EXPLORING THE SOLAR SYSTEM: A SCIENCE ENRICHMENT COURSE FOR GIFTED ELEMENTARY SCHOOL STUDENTS

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"Exploring the Solar System" is a science enrichment program taught at the Lunar and Planetary Institute for gifted fifth grade students from the local Clear Creek Independent School District. The school district selects which students are qualified to participate in the gifted enrichment program. In fifth grade, each student is allowed to choose one enrichment course to attend during the fall semester.

"Exploring the Solar System" has been taught 16 times since 1992. The course is taught during the normal school day. Approximately 20 students meet at LPI for three hours on each of 12 consecutive weeks. We use a pre-test and post-test to assess what the students have learned, but no formal grades are assigned.

In teaching elementary and middle school students, it is essential to have good activities. Slide presentations are sometimes necessary to convey basic facts, but they work best if they are kept short and are interspersed with related activities. It is also essential to make lectures interactive, by posing questions to the students.

Setting the Stage

The focus of "Exploring the Solar System" is not simply on what we know, but on how we know it (or at least *think* that we know it). The first two weeks are used to build a basic foundation. Astronomers tend to use words like million and billion a lot. To build a conceptual understanding of how large these numbers are, we start with some simple counting exercises. Students typically have a good sense of how long 100 seconds are. We ask them what they were doing 1000 seconds ago? 10,000 seconds? 1 million seconds? What were their parents doing 1 billion seconds ago? We use several scale models to illustrate the size of the Solar System (emphasizing that it is mostly empty space!) and the relative sizes of the planets. We illustrate the time history of the Solar System with our Wall of Time, a 46-foot long poster in which each foot represents 100 million years of history.

Week 2 includes a preliminary photographic tour of the Solar System. In this week, and indeed throughout most of the course, we focus primarily on the inner, rocky planets of the Solar System. We consider several key concepts, such as how the density of craters on a planet's surface provides clues to the age of that surface. We also consider the relationship between a planet's size and the duration of its volcanic and tectonic activity. These quantities are related to the rate at which planets have cooled. A simple experiment measuring the rate at which hot water cools in large and small containers illustrates this well.

Geologic Mapping and Processes

Subsequent weeks focus on two major themes. The first involves understanding basic geologic processes. We introduce some simple geologic mapping principles such as the law of superposition. This concept is easily understood if it is first presented in the context of the everyday lives of the students. For example, in their laundry piles at home, clothes on the bottom of the pile have been there the longest, and the clothes on the top of the pile were placed there most recently. The same basic concept can be used to infer the order of geologic events on the surface of planets. This concept is reinforced several times, as the students map the Apollo 15 landing site on the Moon and landslides and flood channels on Mars [1].

We perform several experiments that illustrate how geologic processes have shaped the surfaces of the terrestrial planets. An impact cratering lab shows how the mass and velocity of the impactor affects the size and morphology of the resulting crater [2]. A volcanism lab using molten wax as "lava" illustrates several basic styles of volcanic eruptions. This lab also emphasizes the role of volcanism in resurfacing planetary surfaces. By combining the impact and volcanism labs, we illustrate how complex surfaces can be developed. This reinforces our basic theme of superposition and the sequence of events. In conducting these labs, good safety practices and adequate supervision are essential. Other labs examine analogs of lunar rocks and of martian soil and show how rock samples provide important information about a planet's history.

Remote Sensing of Planetary Surfaces

The second major theme is remote measurements of the properties of planetary surfaces. We conduct several lab sessions on computer image processing [3]. We use an inexpensive spectrometer to measure the visible and near-infrared spectra of soil samples and discuss how this provides information about the chemical composition of distant planets [4]. We also make use of low-tech experiments. For example, we use styrofoam inserts in shoe boxes to create "mystery planets". The students measure the heights of the features through small holes in the box top, thus creating a simple topographic map [2]. This simulates how NASA missions such as Magellan and Mars Global Surveyor have mapped the topography of Venus and Mars using radar and lasers.

Mars Mission Planning Activity

The capstone event for the course is a Mars mission planning activity. This occupies an entire 3 hour class session, usually on the next-to-last week. Teams of 3 or 4 students work together to define an objective for a Mars exploration program. They then plan a sequence of robotic and human missions that are intended to meet this objective.

We provide the students with a list of possible robotic missions such as orbital cameras and radars, simple landers, and rovers. Similarly, we list various components for a human mission to Mars. Each piece has a cost, and the teams must plan their exploration programs within a fixed budget. At the mid-point of the session, we impose a 33% budget cut into the process. This forces the teams to carefully consider which missions they deem most important. At the end of the session, each team makes a 5 minute presentation of their plan to the class.

Helpful Hints for Getting Started

The most direct way to begin a similar course is to approach the principal or a teacher at your local school. This may be easier than working with a school district's central administration. In designing a course, it is not necessary to develop the curriculum from scratch. Many excellent activities already exist [e.g., 5] and can be adapted to a variety of circumstances. Keep your plans flexible – classroom activities rarely go precisely as planned the first time through. Teaming with another scientist or with a classroom teacher can be very helpful. This provides an extra set of hands during activities as well as a source of feedback on your presentation and classroom management styles.

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References

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