National Aeronautics and Space Administration

HAM It Up!
An Amateur Radio Overview

A Digital Learning Network Experience

Designed To Share

NASA Space Exploration

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Designed To Share

The Vision for Space Exploration

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Digital Learning Network (DLN) Expedition

A DLN Expedition is a one time connection that allows students to experience NASA first-hand. Each expedition features an integrated educational package of grade-appropriate instruction and activities centered on a 50 minute videoconference. Students participate in a Question and Answer session with a NASA JSC education specialist or a NASA Subject Matter Expert.

SEQUENCE OF EVENTS

Pre-Conference Requirements
Online Pre-assessment A pre-assessment tool is available to determine the students' level of understanding prior to the videoconference. Suggested answers are included.

Expedition Videoconference
Expedition Videoconference (About 45-60 minute conference)
Join the Digital Learning Network as we explore how astronauts on the International Space Station communicate using amateur, or HAM, Radio. Learn how amateur radio works, its purpose on the International Space Station, and how educators and students can participate in radio downlink events with astronauts through ARISS.

Post-Conference Requirements
Online Post-assessment
A post-assessment tool is available to determine changes in student levels of understanding.

NASA Education Evaluation Information System (NEEIS) Feedback Forms
Educator and student feedback forms are available online for all DLN events.

Expedition Overview

Grade Level K-4

Focus Question

Communication is an essential component of a manned NASA mission. It is important for astronauts to stay in contact with Mission Control. One way astronauts keep in touch on the International Space Station is with amateur radio, or HAM radio. This method is also a means for the public to communicate with astronauts on board the Station. How does HAM radio work? How can educators and students participate in HAM radio connections?

Instructional Objectives

Students will:

- Understand the function and importance of amateur radio on the International Space Station through the videoconference event;
- Identify resources available for radio downlink participation through the videoconference event;
- Understand how sound travels in waves through the pre- and post-activities.

National Standards

National Science Education Standards (NSES)

Content Standard A – Science as Inquiry
Content Standard B – Physical Science
Content Standard E – Science and Technology

International Technology Education Association (ITEA)

Standard 1 – Students will develop an understanding of the characteristics and scope of technology.
Standard 11 – Students will develop abilities to apply the design process
Standard 12 – Students will develop the abilities to use and maintain technological products and systems
Standard 17 – Students will develop an understanding of and be able to select and use information and communcation technologies

National Standards

National Science Education Standards (NSES) *(*from www.nap.edu *)*

Science	Give Me A Call	DLN Connection	Making Radio Waves
Content Standard A: Science as Inquiry Abilities Necessary to do Scientific Inquiry	X	X	X
Content Standard B: Physical Science Properties of Objects and Materials	X	X	X
Content Standard E: Science and Technology Abilities of Technological Design		X	X

Expected Student Behaviors

Content Standard A – Science as Inquiry

Abilities Necessary to do Scientific Inquiry - *Students should begin developing the abilities to communicate, critique, and analyze their work and the work of other students. This communication might be spoken or drawn as well as written.*

Content Standard B – Physical Science

Properties of Objects and Materials - *Through the observation, manipulation, and classification of common objects, children reflect on the similarities and differences of the objects. Sounds are not intuitively associated with the characteristics of their source by younger K-4 students, but that association can be developed by investigating a variety of concrete phenomena toward the end of the K-4 level.*

Content Standard E – Science and Technology

Abilities of Technological Design - *Student abilities should include oral, written, and pictorial communication of the design process and product. The communication might be show and tell, group discussions, short written reports, or pictures, depending on the students' abilities and the design project.*

International Technology Education Association (from www.iteaconnect.org)

