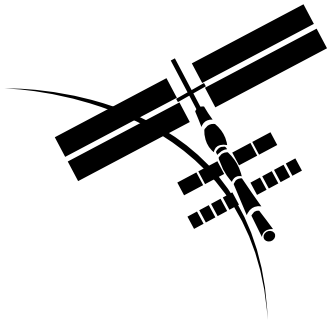
Building a Permanent Human Presence in Space

Grades 5-8

Lesson 2: Are You An Explorer?

The United States and its partners around the world are building the International Space Station (ISS), arguably the most sophisticated engineering project ever undertaken. The ISS is an orbiting laboratory where astronauts conduct research in a variety of disciplines including materials science, physiology in microgravity environments, and Earth remote sensing. The ISS provides a permanent human presence in low Earth orbit. This lesson is one of many grade K-12 lessons designed to bring the ISS experience to classrooms across the nation. It is part of *Building a Permanent Human Presence in Space*, one of several Education Modules developed for the *Journey through the Universe* program.

September 2007



Lesson 2: Are You An Explorer?

Lesson at a Glance

Lesson Overview

When you hear the word 'explorer,' what comes to mind? You will likely conjure up visions of noble, courageous men or women, physically battling with nature to achieve some challenging goal against grave personal risk. That isn,t the only way to explore, however. People explore the world every day, in many ways, without necessarily traveling to far off lands to do so. In this lesson, students examine the characteristics of explorers. They then create an exploration log to determine whether they too possess these qualities and are also explorers.

Lesson Duration

Two 45-minute class periods

Core Education Standards

National Science Education Standards

Standard E2: Understandings about science and technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Standard G1: Science as a Human Endeavor

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.

Essential Question

- What is an explorer?

Concepts

Students will learn the following concepts:

- Explorers can be very different, but share some common characteristics.
- Explorers are people who discover something new or go to new places that no one has ever gone to before.
- It is human nature to explore.

Objectives

Students will be able to do the following:

- Identify characteristics common to all explorers.
- Create a journal of their explorations.

Science Overview

People do not explore the world one-by-one. Even those explorers who venture out into the unknown on their own, take the rest of humanity with them. They share their explorations with everyone else by speaking and by writing about what they have seen and what they have learned. Human language conveys a description of the world that is complex and nuanced, so that explorers are able to describe what they found and where they found it, and can interpret its context and meaning—for example, "I discovered a deposit of valuable ore, but it is in a difficult location to mine it using current technology." Most importantly, human language allows an explorer's discoveries to be used long after the exploration is completed. Written language and audio or video recording are the most obvious ways that modern society saves people's work. Even in non-literate societies, oral history carries knowledge from one generation to the next. In some societies, storytellers or elders may have a ready memory of many hours of oral history, as well as cultural and factual material as a resource and intergenerational memory for their people.

People explore the world in an organized fashion. One level of organization is human society. Another level of organization is among the explorers themselves—how they distribute leadership and supporting roles within a team. A more important form of organization is the organization of the exploration process itself. In modern times, this mode of organization is called the scientific method, but it is really not new. Its importance comes from having a simple philosophy for exploration that provides accurate answers to many questions about the world. Human babies employ a basic version of the scientific method, "trial and error," all the time, trying something to see if it works and abandoning it if it doesn't work. The scientific method expands upon simple trial-and-error by using prior knowledge to make predictions for the outcome of experiments in new situations, and using the results of actual experiments (trials) to revise knowledge.

The power of the scientific method is that the same plan can be applied to many different situations and it makes a framework for how to interpret the results of experiments. A person who tries out something new, for example, does not just make a note of whether the idea was right or wrong. He or she also considers just how well or how poorly the results of the experiment matched expectations and uses that information to modify the original idea. A mostly-successful experiment supports making minor modifications; a crashing failure

leads to major changes. Failure is the engine that moves science. Failures show when a scientist's expectations are wrong and thereby give some understanding of what is really going on in the world. Testing expectations through scientific investigation allows people to develop general rules for the behavior of objects and materials in the physical world, extending the benefits of organized exploration beyond the immediate experiment.

