

KNOWLEDGE AND WONDER IN THE PLANETARIUM

J. Lawrence Dunlap

Flandrau Planetarium, University of Arizona, Tucson, Arizona 85721, U.S.A.

Planetariums around the world attract millions of adults and children each year to public programs popularizing astronomy and related topics. For many urban school children, the planetarium experience is a unique opportunity to observe and to wonder about the night sky and objects in space. In particular, the planetarium provides children with a needed observational basis for increasing scientific literacy and for understanding astronomical concepts.

This paper explores the role of the planetarium in the astronomy education of school children, grades Kindergarten–12, in Tucson, Arizona, over the past 12 years.

1. Background and Scope

The Grace H. Flandrau Planetarium, located on the University of Arizona campus, is Arizona's primary resource for astronomy education for the general public. The mission of the Planetarium is to enhance the public appreciation and understanding of science and astronomy by communicating the beauty, knowledge, and wonders of the universe to persons of all ages. The planetarium produces a visual simulation of sky phenomena. Thus it is a teaching machine that creates a direct visual learning environment that is especially "friendly" to children and laypersons.

In 1974, a cooperative agreement between the University and the Tucson Unified School District established a means to provide instructional programs for pre-college students. In 12 years of operation, the school programs have provided instructional activities in optics, astronomy, and space science to over 260,000 students and teachers from Arizona.

2. Goals and Objectives

The principal goal of the school planetarium programs is to teach selected facts and concepts about the night sky and to motivate students to seek a deeper appreciation of astronomy and the universe.

The general objectives of all the programs are to encourage students to use and develop those intellectual skills described as "the processes of science." Students participate in the learning process by responding to questions in both the theater and exhibit situations. Acceptable responses indicate that students are able to:

- make visual observations
- communicate information accurately
- classify objects by similarities and differences
- use numbers to make quantitative comparisons

- make predictions
- make inferences.

3. The Planetarium and Concept Learning

We acquire concepts by “formation” and by “assimilation.” Concept formation is primarily inductive, as children learn by observing, imitating and trial and error behavior. Childrens’ intuitive world concepts are built from everyday experiences that reinforce their observations. The child’s world is flat, unmoving, and in the center of the universe. Forces are needed to keep things in motion. Rocks fall faster than leaves and feathers. Heavy things are harder to move than light things.

Concept assimilation is primarily deductive. We learn a general rule and then try specific examples. Without a concrete experience, students learn to say or to write the words (the “keyed response”) to answer questions, but they may not develop an intuitive understanding of the concept. The planetarium can provide the experience they need to give physical meaning to the words. Observations and questions can help students build more accurate physical concepts.

4. Typical Observing Activities

Sample observations and grades	A	B	C	D ^a
1. find directions by sun and stars.	X	X	X	X
2. locate star patterns.	X	X	X	X
3. daily motion of sun and stars:				
– for 24 hrs.	X	X	X	X
– for 1 year.			X	X
4. motion of stars at other latitudes.		X	X	X
5. appearance and daily motion of moon.		X	X	X
6. conditions for lunar or solar eclipse.		X	X	X
7. apparent motion of planets relative to stars.		X	X	X
8. synodic periods of planets.			X	X
9. computing relative distances to planets.				X
10. light curve of a variable star.				X
11. precession of the equinoxes.				X
12. landscapes of moons and planets.	X	X	X	X

^aKey: A = Primary, B = Intermediate, C = Middle, D = High School

5. Asking Questions

Questions can be used to acquire feedback about what students have learned, to foster concept formation, or to encourage wonder. Content feedback questions ask for information. Concept formation questions ask for inferences or predictions that require the student to test their conceptual models. A correct response reinforces the model and an incorrect response can lead to new insights and a new model.

Questions to encourage wonder are based on observations, but no explanations are given. Using a mixture of all kinds of questions encourages students to review their knowledge, to test and improve their concepts, and to consider some new mysteries.

6. Some Questions to Wonder About

Primary level:

1. Where is the sun after sunset?
2. Where will the moon be a week from now? Will it be more full, less full, or about the same as it is now?
3. What makes part of the moon look dark?
4. Does the moon have a night and day?
5. What would you see from the moon in the daytime?

Intermediate level:

1. What makes the twilight?
2. What makes starlight twinkle more than planet light?
3. (When one or more planets are in conjunction), where are the missing planets?
4. What makes the ocean appear blue?
5. What would you see in the skies of other planets?
6. Are there planets orbiting other stars?

7. Comparing Live and Recorded School Programs

Live school programs focus on visual observations, concept development and information. Recorded programs permit more extensive audio-visual program content and attract a larger audience. Our most popular school programs have been a 50/50 combination of a live current sky interpretation “talk” and a short recorded program showing landscapes on other worlds, imaginary voyages to other parts of the universe, or highly visual treatments of interesting topics. Many students are motivated to ask questions, to read astronomy books, or to do special projects after seeing an excellent program. Perhaps this is the most important role of the planetarium — to promote and sustain an interest in astronomy and our place in the universe among children everywhere.
