of this lesson is for students to design and build an object capable of being released several feet above the ground and delivering an egg safely to the ground. Students can use any materials the teacher has available!!! Here are some helpful ideas. Cut pieces of posterboard into smaller pieces. For nylon hose, consider the approximately inexpensive off-brand of knee highs at discount stores. Consider asking a fast food restaurant to donate hamburger containers. Adjust the "materials price list" page to reflect the materials and prices that you deem appropriate for your class.

Prior to conducting this lesson, determine the location from which your students will drop their payload packages. Consider the following: the top of a multi-leveled stairwell (inside or out), open window of a high level room, the press box or top bleacher at the school football or baseball field, or consider asking the fire department or the utility company to bring a bucket truck!

Lesson Presentation:
1. Write the term "payload" on the board. Ask students what this term means. Confirm that in aerospace, payload refers to valuable "cargo" (or luggage) that is carried by a plane or rocket. If a rocket is delivering a satellite into space, the satellite is the rocket’s payload, for example.

2. Tell students that rockets have carried rovers as payload to Mars. The U.S. has sent rovers such as Sojourner (that landed in 1997) and Spirit and Opportunity (that landed in 2004) to Mars. Explain that these rovers had to be delivered to Mars safely.

3. (optional - but strongly suggested) To visually explain how the Mars rovers get to Mars and land, show the "Rover Mission to Mars Animation" updated video found at the following link: http://marsrovers.jpl.nasa.gov/gallery/video/animation.html.

4. Tell students that they are going to design a payload package, or lander, capable of delivering a rover, represented by an egg, safely to Mars, represented by the floor/ground. They will be dropping their payload from a higher altitude. (Hopefully, a location is available that will allow students to drop the package from a height of two or three stories.) Explain that this is a competition. The winner of the competition will be the group that designs the cheapest package/lander that delivers the rover (egg) safely to Mars (the floor/ground).
5. Allow students to get into small groups of 2 or 3, or divide students into predetermined groups.

6. Distribute one “Payload Packaging Challenge” sheet and a “materials list” to each group. Explain that questions asked once students begin will cost them money, so it is important to listen carefully! Tell students that not only are they responsible for creating a safe delivery package, they are responsible for designing a cost-effective package. Show students the materials that are available and go over the price for each. Explain that when students determine they are ready to purchase an item, they are to write the item on the “Payload Packaging Challenge” sheet, and ONE person from the group will bring the sheet to the teacher for the teacher to initial and observe the student getting the item(s) purchased. They do NOT have to list all the items at once. They can list and obtain items during the building process. Distribute an egg in a small, plastic self-sealed bag to each group. Tell students that there is no cost for these items (egg and bag) as another company developed and paid for this “rover.” Your task is to land it safely on “Mars.” Ask students if they have any questions before you start charging for questions, which would be considered a “consultant fee.”

7. Set a reasonable time limit for students to build their payload package/lander and allow students to begin.

8. Once time is up, collect each group’s “Payload Packaging Challenge” sheet and go to the drop location. Allow each group to announce the cost of their payload package/lander and drop their payload package. (Allow groups to do this one at a time.)

9. Have each group open their package/lander.

10. Determine the winner by learning who built the cheapest package/lander that delivered the payload to the floor/ground without damage.

11. If time permits, return to the classroom and list the cost of each group’s lander and display the results of each group’s payload. Discuss the results.

**Summarization:**
Discuss why utilizing non-manned space exploration vehicles is important. (safety due to unknown factors; longevity of the mission; weight in terms of additional items that humans would have to take such as food, clothing, restroom; size of spacecraft as a smaller craft can be built since it does not have to accommodate the size of a human; economics; machines do not have to return to Earth)

**Character Connection:** Remind students that engineers who design spacecrafts have a tough job. Not only must they consider safety, but they also must consider cost. They must work carefully with science and math concepts in order to design safe, cost-effective products. How cool would it be to see a spacecraft, satellite, rover, or an astronaut go to another planet and know that you helped make that possible! Remind students that it takes many people to
create aviation and space exploration successes. It took thousands of people working together to get the first men to the moon in 1969. All jobs are important, and when everyone works hard and well together, great things happen. Encourage students to always try their best and work well with others as those are two big ingredients to personal and professional success.