Not every modern society describes the scientific method in the same format, as a hypothesis, followed by testing, followed by rejection, refinement, or acceptance of the hypothesis. This is mostly just semantics. As a practical matter, the scientific method is used all the time. When people get dressed in the morning, they have an expectation for the weather and what conditions they will face. People choose clothing according to their expectations, then face the reality of how that day's choices succeeded or failed. The next day, they try again, perhaps choosing their wardrobe differently, if experience suggests a change is needed. Common sense and the scientific method are often the same thing. An Arctic explorer who assumes warm tropical conditions will have a short career, because it is obvious that he or she should expect extreme cold. How well the explorer's expectations prepare him or her for the real test of weather and nature determines whether he or she will return alive. Physical exploration of the world uses the scientific method in its most severe form, whether it is called the scientific method or not. The great success of science as a modern enterprise comes from recognizing that the same method can be applied across the whole range of interactions with the physical world.

The scientific method is an uncompromising philosophy of how to test notions about the world, to see if they fail, or if they will live to face another test. Human creativity continually invents new ideas for how the world might be and how it might function. The job of science is to face and to accept, unflinchingly, the test of nature to tell whether an idea is correct or not.

In order to have ideas to test, people need a motivation to create them. This is the unique role of human curiosity. Practical necessity is a strong motivator, of course. The need to acquire food and to be able to expect a steady supply of it is an excellent reason to explore; likewise for water, for shelter, and for territory to support growing populations. Hunger, however, does not account for the development of many, if not most, technologies. Pre-Stone-Age people could pick up a sharp rock and use it as a weapon or a tool, but it took experience to learn to select certain rocks and to learn how to strike them together in the right way

Are You An Explorer?
Lesson at a Glance
Science Overview
Conducting the Lesson
Resources

to make stone tools on purpose. Stone-Age people needed experience with fire and with rocks and with metals before smelted ores became a source of tools that could be used for survival. The explorations needed to understand rocks and fire could be recognized as useful only after they had been done. Somebody had to be just plain curious in order to learn those things.

There is an old quip that claims that "experience is something that you get just after you needed it," but that is not always true. Curiosity can provide experience before it is needed, leading people to explore the world with no expectation of immediate gain, without even an idea what the gains could be. Some of the most powerful and far-reaching of the technologies that touch lives in modern society—semiconductor electronics (computers), mechanical motors, radio communications, and a multitude of others—began as pure curiosities with no apparent application. Well over a thousand years passed between Hero's description of the concept of the steam engine and its use in practical technology. Only after sufficient knowledge was gained was it possible to use it in applications that could not be envisioned in advance, driving locomotives, ships, electrical generators, and many other applications. Without curiosity, people could only refine the technologies and knowledge that they already have, instead of looking beyond to entirely new technologies and entirely new realms of understanding the world.

NOTES:

Conducting the Lesson

Warm-Up & Pre-Assessment

Teacher Materials

- Chalkboard

Preparation & Procedures

1. Ask students to brainstorm a list of famous explorers. (*Desired answer: Columbus, Magellan, Lewis and Clark, Leif Erikson, etc.*)

2. As a class, ask students to use their examples to create a definition of an explorer. Write their responses on the board. (*Desired answer: someone who discovers something new for their culture or goes someplace no one from their culture has ever gone before*)

3. Ask students, based on their definition, can they think of modern-day explorers, perhaps people that they did not originally consider. Today, who goes to places that no one has ever been? Who discovers new things? (*Desired answer: astronauts, medical researchers, scientists, etc.*) Ask students if they feel that they too are explorers. (*Accept all answers*)

NOTES:

Activity: Are You an Explorer?

In this activity, students will investigate different explorers and examine the driving questions behind their explorations. Students will then keep a log of the explorations they make over a week in order to determine whether they too are explorers.

Teacher Materials

- Blackboard or whiteboard

Student Materials (per student)

- Explorer biographies
- Student Worksheet 1
- Exploration Journal

Preparation & Procedures

1. Have students read biographies about two different explorers. Students can choose two biographies that interest them from the back of the lesson. After reading the biographies, have students complete the questions on Student Worksheet 1.

2. When all students have completed Student Worksheet 1, have them create a Venn diagram in order to compare the two explorers they read about. Ask students to provide facts from the Explorer Biographies or their personal conclusions in order to complete the Venn diagram.

3. Ask students to look at the similarities between the explorers. Ask students if they qualify as explorers according to the definition the class created earlier. If not, revise the definition as a class. Looking at the qualities shared by both explorers, ask students if they themselves would be considered explorers. Allow students the opportunity to share their opinions.

4. Have your students use the Exploration Journal to document questions that they raise about the world around them. Students should identify the observation or event that prompted their exploration, and use the Scientific Method to answer their question. Students should also note any new questions that the exploration provoked.

