

**Space Science in the Early Elementary Classroom: A New Twist on the Classic Scale Model Solar System Activity.** M. L. Urquhart, Science/Mathematics Education Department, School of Natural Sciences and Mathematics, University of Texas at Dallas (FN 32, P.O. Box 830688, Richardson, TX 75083-0688, urquhart@utdallas.edu).

**Introduction:** Very few space science activities appropriate for children in early elementary are available for classroom use. This is especially true of activities that have quality science and math content. However, the dearth of quality activities does not necessarily reflect the demand. Children as young as preschoolers often have a natural interest in space, perhaps second only to their love of dinosaurs. Educators can utilize lessons that tap into the innate passions of their students to teach a wide variety of skills and content across the curriculum. Leveraging off of natural interest is not the only reason to introduce a young child to space science concepts in a formal education setting. Young children are in the process of forming mental models, with or without instruction [1]. Upper elementary students already have astronomy misconceptions similar to those common in adults [2, 3]. Early intervention through the use of well-designed activities may be able to prevent the formation of some inaccurate astronomical mental models in children.

In order for any hands-on science activity to be suitable for classroom use, it should be engaging, scientifically accurate, developmentally appropriate, and avoid the accidental introduction of misconceptions. Although space science activities for upper elementary and middle school are widely available, adapting many of these materials for use with young children is non-trivial, and in some cases inappropriate. A need exists for activities that build upon the innate interest young children have in space-related topics in ways that are understandable for the students and integrate into existing curricular requirements. The most easily adaptable activities are those that involve children making their own observations of the sky. Another possibility for the successful adaptation of activities commonly used with older children is the introduction of simple physical models.

Scale model solar systems are commonly used in astronomy education with students in upper elementary through undergraduate school. Some of the material used in a typical hands-on scale model solar system activity is difficult for young children to understand. For example, concepts of the absolute sizes and distances of solar system objects are not easily comprehended by many adults, and are almost assuredly far too abstract for young children. On the other hand, other concepts used or introduced in the creation of a scale model solar system are not only appropriate for students in grades K–4, but meet content standards of

the Principles and Standards for School Mathematics [4] and the National Science Education Standards [5].

**Early Elementary Scale Model Solar System:** In this very simplified version of the author's two-part lesson for grades 4–8, students are introduced to each of the nine planets. Using colorful pre-made planet cards with real images of the planets, large numbers and block letters (mixed-case cards are provided as an alternative), students add common objects to make a set of planet cards for their scale model solar system. For part 2, the entire class counts along with the teacher who uses a set of completed planet cards to create a model in distance as well as size. As with the author's versions for older students, the scale factor used for both size and distance is 1 to 10 billion [6]. Using the same scale for size and distance helps ensure that no misconceptions are accidentally introduced. The intent is that the mental picture the students develop as a result of the activity will be consistent with scientifically accurate models. The goals of the lesson are also different for young students than for those in upper elementary and middle school. For grades K–2, the lesson is designed to teach age-appropriate concepts and skills such as the names and order of the planets, the concept of a model, size and distance comparisons, sequential ordering, counting, measurement, and color matching. Students in the 5 to 8 year-old age range should also be able to understand concepts of relative sizes and distances in the model, even if they are unable to conceptualize the real solar system.

**Major Differences in the K–2 Lesson Plan:** The lesson plan for early elementary students is more than an activity simplified for use with young children. Rather it is a complete lesson plan that is:

\* *Specifically designed for young children*, with age-appropriate learning goals, an introduction to concepts of models and scale using toys, and pre-made planet cards with colorful images and large numbers and block letters. The teacher is also encouraged to provide significantly more guidance than he or she would with older children.



Toys provide an excellent way to demonstrate concepts of both models and scale.

\* *Engaging for young students.* Five year-old field test children were remarkably attentive for the hour+ of the lesson, and enthusiastic about talking about the planets, taping objects to their planet cards and counting off steps. One parent reported that a child requested that his planet cards be hung on the wall near the dinner table so that they could be discussed during the evening meal.



Prior to the hands-on activity, children share some of their own knowledge and questions about the planets.



A pre-sorted selection of appropriate objects for the planet cards within reach of all of the students helped make the activity fun rather than frustrating.



Field-test students enthusiastically count off steps to each of the first five planets in the model solar system assuming 1/2 m per step. The approximately 80 meters between the model Sun (a grapefruit) and model Jupiter (an M&M) can be walked on a typical school's property.

\* *Not intended as a replacement for later instruction:* A common concern among space science educators is that a given astronomical topic may be introduced only once. The K-2 lesson plan clearly states that children in the target age group will not achieve the same benefits from the creation of a scale model solar as older students, and therefore the lesson should not replace similar instruction in higher grades.

**Shaping a Mental Model:** One very important aspect of both the K-2 Scale Model Solar System and versions for older students is that they are consistent with scientifically accepted models. Using the same scale factor for size and distance is especially important for young students. Although 5 to 8 year-old students may not be able to form a complete mental picture of the solar system, the mental models they do form will impact future learning [1]. The ability of an early introduction to a scientifically accurate model of the solar system to decrease later misconceptions regarding scale in the solar system has not yet been tested. However, if the instruction is developmentally appropriate and avoids the accidental introduction of misconceptions, then it is reasonable to assume that participation in a scale model solar system activity at an early age will provide an advantage for students when they are re-introduced to the topic in later grades.

**Availability:** The complete classroom-tested K-2 Scale Model Solar System lesson plan is online at <http://cosmos.colorado.edu/~urquhart/Scale>. Supplementary material, including downloadable planet cards, a sample letter to parents for the purpose of extending the lesson at home, as well as other space science and physics activities for older students are also available on the author's education Web site at <http://cosmos.colorado.edu/~urquhart/>.

**Acknowledgments:** The scale factor and basic idea for the author's scale model solar system activities for grades K-2, 4-8, and 6-8 are based on the author's experience using the Colorado Model Solar System at CU Boulder in her undergraduate teaching and pre-college outreach activities. Helpful comments and suggestions for the K-2 version were made by: Camala O'Reilly (educator partner), Brad Switzer, and Brian Grigsby. Web hosting is provided though the generosity of CU Boulder's Sommers-Bausch Observatory.

**References:** [1] NRC (2000) *How People Learn: Brain, Mind, Experience, and School*. [2] Baxter J. (1989) *Intl. J. Sci. Ed.* 11 502-513. [3] Dai (1991) *Dissertation* [4] NCTM (2000) *standards.nctm.org*. [5] NRC (1996). [6] Adopted from the Colorado Model Solar System on the campus of CU Boulder.