Assessment:

- teacher observation
- payload package/lander created by each group
- "Payload Packing Challenge" data sheet for each group
- result of payload drop (Did the egg break, or did it remain intact?)

Additional activity ideas to enrich and extend the primary lesson (optional):

- On the back of the “Payload Packaging Challenge” sheet, have groups write a paragraph to describe their lander and their lander’s performance. Have groups write a paragraph describing any changes they would make on a future lander.
- Allow students to make changes to their initial designs and try the challenge again.
- Have students use the scientific method (question, research – if applicable, hypothesis, experiment, analysis, and conclusion) to write an explanation of today’s experiment. In their conclusion, have them write what they would change or do differently next time.
- Offer a similar payload packaging challenge to students using the following:
  - Have students (in groups of 2-3 members) make an equilateral triangle on cardstock paper with sides measuring 8” long.
  - Have them cut out the triangle and fold each corner toward the center in order to create a tetrahedron.
  - Using a hole-punch, punch a hole in the top of each of the 3 tips of the tetrahedron.
  - Provide students with string, an egg, a small plastic self-sealing bag, 3 balloons, and 3 cotton balls. Additionally, provide them with material to construct a parachute – gift-wrap tissue paper or grocery store plastic bags work well.
  - Tell students their design challenge is to create a spacecraft capable of delivering the egg to the ground from a specified height using the materials provided to them.

Associated Websites:

- Learn more about the rovers of Mars at the following websites:
- Read a cool article about the first Mars rover, Sojourner, at http://www.amnh.org/rose/mars/mi3.html
- Find other great Mars activities, including an “Egg Drop Landing” at http://marsed.asu.edu/pages/pdfs/MSIP-MarsActivities.pdf.
Payload Packaging Challenge

List students in your group. _____________________________________________

Write the name of your company. _________________________________________

List each item you purchase to build your payload package and the cost of each item. You can purchase as few or as many items as you want unless your teacher gives you different instructions. Remember, the cheapest package that safely delivers the rover (egg) wins!

<table>
<thead>
<tr>
<th>ITEM</th>
<th>COST</th>
<th>Teacher’s Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>2.</td>
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<td>15.</td>
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</tbody>
</table>

If you have more items to purchase, list them on the back of this page.

What is the final TOTAL cost of your payload package? ____________________

After the competition, write the results of your team’s design on the back of this paper. Explain why you think your design worked the way it did, and explain what your team would change if you were to do this activity again.
# MATERIALS PRICE LIST

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant Questions</td>
<td>$10,000</td>
</tr>
<tr>
<td>Cardboard/Styrofoam container</td>
<td>250,000</td>
</tr>
<tr>
<td>Cardboard (per sheet)</td>
<td>100,000</td>
</tr>
<tr>
<td>Poster board (per sheet)</td>
<td>70,000</td>
</tr>
<tr>
<td>Construction/Color Paper -1 sheet</td>
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<tr>
<td>Plastic Bag</td>
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<td>Nylon hose</td>
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<td>Balloon</td>
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<td>Handful of Packing Peanuts</td>
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<tr>
<td>Bubble Wrap</td>
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<tr>
<td>Duct Tape – 12 inches</td>
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<tr>
<td>Masking Tape – 12 inches</td>
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<tr>
<td>Use of hot glue – per 5 minutes</td>
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<td>Glue (regular)</td>
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<td>Markers</td>
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<td>Newspaper</td>
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<td>String - 60 cm</td>
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* Sorry, NO refunds or exchanges!*
There is No "I" in Team
Grade 6 Character Lesson #4

Topics: cooperation, ISS (language arts, science, social studies)

Length of Lesson: 45-60 minutes

Objectives:
- Students will explore NASA article about the International Space Station and discuss how the astronauts must work together and cooperate for a common goal.
- Students will discuss and share thoughts about how to stick together as a team.
- Students will create a classroom definition of cooperation.
- Students will participate in a group activity to demonstrate the cooperative spirit.
- Students will learn about neutral buoyancy as it pertains to the space program.