Teaching Tip

Review the steps of the Scientific Method with students.

Reflection & Discussion

1. Ask students to share some of the explorations that they conducted over the past week. Ask students to look at the processes they used to answer their questions. Even though their investigations were different, ask students if the processes were similar. (*Desired answer: all students should have used the scientific method to answer their questions*)

2. Ask students to compare their explorations with those of the explorers in the articles. Were there any similarities? Ask students, based on their explorations, are they too explorers? (*Desired answer: yes, all of us have questions about the world around us that we attempt to learn more about. It does not matter if those questions are big or small; exploration is about learning something new*)

Transfer of Knowledge

Ask students to find an explorer in their community and to write a short biography about that person, highlighting why they think that person is an explorer.

Extensions

- Enlist a local scientist to come to your class to talk about his/her explorations. (Universities, university extension services, federal land management agencies, and private industries are all good resources for locating scientists.)

Placing the Activity Within the Lesson

Discuss how students learned that explorers can be very different, but all share some common characteristics. Students then realize that they, too, share those characteristics and are also explorers, questioning and learning new things about their environment.

Assessment Criteria for Activity

4 Points

- Questions answered on Student Worksheet 1 are complete and accurate.
- Exploration Journal is dated, sequenced, and complete.
- Exploration Journal is well organized so that the reader can understand it.
- Student Question in the Exploration Journal is clearly and thoroughly stated.
- Student's biography clearly depicts why the person they have chosen is an explorer.

3 Points

- Questions answered on Student Worksheet 1 are mostly complete and accurate.
- Exploration Journal is dated, sequenced, and complete.
- Exploration Journal is organized so that the reader can understand it.
- Student Question in the Exploration Journal is stated.
- Student's biography states why the person they have chosen is an explorer.

2 Points

- Questions answered on Student Worksheet 1 are somewhat complete and accurate.
- Some attempt at organization in Exploration Journal, but work is incomplete.
- Reader can understand work.
- Student's biography states why the person they have chosen is an explorer.

1 Point

- Questions answered on Student Worksheet 1 are incomplete.
- Exploration Journal is incomplete or unreadable.
- Student's biography does not clearly state why the person they have chosen is an explorer.

0 Points

- No work turned in.

NOTES ON ACTIVITY:

Lesson Wrap-Up

Lesson Closure

Discuss with students how it is human nature to explore; babies crawl, kids survey the playground, and teenagers question. We are all explorers, as is evident by your Exploration Journal. Exploration can lead you to an exciting career that could benefit society.

NOTES:

Resources

Internet Resources & References

Student-Friendly Web Sites:

Biographies of Explorers
http://www.mariner.org/age/biohist.html

Lunar Exploration
http://nssdc.gsfc.nasa.gov/planetary/lunar/

Zoom Explorers
http://www.enchantedlearning.com/explorers/

Teacher-Oriented Web Sites:

Age of Exploration Timeline
http://www.mariner.org/age/histexp.html

Hero's Steam Engine
http://library.thinkquest.org/C006011/english/sites/heron_bio.php3%3fv=2?tqskip1=1

The Explorers Club
http://www.explorers.org/

Journey through the Universe
http://journeythroughtheuniverse.org/

Teacher Answer Key

Answers will vary depending on what biographies students choose to read.

Student Worksheet 1

Name _____ Date _____

Read two biographies of explorers and then answer the questions below.

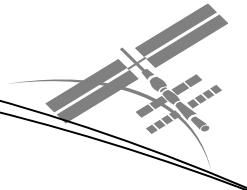
1. What were these people exploring? Use quotes from the biographies to support your answer.

2. What questions do you think these explorations began with? Explain.

3. What tools did these people use in their exploration? Make two lists: one for items that they talk about in the biographies, and one for items you think they the may have needed.

4. Did the people answer their questions, or are these ongoing explorations? Explain.

5. What similarities do you see between these two explorations?



Exploration Journal

Name _____ Date _____

Over the next week, keep a journal of any explorations you conduct. Identify what inspired you to explore. Was it an observation? Was it a conversation? Or was it a thought you had?

Date/Time:
Question:

Why did you ask this question?

Research

What can you find out about your question?

Hypothesize

What do you think is the answer to the question?

Experiment

What can you do to find the answer to your question?

Collect and Analyze Data:

What did you find out through your experiment?

