National Center
for Earth and Space Science Education

Universities Space Research Association

# Introduction to the *Journey through the Universe* Program, the *Voyage* Program, and the *Voyage* 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.*

***Voyage: a Journey Through Our Solar System*** (http://voyagesolarsystem.org) is a one to ten billion scale model of the Solar System exhibition that was permanently installed on the National Mall in Washington, DC, in October 2001. The greater *Voyage* Program includes the exhibition on the National Mall; replicas of the exhibition available for permanent installation in communities worldwide—designated *Voyage Communities*; and programming in Solar System science and exploration for thousands of students, educators, and families available to each of the *Voyage Communities*. The programming is provided through *Journey through the Universe*, and supported by a grade K-12 compendium of lessons—the ***Voyage* Education Module**.

## 2. The Grade K-12 *Voyage* Education Module

The *Voyage* Education Module includes an **Education Unit** at four grade levels: lower elementary (K-2); upper elementary (3-4); middle (5-8); and high school (9-12). Each Unit 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, and are comprehensive enough to be adopted by school districts as the space science curriculum. Lessons target core standards and benchmarks through inquiry-based, hands-on activities whose objective is deep conceptual understanding of both content and process. The lessons are also meant to work in concert with a trip to a *Voyage* exhibition, serving as pre- and post-visit activities.

## 3. The *Voyage* Grade 5-8 Lessons

This document provides a description of each lesson and the embedded inquiry-based activities for the *Voyage* **middle school (grade 5-8)** Education Unit. Also provided are connections to National Science Education Standards for grades 5-8, and AAAS Benchmarks for Science Literacy for grades 6-8.

| VOYAGE for Education: The 5-8 Unit Progression | | |
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| Lessons 1-3 are found in the *Voyage* Education Module for the *Journey through the Universe* Program. Lessons 4-10 are additional lessons found in *The Voyage Continues*. Lesson 9 is not yet available. | | |
| Lesson Title | The 5-8 Story | Activities |
| Lesson 1: Our Solar System | In this lesson, students tour the Solar System. They examine and define its various components—the Sun, planets, moons, comets, asteroids, and Kuiper Belt Objects. They recognize that the Solar System is the family of the Sun, an average star, and other stars have families of their own. Taking a close look at the planets they find that characteristics like size, location, composition, and presence of rings and moons, reveal two major categories of planets—terrestrial (Earth-like) and Jovian (Jupiter-like). But tiny Pluto seems to be in a class all its own, perhaps the largest of the many ice worlds discovered beyond Neptune | *Activity 1: Solar System Catalog*; Students will create a catalog for the components in the Solar System. Through their research and class discussion, students will come up with a class-wide definition of each component.<br>*Activity 2: What a Wonderful World*; Students will research one planet in depth. Students will use their research to create a travel brochure for that planet. |
| Lesson 2: *Voyage* of Discovery | Models are powerful tools of exploration, especially as students investigate the size and distance relationships between the Sun and the planets in the Solar System. Examining the relative sizes of the planets using models at a one to ten billion scale, students realize that the Earth, the biggest thing they have ever touched, is quite small in comparison to the Sun and some of the other planets. Moving outdoors, students then create a one to ten billion scale model of the Solar System. Walking through their model as cosmic giants, students are awed by the tiny worlds in a vast space, and gain a new appreciation for Earth, their home. | *Activity 1: Exploring Planet Sizes;* Students will make predictions about the sizes of the planets in the Solar System, including the Earth, on a one to ten billion scale using models. Students will compare the size of the Earth to the other planets, and realize that the Earth is a rather small planet.<br>*Activity 2: Making a Scale Model of Our Solar System*; Students will create a scale model of the Solar System that is one 10-billionth actual size to investigate the relative sizes of the Sun and planets, and the distances between them. |
| Lesson 3: How Far Is Far? | Students will determine the actual distance to the Sun and the Moon without ever leaving the Earth, and in doing so will gain a better understanding of the huge distances in the Earth-Sun-Moon system. In order to determine these distances, students will apply their understanding of mathematical models in two different ways, using a single mathematical principle. | *Activity 1: Sun – Ruler of the Solar System;* In this activity, students create a pinhole tube and use it to make a model of the Sun. They will then use this model and similar triangles to determine the distance from the schoolyard to the Sun.<br>*Activity 2: A Model Moon;* In this activity, students will create a Moon-viewer and use it, along with models and the principle of similar triangles (which they learned in Activity 1), to determine the distance to the Moon. |
| Lesson 4: Going through a Phase | In this lesson, students investigate many aspects of our nearest celestial neighbor, the Moon. Students begin the lesson by observing the Moon and watching how it appears on a daily basis. They hypothesize a reason for the phases of the Moon, and then they test that idea in Activity 2, in which they simulate the phases of the Moon with a hands-on model and are able to explain the reason for the phases. Students conclude the lesson by discussing phases of other Solar System objects. | *Activity 1: Viewing the Moon;* In this activity, students will make observations of the phases of the Moon. The activity is designed to make students start paying more attention to the Moon than they would otherwise, and to think about why the Moon might go through phases. They will then hypothesize why phases occur, and see if their hypothesis is true by conducting Activity 2.<br>*Activity 2: The Earth-Moon-Sun System;* In this investigation, students will be making a model of the orbit of the Moon around the Earth; an overhead projector is used to represent the light from the Sun. By having the model Moon to orbit the model Earth, students will be able to see the phases of the Moon and learn why the phases occur. |