National Standards:
Character Education Partnership (CEP)
Principle 1: Promotes core ethical values as the basis of good character.
Principle 2: Defines "character" comprehensively to include thinking, feeling, and behavior.
Principle 3: Uses a comprehensive, intentional, proactive, and effective approach to character development.
Principal 7: Strives to foster students self motivation.

English
Standard 4: Communication Skills
Standard 5: Communication Strategies
Standard 12: Applying Language Skills

Background Information:
In our society today, it seems that everyone is out for themselves. Often, our students witness false statements made by politicians in an attempt to get ahead of their opponents or see firsthand how others put people down in an attempt to raise themselves higher. It is important that students know that a key element in landing and maintaining employment in today's global market is the ability to work well with others. When you work well with others, you cooperate, and everyone wins. In the words of H. E. Luccock, "No one can whistle a symphony. It takes a whole orchestra to play it!" No where is that statement better illustrated than in the International Space Station, where astronauts from different countries must work together in cylindrical modules which serve as an observatory, laboratory, and workshop. Talk about teamwork!

One of the activities in this lesson involves "neutral buoyancy" wherein an object neither floats nor sinks: it appears to be "weightless." When an astronaut works in space, he/she is working in a microgravity environment that is unlike the gravity-filled environment of Earth. Thus, the
astronaut has to train to work in such an environment in space. The activity can be related to the space program’s Neutral Buoyancy Lab (NBL).

**Background information on NBL:** (from NASA at [http://dx12.jsc.nasa.gov/site/index.shtml](http://dx12.jsc.nasa.gov/site/index.shtml))

Since the mid-1960s, neutral buoyancy has been an invaluable tool for testing procedures, developing hardware, and training astronauts. This neutrally buoyant condition simulates reduced gravity sufficiently for the astronaut to practice future on-orbit procedures, such as extravehicular activities (EVA) and to work through simulation exercises to solve problems encountered on-orbit. Some of these exercises are carried out on a real-time basis.

In 1995, Johnson Space Center (JSC) named the NBL training facility, near Ellington Field, in honor of the late astronaut M. L. "Sonny" Carter, who was instrumental in developing many of the current space-walking techniques used by the astronauts. Opened in 1997, the Sonny Carter Training Facility (SCTF) provides controlled neutral buoyancy operations to simulate the zero-g or weightless condition that is experienced by spacecraft and crew during space flight. It is an essential tool for the design, testing and development of the International Space Station and future NASA programs. For the astronaut, the facility provides important pre-flight training for extravehicular activities (EVA) and with the dynamics of body motion under weightless conditions. Also, be sure to read the rationale behind building the NBL -- a "better, faster, cheaper" solution for providing quality EVA preparations.

The NBL was sized to perform two activities simultaneously; each uses mockups sufficiently large to produce meaningful training content and duration. It is 202 ft in length, 102 ft in width, and 40 ft in depth (20 ft above ground level and 20 ft below) and holds 6.2 million gallons of water. Even at this size, the International Space Station, at 350 ft x 240 ft when complete, will not fit inside the NBL.

**Note:** The first underwater training facility for astronauts was the Neutral Buoyancy Simulator located on the Redstone Arsenal at Marshall Space Flight Center (MSFC) in Huntsville, Alabama. Until an additional facility was constructed at the Johnson Space Flight Center to support the Space Shuttle Program, the facility at MSFC, was the only test facility that allowed astronauts to train underwater for EVAs. The Neutral Buoyancy Simulator at MSFC was officially closed for NASA’s use on July 1, 1997, because NASA’s requirements could be accommodated at the new, larger tank at NASA’s Johnson Space Center in Houston.

**Materials:**

- copies of “International Space Station”
- gem clips (paperclips)
- small pieces of paper
- helium latex balloons with long ribbons or strings attached – one for each group of 3-4 students (If you bring your own latex balloons to a store, the business may fill them with helium for you at no cost. Small balloon helium tanks are available at some popular discount stores for about $25.) You will need a few more balloons than you plan to use just in case you have balloons that pop before or during the activity)
- copies of “Cooperation Means” (optional)
Lesson Presentation:

1. Ask one good-natured student in your classroom to get some desk cleaner and begin to clean all of the desk seats. (You might want to cue him or her in beforehand that you are not really expecting them to clean all of the desk seats, but to play along as an opening activity.) Have the student go ahead and begin by cleaning a side desk chair or a chair at a table where no one is seated.