Technology	Give Me A Call	DLN Connection	Making Radio Waves
Standard 1: The Characteristics and Scope of Technology			
(K-2) B: All people use tools and techniques to help them do things	X	X	X
(3-5) D: Tools, materials, and skills are used to make things and carry out tasks	X	X	X
Standard 11: Students will develop abilities to apply the design process			
(K-2) B: Build or construct an object using the design process	X		X
(3-5) E: The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.	X		X
Standard 12 – Students will develop the abilities to use and maintain technological products and systems			
(K-2) A: Discover how things work	X		X
(3-5) D: Follow step-by-step directions to assemble a product	X		X
Standard 17 – Students will develop an understanding of and be able to select and use information and communication technologies			
(K-2) B: Technology enables people to communicate by sending and receiving information over a distance		X	
(3-5) F: Communication technology is the transfer of messages among people and/or machines over distances through the use of technology		X	

Expected Student Behaviors

Standard 1 – Students will develop an understanding of the characteristics and scope of technology.

(K-2) All people use tools and techniques to help them do things – *At this grade, students should begin to explore how people have developed ways to shape their world in order to improve comfort, ease workload, and increase leisure time.*

(3-5) Tools, materials, and skills are used to make things and carry out tasks – *When students observe how various things are made, grown, or used, they should begin to see that different processes and techniques are used.*

Standard 11 – Students will develop abilities to apply the design process

(K-2) Build or construct an object using the design process – *After they have selected a solution, students should build or construct it to demonstrate the design idea.*

(3-5) The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many – *Students will select the best possible solutions and then create a design using sketches and drawings.*

Standard 12 – Students will develop the abilities to use and maintain technological products and systems

(K-2) Discover how things work – *The students should be encouraged to investigate each item, perhaps by taking it apart or by comparing it similar ites to discover how it works, its use, and its purpose.*

(3-5) Follow step-by-step directions to assemble a product – *Students must learn to follow step-by-step directions. Teaching this ability will require a significant period of time with many exposures to directions that are both well and poorly done.*

Standard 17 – Students will develop an understanding of and be able to select and use information and communication technologies

(K-2) Technology enables people to communicate by sending and receiving information over a distance – *Students will learn about the communication process and the different ways that they can locate information and communicate with others.*

(3-5) Communication technology is the transfer of messages among people and/or machines over distances through the use of technology – *Students at this grade level should be given various opportunities to use information and communication tools in order to experience firsthand how technology can be used to enhance the communication process.*

Expedition Videoconference Guidelines

Audience Guidelines
Teachers, please review the following points with your students prior to the event:
Videoconference is a two-way event. Students and NASA presenters can see and hear one another.

Students are sometimes initially shy about responding to questions during a distance learning session. Explain to the students that this is an interactive medium and we encourage questions.

Students should speak in a loud, clear voice. If a microphone is placed in a central location instruct the students to walk up and speak into the microphone.
Teacher(s) should moderate students' questions and answers.

Teacher Event Checklist

Date Completed	Pre-Conference Requirements
	Print a copy of the module.
	Have the students complete the pre-assessment.
	Email questions for the presenter. This will help focus the presentation on the groups' specific needs.
	Review the Audience Guidelines, which can be found in the previous section.
	Day of the Conference Requirements
	The students are encouraged to ask the NASA presenter qualifying questions about the Expedition.
	Follow up questions can be continued after the conference through e-mail.
	Post - Conference Requirements
	Have the students take the Post-Assessment to demonstrate their knowledge of the subject.
	Use the provided rubric as guidelines for content and presentation criteria.
	Teacher(s) and students fill out the event feedback.

Expedition Videoconference Outline

Introduction to Expedition Videoconference

Join the Digital Learning Network as we explore how astronauts on the International Space Station communicate using amateur, or HAM, Radio. Learn how amateur radio works, its purpose on the International Space Station, and how educators and students can participate in radio downlink events with astronauts through ARISS.

Outline for Video Conference

Welcome
Introduction
Define Amateur Radio
How HAM Radio Works
How World Uses Amateur Radio
How NASA uses Amateur Radio aboard ISS
How Educators and Students use Amateur Radio
How to Connect with the ISS
ARISS Connection Demonstration
Online Resources
Q&A
Good-Bye

Pre-Conference Requirements

Pre-Assessment

A week before the event, students will need to take the pre-conference assessment. This short assessment will provide useful background information for the presenters to prepare for the videoconference.