| VOYAGE for Education: The 5-8 Unit Progression | | |
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| Lesson Title | The 5-8 Story | Activities |
| Lesson 5: Round and Round We Go – Exploring Orbits in the Solar System | In order to have an appreciation for the complexity of the Solar System students must understand that the Solar System is a dynamic machine made of many moving parts. Students explore the nature of circles versus ellipses and how they relate to orbits in the Solar System. After creating a model of the Solar System, in which students plot the orbits of Solar System objects around the Sun, students begin to understand how orbits can be used to help categorize objects in the Solar System | *Activity 1: Ellipses are Eccentric!;* Students will learn how to draw ellipses based on the major axis and the distance between the foci.<br>*Activity 2: The Eccentricity of Solar System Objects—How Crazy Are They?;* Students will plot the elliptical orbits of some of the Solar System objects and examine how the orbits of the planets are different from one another and also different from the rest of the objects in the Solar System. |
| Lesson 6: Where To Look For Life? | One reason scientists study the Solar System is to determine whether life could exist elsewhere. Students come to the conclusion that one of the essential conditions for life is liquid water. Students create a mathematical model of the temperatures in the Solar System, and discover that there are several worlds on which the temperature range could allow liquid water to exist. Students then discover there are other requirements for hosting life, and not all worlds possess those. | *Activity 1: Happy Places;* Students predict and graph the temperature of a blackbody at various distances from the Sun. Students then analyze the graphs and determine the reasons why the worlds do not behave like blackbodies.<br>*Activity 2: Earth vs. Other Worlds;* In this activity, students identify characteristics of Earth that are important for life as we know it, in addition to the presence of liquid water. They will then research the planets and some of the moons in the Solar System and compare their characteristics with those of the Earth. |
| Lesson 7: Is There Anyone Out There? | Once scientists have determined where they want to look for life in the Solar System, the next question they ask is how will they do it? In this lesson, students create an operational definition of life by observing a mystery object. They then conduct an experiment, modeled after the ones performed by the Mars Viking Landers, to determine if they have discovered life forms in simulated Martian soil samples. | *Activity 1: Is It Alive?;* In this activity, students will be given a mystery object that they must take care of for several days. Students must observe their objects in order to determine if they are alive. Students will use their observations to create a definition for identifying the presence of life.<br>*Activity 2: Searching for Signs of Life;* In this activity students perform experiments on simulated Martian soil samples (sand) to determine the presence of life. Students "feed" the samples and watch their reactions to determine which (if any) of the sample contain life. This activity is modeled after the Viking Landers' experiments of the 1970s. |
| Lesson 8: Comets: Bringers of Life? | In this lesson, students will discover why comets are thought to be important in Earth's development. They will examine how a comet's composition relates to the composition of the entire Universe, and to life on Earth, by creating a model of a comet nucleus. By the conclusion of the lesson, students will understand why comets are sometimes said to be bringers of life. | *Activity 1: A Handful of the Universe;* Students will understand the average composition of the Universe through a model.<br>*Activity 2: Cookin' Up a Comet;* Students will create a model of a comet and compare their model to a real comet. |
| Lesson 9: Asteroids and Meteorites | Asteroids and meteorites are a class of small rocky bodies in the Solar System, often overlooked in a study of the Solar System. They are important, however, because they are leftovers of Solar System formation. By studying these rocks, especially when we get samples of them here on Earth as meteorites, we can get a better understanding of the formation and evolution of the Solar System. | *Activities TBD* |
| Lesson 10: Impact Craters: A Look at the Past | In this lesson, students discover that it is possible to learn a lot about objects in the Solar System and their history, as well as the history of the entire Solar System, just from looking at the craters on their surfaces. Students simulate how impact craters are formed, and how craters can look different based on the amount of energy they had during impact. They also examine pictures of cratered surfaces of other worlds in the Solar System and discover that impact craters can provide a lot of information about a world's history, and the history of the entire Solar System. | *Activity 1: Creating Craters;* In this activity, students will simulate crater impacts by dropping pebbles or marbles into a pan of flour and cocoa. Students will identify the characteristics of impact craters and compare them to the picture of a lunar crater.<br>*Activity 2: Craters in the Solar System;* In this activity, students will examine impact craters on different worlds in the Solar System and discover that the craters can tell us a lot about the world on which they formed. |

