National Center
for Earth and Space Science Education

Universities Space Research Association

USRA

# Introduction to the *Journey through the Universe* Program, the MESSENGER Education and Public Outreach Program, and the MESSENGER Education Module *Staying Cool* Grade 5–8 Lessons

## 1. The Programs

***Journey through the Universe*** (http://journeythroughtheuniverse.org) is a national science education initiative that engages *entire* communities—students, teachers, families, and the public—using education programs in space exploration and the space sciences to inspire and captivate. The initiative embraces the notion that—*it takes a community to educate a child.*

*Journey through the Universe* programming is tailored to a community's strategic needs in science, technology, engineering, and mathematics (STEM) education, and is a framework for partnership between school districts, museums and science centers, colleges and universities, civic and business organizations, and the public. The cornerstone philosophy for all programming is—*inspire… then educate.*

***NASA's MESSENGER Spacecraft Mission to Mercury*** (http://messenger.jhuapl.edu} includes education programs delivered by organizations nationally. The National Center for Earth and Space Science Education oversees a number of these programs, including: 1) the development of middle and high school components for grade pre-K-12 MESSENGER Education Modules—each a theme-based compendium of inquiry-based lessons on Solar System science and exploration (the Carnegie Institution of Washington is responsible for the grades pre-K-4 component); 2) delivery of Solar System content through community initiatives such as *Journey through the Universe*, and 3) the creation, training, and support of a cadre of master science educators—the MESSENGER Educator Fellows—which in turn train 3,000 teachers a year on the Modules, corresponding to 27,000 teachers trained over the mission lifetime (through 2012), and translating into experiences for over 1 million students.

## 2. The Grade pre-K-12 MESSENGER Education Module *Staying Cool*

The MESSENGER Education Module *Staying Cool* focuses on the process of scientific inquiry as applied to engineering problems in planetary exploration. The lessons specifically address the extreme conditions of the space environment, the problems these conditions pose for spacecraft, and the engineering solutions to these problems. Lessons explore how MESSENGER—or any other spacecraft—can use sunlight and other forms of radiation to meet the scientific goals of the mission, while still protecting the instruments and other sensitive parts of the spacecraft from too much sunlight and radiation.

The MESSENGER Education Module *Staying Cool* includes grade level components at three grade levels: elementary (pre-K–4); middle (5–8); and high school (9–12). Each component contains lessons comprised of content overviews, inquiry-based hands-on activities, assessment rubrics, resource listings, student worksheet masters, and answer keys.

The lessons were developed from the ground up from national science education standards and benchmarks. Lessons target core standards and benchmarks through inquiry-based, hands-on activities whose objective is deep conceptual understanding of both content and process.

## 3. The *Staying Cool* Grade 5-8 Lessons

This document provides a description of each lesson and the embedded inquiry-based activities for the *Staying Cool* **middle school (grade 5–8)** component. Also provided are connections to grades 5–8 National Science Education Standards and AAAS Benchmarks for Science Literacy.