Conclusion

Based on your data, what do you believe is the answer to your question.

Did your investigation generate any new questions?

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Conclusion
Based on your data, what do you believe is the answer to your question.

Did your investigation generate any new questions?

At the end of the week, answer the following questions based on your explorations.

1. Did your explorations answer your questions? Which ones were successful, and which ones were not? What is it that makes an exploration successful?

2. Did you use some sort of tools or technology in your exploration? If so, could you have done the exploration without the use of technology?

3. How do you think scientists come up with new things to explore once they have learned the answer to their old questions?

Explorer Biography

Joseph Njoroge Kagenyi
Meteorologist
Institute for Meteorological Training and Research
Nairobi, Kenya

Birth Date: May 16, 1960
Grew up in: Central Kenya, a country in Africa
Hobbies: computer technology, reading books
Favorite subject in school: mathematics, physics, chemistry, biology, and geography

What does he do?

I'm a weather scientist. Another word for that is meteorologist. Thirteen years ago, I got my first job as a weatherman. I used satellites to tell ahead of time what the weather would be like. The satellites send pictures down to Earth. With the pictures we can see things like storms that are coming toward where we live!

I learned a lot as a weatherman. One thing I studied was how to predict frost in the Kenyan highlands. Kenya is the country I live in. Knowing when the frost is coming can help people like farmers because frost can hurt crops. If people know about the frost ahead of time, they can plan for it.

When he was young:

I grew up in a small village in central Kenya. I spent my weekends hunting antelopes, dikdik and rabbits, and fishing in rivers. My parents could not afford meat most of the time, so we would go out and hunt. My family lived on about nine dollars a month, and there were twelve of us kids! We were very poor, but the days were exciting. On fishing days we would walk about eight to ten miles away from home and fish upstream. We would light a fire and roast the small fish we had caught. The rest we would carry home for dinner. At home we had no oil for a lantern lamp. I would wait until Mum had finished cooking and all the family had gone to sleep. Then, I used the light from the fire to study until past midnight.

When he was older:

I did very well in school. Because of my good grades, I was admitted into Kiambu High School, but it costs money to go there. During vacation, Mum and I worked so that we could pay the school fees. After three weeks of work, thrashing corn, we made a total of seven dollars. All of this was to pay for school, but when we got back we found out that the fees were paid by a scholarship. My Mum used the seven dollars to buy a cow for milk which made life a lot better for my younger brothers.

He has a really cool job:

Since I have been a weather scientist for so long, I help people from other African countries learn how to predict weather. We look at violent weather activities in the tropics. We can learn about this weather by using satellites, too. The satellites take wind readings, which tell us about bad weather that is on its way. I like helping other people, and I love my job.

Explorer Biography

Jerry Elliott, High Eagle
(Osage-Cherokee)
Assistant Chief Technologist

Birth Date: February 6
Grew up in: Oklahoma
Hobbies: playing guitar and Indian flute
Favorite subject in school: math

What does he do?

I look at the world like you do, always wondering what it is made of, and how its pieces are put together. I am a scientist. That is a big fancy word for a person who explores new things and discovers secrets about the world. Scientists and engineers like to solve puzzles and build things.

I worked with a team of people to design the International Space Station (ISS). We drew pictures of how we thought it should look. Then we began to make small models of the ISS. Next, we began to think of the best way to build it so people could live there. We also had to figure out how to pack all the pieces of the ISS in the Shuttle spacecraft. Kind of like packing your suitcase. The pieces are brought up into orbit and then put together.

I also worked with the Ground Support and the Flight and Orbital Equipment. The Ground Support Equipment tests the Space Station components before they launch into orbit to make sure they are working properly. Flight and Orbital Equipment is what the astronauts use to perform jobs for the ISS.

When he was young:

I lived and played on a small farm with lots of animals. I wondered what made rainbows, and why sunsets were always red. I wondered about a lot of things and wanted to find the answers. I made paper airplanes and flew them to see if they could touch the clouds. Some would fly long distances. Some crashed! But I always learned from my mistakes. There were no astronauts then. But I knew someday, people would fly in rockets and go to the stars. That was my dream.

When he was older:

I wanted to be in the space program. I knew that it would be hard work and I would have to learn new things. I liked math and always studied hard because I knew one day my dreams would come true. But I had to make them happen! Anything good and worthwhile takes effort. When I went to work for NASA, I saw my dream come true.