2. While the selected student is beginning the cleaning assignment that you have given, ask all of the students to stand where they are. Explain that you have a very important job for them today before class begins. Emphasize that they must follow instructions exactly for the job to be done correctly. Ask all of the students to sit down on the count of three. Then, count, “1, 2, 3” and make sure that all students are seated. Then ask them to slide from side to side in their desks for 30 seconds or so. As the students begin to giggle and stare around the room, make the point that it took approximately 40 seconds for all of the students in the classroom to do what it would have taken perhaps 40 minutes for the single student that you selected at the beginning of the class to do. Explain that by cooperating, the task at hand was much easier, took less time, and everyone participated. Be sure to thank the student who assisted for being a good sport.

3. Write the word TEAM on the board. Talk about what TEAM stands for: Together Everyone Achieves More! Remind the students that there is no “I” in TEAM… the key word is “together,” which includes more than just one’s self.

4. Discuss different kinds of teams with which the students come in contact and how those teams make a difference in their homes, their school, and their community. Discuss how if everyone in the world would cooperate, we could have world peace and could achieve much more than trying to be in competition with other countries.

5. Explain how the International Space Station is one good example. Distribute a copy of the “International Space Station” article to groups of 2-3 students. Have the groups follow the directions to locate acts of cooperation in the article. Then, discuss the correct responses and why each is an act of cooperation. (Use Teacher Answer Sheet) Emphasize how cooperation is key among the American astronauts and Russian cosmonauts living and working on the International Space Station.

6. Divide the class into groups of 3-4 students and have the groups complete the “Neutral Buoyancy” activity, as described below:

   a. The teacher should explain the information about neutral buoyancy and the space training program, as described in the Background Information.

   b. Each group of students should be given one latex balloon with long ribbon or string attached, a zip-lock baggie of gem clips, and 1-2 sheets of paper.

   c. Each group should be given the directions that when the teacher says to start, the groups should work together to make the helium-filled balloon gain a state of neutral buoyancy (wherein the balloon “floats” at a steady altitude; it neither rises nor falls) for at least 10 seconds. To do this, they
should add and take away both gem clips and small pieces of torn paper from the ribbon or string attached to the balloon until neutral buoyancy is achieved. (It is best to do this inside the classroom where wind will not blow the balloon and impact the desired results.)

d. The first group to achieve this state is the winner. But, having all groups work together in a cooperative team makes each group winners! Thus, small treats or a class reward would be appropriate.

**Summarization:**
Students should be reminded that it is extremely important not only to do their very best for themselves, but to also do their best to cooperate with others for the greater good of everyone involved. Explain that with every act of cooperation, we are making others' lives better. With every act of an uncooperative spirit, we can make the lives of others, and ourselves, more difficult.

Although the word "I" is not found in the word TEAM, it is of vital importance that each person works hard to be the best he/she can be so that his/her contributions to a team effort are excellent. Another adage forms forth as the closing part of the lesson on cooperation: each chain is only as strong as its weakest link. Every person needs to work hard, be good and right, and be prepared to be the best cooperative team member as is possible.

**Assessment:**
- student participation/attentiveness during discussion, activities, and activity pages

**Additional activity ideas to enrich and extend the primary lesson (optional):**
- Distribute a "Cooperation Definition" page to each "Neutral Buoyancy" activity group and have each group develop a good definition for cooperation; or have the class as a whole develop the definition. A good example might be *Cooperation means everyone working together so everyone wins*. Post the definitions in the classroom to remind students that when one person wins, everyone wins!