| Staying Cool: The 5-8 Grade Level Component Progression | | |
|---|---|---|
| Lesson Title | Lesson Description | Activities |
| Lesson 1: Sensing the Invisible – The Herschel Experiment | Students reproduce William Herschel's experiment of 1800 and find out that there is radiation other than visible light arriving from the Sun—in this case, they discover the presence of infrared radiation in sunlight. Students learn that since planets emit most of their light as infrared and not as visible light, infrared is an important tool in studying planets. Students also discuss current uses of infrared radiation and learn that it is both very beneficial and a major concern for the MESSENGER mission to Mercury. | *Activity:* The students will create a device in which sunlight will pass through a prism and produce a spectrum of light on the bottom of a cardboard box. Using a series of thermometers, the students will measure temperatures at various locations within, and outside of, the spectrum. By doing so, the students discover the existence of radiation beyond the spectrum of visible light. |
| Lesson 2: Snow Goggles and Limiting Sunlight | By studying ancient solutions to the problem of excessive sunlight on human vision, students understand that too much of a good thing can be dangerous! We need some sunlight to see, but too much may be harmful to our eyes. In a similar way, the MESSENGER spacecraft needs some sunlight to operate and observe Mercury, but too much of it can heat up the spacecraft and cause serious damage. | *Activity:* The students will make snow goggles similar to those used by ancient Inuit hunters and observe their properties. By using the scientific method to come to the idea of making the goggles, the students become familiar with the same process used by spacecraft designers. |
| Lesson 3: My Angle on Cooling – Effect of Distance and Inclination | After discussing what heat is and how it travels, students discover that two ways to cool an object in the presence of a heat source are to increase the distance from it or change the angle at which it is faced. The students learn to distinguish which effect is more important for determining the seasons on Earth. They also discuss how the MESSENGER mission to Mercury takes advantage of similar cooling methods to keep the spacecraft comfortable in a high-temperature environment. | *Activity:* The students will measure the effect of distance and inclination on the amount of heat felt by an object. First, the students set up two thermometers at different distances from a light bulb and record their temperatures to determine how distance from a heat source affects temperature. Then, the students construct a device designed to measure the temperature as a function of viewing angle toward the Sun by placing a thermometer inside a black construction paper sleeve, and placing the device at different angles toward the Sun. |
| Design Challenge: How to Keep Gelatin from Melting? | Design Challenges provide motivating experiences for students by incorporating problem-solving, scientific approach, and cooperative teamwork into a standards-based activity. Focusing on real-life situations, Design Challenges give students the chance to deal with many of the same issues with which scientists and engineers are confronted when they plan spacecraft missions such as MESSENGER. In this Design Challenge, the students will design and build a platform that can keep items cool when placed on top of a heat source. | *Activity:* Students will design and build a platform that will be placed on top of a heat source. A 6 cm x 6 cm x 6 cm cube of gelatin will be placed on the platform, with a thermometer inserted in it. The goal is to keep the temperature inside the cube as cool as possible and prevent the gelatin from melting. |

## Connection to Standards

This Education Unit has been mapped to the National Science Education Standards (National Research Council, National Academy Press, Washington, DC, 1996) and to the Benchmarks for Science Literacy, (American Association for the Advancement of Science, Project 2061, Oxford University Press, New York, 1993). A complete explanation of the Standards can be found at: http://www.nap.edu/html/nses/html/. A complete explanation of the Benchmarks can be found at: http://www.project2061.org/tools/benchol/bolintro.htm. Core standards for each lesson are indicated by a "√"; related standards are indicated by an "x."

**Education Standards In Staying Cool**
**5-8 Grade Level Component**

| | National Science Education Standards | | | | | | | | AAAS Benchmarks for Science Literacy | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standard A: Science as Inquiry | | Standard B: Physical Science | Standard D: Earth and Space Science | Standard E: Science and Technology | Standard G: History and Nature of Science | | | Benchmark 1: The Nature of Science | Benchmark 4: The Physical Setting | | Benchmark 8: The Designed World | Benchmark 11: Common Themes | Benchmark 12: Habits of Mind | | |
| | Abilities necessary to do scientific inquiry | Understanding about scientific inquiry | Transfer of energy | Earth in the Solar System | Abilities of technological design | Science as a human endeavor | Nature of science | History of science | Scientific inquiry | Energy transformations | Motion | Health technology | Models | Values and attitudes | Manipulation and observation | Critical-response skills |
| Lesson 1: Sensing the Invisible – The Herschel Experiment | x | x | √ | | | x | x | x | x | | √ | | | | √ | |
| Lesson 2: Snow Goggles and Limiting Sunlight | √ | √ | | | x | | | x | | | √ | | √ | | √ | |
| Lesson 3: My Angle on Cooling – Effect of Distance and Inclination | x | x | x | √ | | | x | | | √ | | √ | | √ | | √ |
| Design Challenge: How to Keep Gelatin from Melting? | | | | | √ | | | | | √ | | √ | √ | | | |