Pre-Conference Assessment Questions

1. What is sound?
2. How does sound travel?
3. List ways we can communicate with people on Earth.
4. List ways astronauts can communicate to Earth.
5. What is HAM radio?
6. Why is communication an important factor of NASA manned missions?

Suggested Answers to Pre and Post Assessment Questions:

1. What is sound?
   Sound is vibration that passes through a solid, liquid, or gas. Certain frequencies of sound can be detected by the human ear.
2. How does sound travel?
   Sound travels in waves.
3. List ways we can communicate with people on Earth.
   Answers will vary.
4. List ways astronauts can communicate to Earth.
   Radio and email are the most common forms of communication to the ground.
5. What is HAM radio?
   HAM radio is another name for amateur radio. The word “ham” refer to the radio operators.
6. Why is communication an important factor of NASA manned missions?
   Answers will vary.

Pre-Conference Activities

Hamming It Up on ISS

Amateur radio, also called ham radio, is a fun way to talk with astronauts. Anyone with a scanner can hear astronauts talk back to Earth. If you have a transmitter, you can talk to astronauts in space.

Before 1983, only a few people could talk to astronauts in space. Now with an amateur radio license, you can talk too. The ham radio project was the first to allow astronauts to talk with the public.

How do you talk with the astronauts? Paul Dumbacher, an engineer at Marshall Space Flight Center in Alabama, tells us how. Know when the Space Station will be over your area. Know what station the astronauts transmit on. Know what the crew's schedule is. Taking time to learn a bit of amateur radio lingo will help.

People can listen to Space Station talk from home. School groups can talk with astronauts in space. It takes time to learn ham radio lingo. It's a way to be part of history. Being able to hear the astronauts talking on the radio makes it real.

This shows how math and science are good things. It shows that addition and subtraction are good things. This shows how science matters.

Courtesy of NASA's Space Operations Mission Directorate

Give Me A Call

Teacher Sheet(s)

Objective: Students will explore how sound travels by conducting a range of experiments with paper cup telephones.

Level: K-4
Subjects(s): Physical Science
Prep Time: Less than 10 minutes
Duration: 40 minutes
Materials Category: Common Household

National Education Standards
Science: Science as Inquiry, Physical Science
Technology (ITEA): 1b, 11b, 12a

Materials:
(Per group)

- Two paper cups
- Six meters (20 feet) of fishing line, string, or waxed dental floss
- Two paper clips
- Paper and pencil

Pre-Lesson Instructions:
Each group will need 6 meters (20 feet) of fishing line, string, or waxed dental floss. The fishing line seems to work best.
Choose a quiet place for students to do this activity.
Set out the materials in a central location.
Have students pick a partner.

Background Information:
None

Guidelines:
Ask students, "How do you think sound travels from your mouth to their ears?"
Guide students to the answer that some type of sound vibration is moving through the air. Ask students, "How can sound vibrations move through the air?"
Sound needs a substance through which to travel. When people talk to each other, the space between them is not empty; it's filled with air. Air is a substance just as the dental floss or fishing line between the cups is a substance.

Answers To Questions

8. Answers will vary. Sound will be muffled.

9. It will be difficult to hear because the sound waves will not transmit efficiently along a sagging line.

10. Answers will vary. The tighter the string, the clearer the sound will be.

11. It doesn't work because the vibrations are partly diverted by the person holding the line, weakening the signal that reaches the "receiving" paper cup.

12. They travel through the line.

13. The sound waves cause the string to vibrate, moving the air inside the cup in the same pattern that was created by the original sound.

14. The reason is that wave energy is passed from atom to atom. The closer the atoms are to each other (and the stronger the wave), the more efficiently sound can travel.

15. When the particles of a substance are densely packed, as in a solid such as string or copper wire, sound waves can generally move more quickly through them. When the particles of a substance are farther apart, as in a gas such as air, the waves take longer to travel through them.