- Share the sentiment expressed by Jackie Robinson (early African American baseball player): "A life isn't significant except for its impact on other lives." Have the students research people who have made a significant impact on others by working with others to do something significant. Make a class book: *Cooperative Spirit: the American Way*. Examples of people to research and report on are: Thomas Edison, Martin Luther King, John Glenn, Wilbur and Orville Wright, Mae Jemison, A. Scott Crossfield

- Have students make a class cooperation chain. Each student should be given the same size strip of colored construction paper (2" X 6"). On it, the students should each write his/her name and a word that describes a trait team members should possess to be a successful team: integrity, dependable, responsible, knowledgeable; honest; etc. Then, all students should tape their strip into a "link" that should be "intertwined" with the rest of the class chain. The chain can be displayed in the classroom or in the hall of the school.
The International Space Station is a large, inhabited Earth satellite that more than 15 nations are building in space. The first part of the station was launched in 1998, and the first full-time crew, one American astronaut and two Russian cosmonauts, occupied the station in 2000.

The International Space Station orbits Earth at an altitude of about 250 miles. The orbit extends from 52 degrees north latitude to 52 degrees south latitude.

The station will include about eight large cylindrical sections called modules. Each module is being launched from Earth separately, and astronauts and cosmonauts are connecting the sections in space. Eight solar panels will supply more than 100 kilowatts of electric power to the station. The panels are being mounted on a metal framework 360 feet (109 meters) long.

The United States and Russia are providing most of the modules and other equipment. Canada built a mobile robot arm, which was installed in 2001. Other participants include Japan and the member nations of the European Space Agency (ESA). Brazil signed a separate agreement with the United States to provide equipment. In exchange, Brazil will have access to U.S. equipment and permission to send a Brazilian astronaut to the station.

More than 80 flights of U.S. space shuttles and Russian rockets will be necessary to complete the International Space Station. The ESA and Japan plan to develop supply vehicles to be launched on the ESA’s Ariane 5 and Japan’s H-2A booster rockets. The space station was originally scheduled for completion in 2006, but unpredicted expenses have created major delays.
Missions

The crew and scientists on Earth -- using radio signals -- operate laboratory equipment on the station. Some of the equipment measures the effects of space conditions, such as apparent weightlessness, on biological specimens -- including the crew. Other equipment produces various materials, including protein crystals for medical research. Crystals grown in space have fewer imperfections than those grown on Earth and are therefore easier to analyze. Medical researchers will use results of protein analyses to determine which crystals to mass-produce on Earth.

The major value of having a space station is that all the equipment needs to be carried into space only once. Also, the station can be used again and again by visiting astronauts and cosmonauts. Scientists on Earth can analyze experimental results and modify follow-up investigations much more quickly than before. The station has been designed to operate for at least 15 years. But it could last for decades if parts are repaired and replaced as they wear out or are damaged.

The first two modules of the International Space Station were assembled in December 1998. In the foreground is the Unity module, which was built by the United States. Behind Unity, with solar panels attached to it, is a Russian-built module named Zarya -- the Russian word for sunrise.

Image credit: NASA

The International Space Station will function as an observatory, laboratory, and workshop. Astronauts and cosmonauts will live and work in cylindrical modules, and solar panels will furnish electric power. Fifteen countries are building the station, shown here as it will look when finished.

Image credit: NASA

http://www.nasa.gov/worldbook/intspacestation_worldbook.html
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Cooperation Means

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I'm so Dizzy, My Head is Spinning
Grade 6 Physical Fitness Lesson #2

**Topics:** dizziness, disorientation (PE, science)

**Length of Lesson:** 30-45 minutes

**Objectives:**
- Students will practice teamwork and coordination skills.
- Students will simulate astronaut/pilot disorientation due to blood pressure issues.
- Students will discuss alternatives to taking mind-altering drugs or chemicals in life.
- Students will perform physical activities for good health.

**National Standards:**

**Physical Education**
- Standard 1: Demonstrates competency in motor skills and movement patterns needed to perform a variety of physical activities.
- Standard 2: Demonstrates understanding of movement concepts, principles, strategies, and tactics as they apply to the learning and performance of physical activities.
- Standard 5: Exhibits responsible personal and social behavior that respects self and others in physical activity settings.
- Standard 6: Values physical activity for health, enjoyment, challenge, self-expression, and/or social interaction.