He has a really cool job:

It was fun to make pictures of the International Space Station and then build it. The Space Station is our first home in space! We had to make it work so people like you and me could live, work, and play there. Someday, we may even build homes on the Moon or other planets. Where would you like to live? Would you take your dog or cat with you? I bet they would have funny looking space suits!

Explorer Biography

Pat Rawlings
Space Artist and Conceptual Designer

Birth Date: June 2, 1955
Grew up in: Greenville, Texas
Hobbies: indoor soccer, movies, reading
Favorite subject in school: science

What does he do?

When I drive down the road, I look at things and I think 'what would that be like if it were in space?' If I read a book or watch a movie I ask the same question. I'm always looking at things and wondering what they would be like in space. This is how a space artist thinks!

I do artwork of what space might really be like in the future. I don't paint things you can go out and take a picture of, like the Shuttle. I create pictures that show what space could be like 10 to 100 years in the future. Every picture I do is like a story. There are details that show what time of day it is, what planets are in the background and what the atmosphere and weather outside are like.

These pictures help all sorts of people. Have you ever heard the saying that a picture paints a thousand words? A lot of times, engineers and scientists ask me to do a picture showing what it would be like to go to the Moon or to Mars. They use the picture instead of the thousand words! A painting can help them show off the ideas that they have in their head.

When he was young:

When I was in school I had been doing art for a long time. I did art during math in the first grade and during English in the second grade. I was drawing pictures to amuse my classmates. What I really wanted to be was a magician. A friend and I used to put on magic shows for people. We'd go out and give magic shows for retired people.

When he was older:

I wanted to be a chemist. I spent all my extra money on glassware and chemicals. I set up a lab in an extra room in the house. I tried to figure out ways to make things change color or explode. I also read tons of science fiction stories. All the time I was doing things that ended up being very helpful for being a space artist and I didn't even know I wanted to be a space artist. You mix chemistry, science, and magic and you come out with space art. It involves illusion of reality, scientific accuracy, and knowledge of a number of the sciences and artistry. You never quite know how things will help you when you're growing up until it hits you in the face.

He has a really cool job:

My hobby is my job. The coolest thing about my job is being able to sit in my office all day long and listen to classical music while I paint. Sometimes I produce pictures out of my head. If I need help with the idea, I can pick up the telephone and call the world's top experts on whatever I'm painting. So I get to talk to really cool people.

Explorer Biography

Monsi C. Roman
Microbiologist, Environmental Control and Life Support Branch
NASA/Marshall Space Flight Center

Birth Date: November 1, 1962
Grew up in: Puerto Rico
Hobbies: cooking (especially desserts), crafts, visiting museums and zoos
Favorite subject in school: science

What does she do?

I work with a team of engineers who design and test the water and air systems for the International Space Station (ISS). In the ISS, all the water the crew uses will be recycled. The water they use for showers and washing hands, and even the crew's urine, will be collected, cleaned, and returned to the crew for drinking. Recycling the water means less water will need to be brought to them on the Space Shuttle Orbiter. This will allow the Orbiter to have more space for more experiments and other supplies.

As the microbiologist of the group, I make sure that the recycled water is safe to drink. A microbiologist studies living organisms that you cannot see. You can only see them under a microscope. These organisms include viruses, bacteria, yeast, molds, and parasites. Some of these organisms can make you sick, but others are good for you.

I help the engineers figure out how to test the crew's water for bad microorganisms. We also make sure that microorganisms do not grow in the systems that provide clean air to the crew. This is important. Water and air are two of the most important things humans need to stay alive.

When she was young:

I was very active in my school's science fairs. The fairs helped me organize my ideas. A concept in my head would become a final display that explained what I did, and how I did it. I was lucky to have had a chance to interact with real scientists for some of my experiments. It was then that I realized that I really liked science. I knew that when I grew up, I wanted to work with living things.

When she was older:

In college I studied biology which is the science of living organisms. I was not sure what I wanted to do in biology. So, I took as many different biology classes as I could. I really liked microbiology so I started working in a microbiology lab for free, washing lab dishes and helping other students. Then, they hired me as a research assistant. After college, I decided to go back to school to specialize in microbiology.

She has a really cool job:

Being a NASA scientist is like a dream come true. When I was in school someone dared to imagine a Space Station, and here we are building it. It is great to be part of the design of a "station on orbit," where people will live for months at a time. Can you imagine the feeling of knowing that you are helping build the International Space Station? It is really cool! Imagine the future and go make it happen!