Discussion/Wrap-up:
None

Extensions:
None

Give Me A Call

Student Sheet(s)

Objective
To explore how sound travels by conducting a range of experiments with paper cup telephones.

Materials
(Per Team)

- Two paper cups
- Six meters (20 feet) of fishing line, string, or waxed dental floss
- Two paper clips
- Paper and pencil

Procedure

1. Cut the fishing line or string into roughly 6-meter (20-foot) sections.

2. Use a pencil to poke a hole in the bottom of a cup.

3. Tie one end of the string or fishing line around a paper clip.

4. The inner "loop" of the paper clip should then be inserted through the hole from the outside of the cup so that it is clipped securely to the circular bottom of the cup.

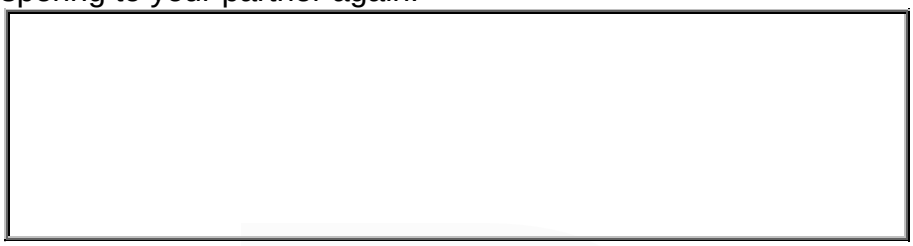
5. Repeat this process using the other end of the line and the second cup.

6. Pull the string tight between the two cups.

7. Take turns placing the cup against one ear while your partner whispers into the cup at the other end of the line.

8. You should be able to hear your partners' voice resonating in the cup against your ear. Write your observation.

9. Step in closer to your partner, so the string is now loose (sagging). Try whispering to your partner again.



10. Test whether or not your telephones will work when the line is stretched under a closed door.

11. Have a third person hold the fishing line in the middle. Does the telephone still work?

12. How are the sound vibrations getting from one cup to the other?

13. After the vibrations get to the cup at the end of the line, what might they be doing to the bottom of the cup?

14. How does sound travel through air?

15. How you think the telephone would work if you used copper wire instead of fishing line?

Post-Conference Activities

Online Post-Assessment

After the event students will need to take the post-conference assessment. (These questions are the same questions used in the pre-assessment.) The short assessment will help us measure student learning and identify any changes that need to be made in future programs.

Post-Conference Assessment Questions
Grades K-4

1. What is sound?
2. How does sound travel?
3. List ways we can communicate with people on Earth.
4. List ways astronauts can communicate to Earth.
5. What is HAM radio?
6. Why is communication an important factor of NASA manned missions?

Making Radio Waves

Teacher Sheet(s)

Objective: Students will make and test a simple radio-wave generator using ordinary household materials.

Level: K-4
Subjects(s): Science as Inquiry, Physical Science, Technology
Prep Time: 10-30 minutes
Duration: 50 minutes
Materials Category: Special Requirements

National Education Standards
Science: 2a, 3a, 6a
Technology (ITEA): 1b, 11b, 12a

Materials:
(Per group)

One inexpensive transistor radio (must receive AM)
Two 25-centimeter lengths of insulated wire (18-24 AWG)
One metal fork
Tape (masking or electrical)
One "C" or "D" flashlight battery
Metal tray or metal foil
Tape measure or meter sticks

Pre-Lesson Instructions:

1. Begin collecting small radios that can receive AM stations. Students may have radios at home they can bring in.

2. Cut two wire "leads" (lengths) for each group. Cut the leads each 25-centimeters long from a spool of wire.

3. Using a sharp knife or wire stripper scrape about 1 centimeter of plastic coating from each end of the wire.

4. Divide the class into groups of three to four.

Suggested Discussion Starters:
Ask students, "How do you think radios work?"

Ask students, "Why can we hear something when we strike a drum, but we don't see anything happen?"