**Science**
- Standard A: Science as Inquiry
- Standard B: Physical Science
- Standard C: Life Science
- Standard F: Science in Personal and Social Perspectives

**Background Information:**

Landing a spaceship is a terrible time to feel dizzy, yet that is what happens to some astronauts. Their legs become heavy and their heads become “light” even as the planet below expands to fill the windshield. It is an unwelcome side-effect of returning home.

Researchers have learned that the dizzy sensation is caused, in part, by orthostatic hypotension—“in other words, a temporary drop in blood pressure,” explains NASA chief Medical Officer, Rich Williams. On Earth you feel it by standing or sitting up too fast. Gravity has much the same effect on astronauts returning from a long spell in space: Blood rushes down away from the head and the space travelers become, literally, lightheaded.
Susceptibility is highly individual. Some astronauts are hardly affected while others feel very dizzy: About 20% of short-duration and 83% of long-duration space travelers experience the symptoms during re-entry or after they land.

Astronauts do not feel orthostatic hypotension while they are traveling through space, but they do begin to feel it during re-entry (when g-forces mimic gravity) and after landing. After being in a micro-gravity environment, blood flows back down to the lower body and, thus, blood pressure to the head is suddenly reduced, hence the dizziness. (The sensation can continue for a while after landing, too.)

For many years, astronauts have tried to counteract orthostatic hypotension by drinking lots of salt water, which increases the volume of body fluids. (There is a general loss of body fluids during space missions.) Astronauts also wear "G-suits"—rubberized full body suits that can be inflated with air to keep the blood where it needs to be. This action squeezes the extremities of the body and raises blood pressure.

An anti-dizzy pill would be helpful, but until recently, there was no such thing. Enter *Midodrine:* Midodrine is the first drug approved by the United States Food and Drug Administration to treat orthostatic hypotension. It constricts blood vessels and so increases blood pressure. "By increasing blood pressure when patients need it, Midodrine can help people lead a more normal life," writes Low.

An important advantage to Midodrine, says, Cohen, is that it can be administered just before re-entry or even after landing. The benefits are immediate. Astronauts would not have to take it throughout their mission when it might interfere with their body's own (and welcome) adaptations to micro-gravity.

*Midodrine has been shown to successfully reduce orthostatic hypotension in patients on Earth, as orthostatic hypotension affects people other than astronauts. To date, this investigation has been performed on some space shuttle crew members and on an Expedition 5 crew member. Further Expeditions will involve testing on more subjects before conclusive results can be determined. But, this is an example of how the space program's "spin-offs" have helped to improve the lives of the regular populace. ([http://www.nasa.gov/mission_pages/station/science/experiments/Midodrine.html](http://www.nasa.gov/mission_pages/station/science/experiments/Midodrine.html))

**Materials:**
- 2 baseball bats (one bat per team)
- cones, lines, or other items to mark starting point and spinning point
- cones to set up obstacle course for return trip to starting point
- jump ropes (optional)

**NOTE:** The field should be prepared before class, if possible.
Lesson Presentation:

1. Ask students how an astronaut who has been in space for six days or six months may physically feel after returning home to Earth. If no one says “dizzy,” tell students that many astronauts have said that they experienced dizziness after returning to Earth. They may feel this way because after being in a micro-gravity environment, the blood in their body flowed freely through their body, thus distributing the blood evenly throughout the body, to include their head. When the astronauts enter the earth’s gravitational atmosphere, the blood rushes from their head to flow into the lower extremities of their body, and this sometimes makes them dizzy. Some shuttle astronauts reported that the dizziness lasted for just a few minutes, while other astronauts reported that the feeling of dizziness lasted several days.

2. Tell students that they will play a game called “Dizzy Izzy” to simulate the dizzy feeling an astronaut might feel upon returning to Earth from space.

3. Before beginning the physical activity, have the students participate in warm-up exercises, such as neck rolls, lunges, and jogging in place.

4. Divide students into two teams. Set up two courses- one for each team. Each course should include a path for students to run from the starting line of students to the end line where the students will spin on a baseball bat. At the end point, a student will sit or stand to count rotations on the bat. The other part of each course should be some cones or other marking items set up for students to run through on their way back to the starting point. (Thus, each team will have a forward path to get to the bat spinning area and a return path with obstacles to go through to get back to the starting point.)

