Astronomy For Very Young Children

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BIOGRAPHIES
Linda Shore, CEO of the Astronomical Society of the Pacific spearheads the society’s education initiatives in support of ASP’s mission to improve scientific literacy through astronomy. She was also the Director of the Exploratorium Teacher Institute and is the co-author of several activity books for children, families, and adults.

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ABSTRACT
Six years ago, the Astronomical Society of the Pacific (ASP) asked a very provocative question: Can very young children (aged 3 - 5 years) learn astronomy – and if so – what kinds of concepts can they comprehend and can astronomy be used to develop age appropriate science thinking skills? With five years of funding from the National Science Foundation's Advancing Informal Science Learning (AISL) division, the ASP collaborated with experts in early childhood development, informal learning, and evaluation to conduct a five-year research and development project. This project (My Sky Tonight: Early Childhood Pathways, or MST) is in its sixth and final year, after a timeline and scope expansion enabled by supplemental funding from the NSF. The goals of the MST project are to: (1) Advance the knowledge base concerning the astronomy conceptions and curiosities that children have in their early years, and how these can be built upon to position children for later scientific understanding as they grow. (2) Develop interactive learning experiences to be used by museum educators (and parents and other adults in children’s everyday lives) enabling young children to progress to increasingly sophisticated levels of astronomy concepts and scientific reasoning, providing a foundation for lifelong learning about astronomy and about science in general. (3) Increase participation in astronomy of families in general, and specifically underserved families by engaging minority groups in formative development of the deliverables, delivering culturally relevant content, and targeting underserved groups as end audiences. (4) Improve practice by engaging informal education practitioners in research, co-learning, and the development of effective practices, and providing them with the tools and the support they need for implementation. In this hands-on, interactive session, we will (1) describe the interactive research and design process used to successfully develop a suite of preschool level activities designed for museums, planetariums, and other informal learning settings, (2) show videos of young children engaged in a selection of the astronomy activities and discuss our key observations, (3) present results from the MST research, and (4) engage session participants in sample preschool level astronomy activities and share our ideas for next steps, which include investigating the role of using storybooks in combination with our science-rich MST astronomy activities for young children to support engagement in science practices.

I. INTRODUCTION

1.1 A Crazy Idea
The ASP has had a long and successful track record of developing astronomy-related activities, materials, and resources for informal learning venues. We have also been at the forefront of providing high-quality professional development to informal science educators to help them bring engaging astronomy experiences to their public audiences. Since 2005, over 500 science centers, planetariums, libraries, state and national parks, nature centers, and children’s museums have participated in ASP professional development programs and received kits of astronomy-focused activities. Today, these institutions comprise the ASP’s network of like-minded, informal learning organizations (Astronomy from the Ground Up, or AFGU), each dedicated to wanting to improve their ability to use astronomy to support science literacy.
The astronomy learning experiences and materials we produced for these informal learning venues were developed to support older children, pre-teenagers, and families. Yet increasingly, members of the AFGU network were asking us to develop age-appropriate astronomy experiences for their very youngest visitors – children in preschool and early elementary grades. A needs assessment of the AFGU network conducted in 2012 revealed that 92% of the respondents were interested in learning how to introduce pre-school children to astronomy. So we began to consider an idea that many of our closest colleagues in the field thought impossible to accomplish – could we create developmentally appropriate astronomy activities for children between the ages of 3 and 5 years? Was it possible for young children, still in the early stages of developing basic thinking skills, to engage with astronomical ideas requiring an ability to think abstractly and use multiple frames of reference? And if it were possible to create opportunities for young children to engage with astronomy, how would one even go about the process of developing, testing the materials, and conducting research on an audience that was barely verbal? Finally, what would educators need to know to facilitate activities on their museum floors, inside their planetariums, or at other informal venues?

1.2 The My Sky Tonight Project

In 2011, we assembled a team of renowned experts in early childhood development, informal learning, and evaluation and began to pool our expertise to develop an initial plan for a design, research and development project. The team developed a project design that included the following elements: (1) creating a pilot set of early childhood level astronomy learning experiences for informal venues, (2) conducting evaluation research on the activities as they were tested with children in museums, (3) revising the activities and repeating the testing in informal settings, and (4) collecting and analyzing data to determine the impact that engaging in age appropriate astronomy activities has on the development of science thinking skills. All activities were created using the principles of “developmentally appropriate practice,” described by the National Association for the Education of Young Children (NAEYA, www.naeyc.org). Young children learn through play and exploration and what they learn varies across ages, individual interests, and their unique set of experiences. The team also drew heavily from recommendations derived from empirical research in developmental psychology and early childhood education.

The Astronomical Society of the Pacific (ASP) received five years of National Science Foundation (NSF) funding in 2012 to carry out this project. Our research focused on the following question: if and how can engagement in astronomy experiences develop age appropriate science thinking skills in preschoolers and very young children? Titled, My Sky Tonight: Early Childhood Pathways to Astronomy (MST), very young children and their families engaged in age appropriate astronomy experiences in settings that included science centers, planetariums, libraries, and other informal learning environments. In addition, we studied the impact of combining imaginative narrative with hands-on experiences. One of the toolkit activities, Bear’s Shadow, incorporates the storybook Moonbears’ Shadow by Frank Asch and engages children in investigating shadows. With supplemental funding, we field tested, revised, and studied a new storybook, Breakfast Moon by Meg Gower, which introduces children to the pattern of lunar phases, as well as the Moon’s position in the daytime sky.