## 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 Voyage: A Journey Through Our Solar System: 5-8 Education Unit | | | | | | | | | | | | |
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| | National Science Education Standards, 5-8 | | | | | | | AAAS Benchmarks for Science Literacy, 6-8 | | | | | |
| | Standard A: Science as Inquiry | Standard B: Physical Scienced | Standard C: Life Science | | Standard D: Earth and Space Science | | | Benchmark 1: The Nature of Science | Benchmark 2: The Nature of Mathematics | Benchmark 4: The Physical Setting | | | Benchmark 5: The Living Environment |
| | A1: Abilities necessary to do scientific inquiry | B3: Transfer of Energy | C3: Regulation and Behavior | C5: Diversity and adaptations of organisms | D1: Structure of the earth system | D2: Earth's HIstory | D3: Earth in the Solar System | 1B: Scientific Inquiry | 2B: Mathematics, Science, and Technology | 4A: The Universe | 4B: The Earth | 4C: Processes that Shape the Earth | 5C: Cells |
| Our Solar System | | | | | | | √ | | | √ | | | |
| *Voyage* of Discovery | | | | | | | √ | | | x | √ | | |
| How Far is Far? | √ | | | | | | √ | | √ | √ | | | |
| Going through a Phase | | | | | | | √ | √ | | | √ | | |
| Round and Round We Go—Exploring Orbits in the Solar System | | | | | | | √ | | | √ | | | |
| Where to Look for Life? | | √ | | | | | √ | | | | √ | | |
| Is There Anyone Out There? | | | √ | √ | | | | | | | | | √ |
| Comets: Bringers of Life? | | | | | | √ | √ | | | √ | | | |
| Asteroids and Meteorites | | | | | | | | | | | | | |
| Impact Craters: A Look at the Past | | | | | √ | √ | | | | | | √ | |