5. Give the students the directions for the game of Dizzy Izzy:

   a. Students will divide into pairs. One student will be the guide and counter while the other person spins and tries to get back to the starting line through the obstacle course. This student will count the number of complete rotations on the bat for their partner and tell them when they can drop the bat and run back to their team through the obstacle course. Explain that a complete spin means the person has gone all the way around one time. Tell the teams that the individual who is counting the number of spins must count aloud. After the last spin is completed, the counter will say, “go,” to indicate that the spinner can go back to their team.

   b. The “counter” will run beside his/her partner to ensure the partner does not fall after becoming a bit dizzy.

   c. Each member of the team will take a turn to run from the starting line to the other side of the course wherein they will spin around a bat before running back to the starting point by way of an obstacle course.

   d. When students get to the bat, they are to pick up the bat, bend over, place their forehead on the end of the bat, and start spinning around.
e. An appropriate number of times for all of the students to spin around the bat should be determined, such as 10. Adjust, if necessary.

f. After spinning the appropriate number of times on the bat, the team member will be told by the “counter” to drop the back and run back to his or her team while weaving in and out of cones that have been set up as obstacles. The “counter” will assist the “spinner” through the obstacle course and back to the starting point.

g. When the pair returns to the team line, they will tag the hands of the next pair of students to begin the same course.

h. The first pair will go to the back of the team’s line to await their turn to switch places wherein the counter becomes the spinner and the spinner becomes the counter and guide.

i. The first team finished with all students wins the game.

6. The adult should be very alert during the game to assist any student who may be too dizzy to continue. The game is fast-paced and fun, but students need to work together so no one falls after spinning.

Summarization:
After completing the activity, ask students what problems they encountered while running back to their team weaving through the cones after spinning around the bat. Ask what other problems they might experience during the day if they remained dizzy.

Have the students discuss how important it was to have a partner to assist them through the process. Have them also discuss the need to have good coordination in order to complete the course more easily. Lastly, have them discuss how their "reaction time" was impeded after being so dizzy; how they reacted more slowly to the need to adjust their path of movement.

Ask students to explain why dizziness for astronauts returning to Earth could be a problem. Besides making them feel sick, it could pose a problem while trying to land the orbiter. A dizzy astronaut might accidently hit the wrong switch or button. His or her reaction time might be slower, which could also pose a problem.

Ask the students why persons on earth may become dizzy or disoriented. Explain to the students that feeling dizzy and sick can occur for a number of reasons, but one reason it could occur is because of taking inappropriate drugs or drinking alcohol. Remind the students that drugs and alcohol are bad and can do even more damage than just making a person dizzy or slowing their reaction time.

Tell the students that the adults who care for them do not want them to spin out of control in life, much like in the game of Dizzy Izzy. Thus, adults in their lives are working diligently to arm the students with alternatives to mind-altering chemicals. They are
trying to teach them to exercise regularly, to join sports teams and community organizations and to surround themselves with positive peers and friends with whom they choose to spend their free time. Encourage the students to keep their paths straight in life by saying no to drugs and alcohol and yes to positive actions, helping others, working hard and being around positive people.

Assessment:
- teacher observation
- student responses to summary discussion questions

Additional activity ideas to enrich and extend the primary lesson (optional):
- Place another task for students to complete in the spin area. For example, have students complete 5 successful jumps using jump ropes.

- Have the students research the gravitational pull of all the planets and determine which planets you would be most dizzy on after landing from an outer space trip. (Hint: the more gravitational pull, the more dizziness one would feel.)

- Provide a writing experience for students by giving them the following scenario:

After a seven day space trip, you land gently on another planet, which has gravity, just like Earth. When you leave the space ship, you are taken hostage by aliens. The aliens motion for you to follow them. You, however, are very dizzy after entering the gravitational pull of the planet and are having difficulty following them. The aliens notice you do not seem well, and when you try to explain that you are "dizzy," they do not understand you. Help the aliens understand by writing a descriptive paragraph that describes being dizzy. Draw a picture to illustrate.