Notes:
This activity will need to be completed outdoors because each group will need a space several meters long to test how far radio waves from their radio wave generator can travel.

Set out the trays, flashlights, and tape measures in a central location.

Background Information:
None

Guidelines:
When the bare wire is stroked against the fork, it generates something called electromagnetic radiation by releasing electric energy from the battery.

Ask students, "What does this activity tell you about the sound you hear on the radio? (Radio and light waves are both types of electromagnetic radiation. The electromagnetic spectrum is made up of different lengths of waves.) Explain to students, that electromagnetic radiation travels through space. Radio waves are long. Light waves are shorter.

Discussion/Wrap-up:
None

Extensions:
Draw the electromagnetic spectrum. (For upper elementary levels)

Making Radio Waves

Student Sheet(s)

Materials
(Per group)

One inexpensive transistor radio (must receive AM)
Two 25-centimeter lengths of insulated wire (18-24 AWG*)
One metal fork
Tape (masking or electrical)
One "C" or "D" flashlight battery
Metal tray or metal foil
Tape measure or meter sticks
*AWG is the standard gauge used to measure wire. Insulated, 18-24 AWG wire will be thin copper wire coated with plastic, and is available from electronics, hardware, or home supply stores.

Procedure

1. To create a radio-wave generator, securely tape the end of one length of wire to one end of the battery.

2. Tape the end of the second wire to the other end of the battery.

3. Wrap the other end of either one of the wires tightly around the handle of the fork, making sure that the bare copper is touching the handle.

4. Put your radio on the AM band.

5. Turn on the radio.

6. Turn the dial all the way in one direction so that all you hear is static.

7. Holding the fork close to the radio, stroke the bare end of the other wire lead across the fork's prongs.

8. You should hear corresponding static on the radio. If you do not, you should make sure the wires are securely attached to the battery and fork handle. You have just created radio waves (represented by the static).

9. Measure off a distance of 20 centimeters from the radio.

10. Place your radio wave generator at the spot 20 centimeters from the radio. Record observations.

11. Vary the distances between the radio and the radio-wave generator. Record the distances and observations.

12. Insert obstacles between "source" and "receiver." Record your observations.

Observations

Distance (centimeters)	Observations

Record your observations from placing something between the "source" and the "receiver".

How did the fork affect the radio?

How did changing the distance affect the radio waves?

NASA Education Evaluation Information System (NEEIS)

Please complete an online evaluation form to provide feedback on the NASA Challenge.
Feedback from you and a few of your students would be appreciated.

http://dln.nasa.gov/dln/content/feedback/

National Aeronautics and Space Administration

NASA Digital Learning Network

presents

Certificate of Completion

to

_____

for

HAM It Up!

_____ _____

Instructor *Date*

Vocabulary

ARISS: acronym for Amateur Radio on the Internation Space Station; a volunteer program which inspires students, worldwide, to pursue careers in science, technology, engineering and math through amateur radio communications opportunities with the International Space Station (ISS) on-orbit crew.

Astronaut: A person trained to travel and work in space.

Energy: strength or power to work or be active; force; vigor; the power of certain forces of nature to do work.

HAM Radio: also known as amateur radio

International Space Station: a laboratory orbiting the Earth; a joint mission with the space programs of 16 countries, including the United States.

Radio: a form of communication; can be found in a car, on a plane, etc.

Radio Waves: electromagnetic waves occurring on the radio frequency portion of the electromagnetic spectrum.

Sound Waves: the vibration transmitted through a solid, liquid, or gas; particularly, sound means those vibrations composed of frequencies capable of being detected by ears.

Resources

NASA
For information on exploratory missions, manned spaceflight, and more, please visit this website.
www.nasa.gov

NASA Kids Club
For activities, games, stories and more, visit this website specifically designed for kids that are interested in space and NASA.
http://www.nasa.gov/audience/forkids/kidsclub/flash/index.html

American Radio Relay League (ARRL)
http://www.arrl.org

Radio Amateur Satellite Corporation (AMSAT)
http://www.amsat.org

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