The research and development of astronomy activities for young children involved the following steps:

- An initial meeting of the MST project team and advisory board – consisting of renowned experts in informal learning, astronomy education, early childhood development, informal education research, and program evaluation – assisted in the initial development of astronomy activities, research instruments, and research protocols.
- A pilot kit of astronomy experiences for young children was developed and disseminated to 40 museums for evaluation and field-testing in two rounds. Revisions were made based on each round of evaluation result, with several rounds of iterative testing at partner museums between versions of the toolkit.
- Along with the pilot activities and resources, educators at the testing sites received over 18 hours of on-line professional development (both synchronous and asynchronous) focused on helping them develop the knowledge and skills needed to successfully facilitate these activities with preschool age children.

Figure 1: MST project team and expert advisors discuss the initial set of astronomy activities for very young children.

Through this iterative process of development and testing, the project resulted in a final astronomy kit that includes: 9 field tested astronomy activities, 2 children’s songs supporting the astronomy content, and 12 training videos for educators focused on how to facilitate the activities with preschool age children.
II. EXAMPLES OF ACTIVITIES

II.1 “Hide And Seek Moon”
A large photograph of the Moon is hung on a wall. Small images of familiar objects are placed on the photograph of the Moon, representing items an astronaut has lost and apparently left behind, including an ice cream cone, a teddy bear, a boot, a pair of gloves, and a bucket. When the children stand 10-12 feet (3-3.5 meters) from the photograph, they can tell there are small objects on the lunar image, but they are too far away to identify what they are (Figure 2). When given 2X binoculars to use, designed especially for their small faces and tiny hands, children find they can more easily identify the objects and help the astronaut find the things they misplaced. While observing the Moon through binoculars, children are encouraged to describe what they notice and compare what they see using the tool versus with their unaided eyes (“How does it look different when you use the binoculars?”). The very youngest children might not be able to articulate differences in appearance, but older children might use terms like “bigger” or “closer.” As an extension, children are given a photograph of the Moon and a marker and encouraged to mark the location of the astronaut’s lost things. Children practice a number of science practices through this activity, including using tools, noticing, collecting data, and making comparisons.

![Figure 2: Using a tool (binoculars) to notice tiny objects pasted on a poster of the Moon.](image)

II.2 “Bear’s Shadow”
Children listen to the Frank Asch story, Moonbear’s Shadow, and recreate scenes from this picture book using a Bear figurine, felt landscape, model of a tree, little felt fish, and a flashlight (to represent the Sun). In the story, Bear tries to lose his shadow after discovering it scares away the fish he wants to catch. He tries out different ideas, but his shadow always reappears. Illustrations in the book show the Sun’s apparent motion across the sky, as well as the changing size, shape, and position of Bear’s shadow through the day. Facilitators of this activity read Moonbear’s Shadow and ask questions designed to focus attention on the position of the Sun and the direction of Bear’s shadow in the illustrations. By asking questions about the illustrations, facilitators encourage children to engage in a fundamental science practice – noticing. The story is followed by an interactive, hands-on experiment where children are given the models, felt landscape, and a flashlight (Figure 3). Using “challenge cards” as starting points, children are asked to recreate scenes from the story and make Bear’s shadow change in length and direction, modeling the way that the Sun casts shadows of objects (e.g. “Try to make Bear’s shadow in front of him”). This inquiry-rich activity provides opportunities for children to use what they notice to engage in other science practices: modeling, making and comparing observations, and using evidence to make claims about the shadow’s appearance.

![Figure 3: Exploring how light creates shadows by noticing and comparing.](image)

II.3 “Moon Phase Matching”
In this activity, children learn features are important to pay attention to when observing the Moon. Children match pictures of the Moon printed on cards with sequential photographs of the Moon’s phases printed on a large banner (Figure 4). The Moon image cards are each labeled, so children can use the words as clues to help them, which also helps develop their literacy skills. Through the process of matching the cards to the correct photos, children are encouraged to notice patterns, ask questions, and share past experiences of looking at the Moon. The conceptual goals of the activity are to help children begin to comprehend that the Moon appears to change shape, or have different phases and there is a pattern to how the shape of the Moon’s appearance changes over time. Children also get practice in using scientific words for the Moon’s phases (crescent, full, quarter, etc.). A number of important science practices are
introduced to children in this activity, including noticing, comparing, and for older children, identifying patterns. Recently, we augmented this activity with a new children’s storybook, Breakfast Moon, which follows a family at breakfast as they observe the Moon’s phase over several mornings, comparing the Moon’s shape to the various foods they eat (e.g. banana’s, partially eaten pancakes, etc.). Adding imaginative narrative provides children with examples of activities they can try and more opportunities to notice and compare. Because the family in the story is African American, the book also makes the activity as a whole more inclusive, promoting the engagement of children often underserved and underrepresented in science.

III. YOUNG CHILDREN AS SCIENTISTS

The ASP embarked on a very ambitious project six years ago that experts and colleagues in astronomy education were skeptical about. We sought to answer the question, “if and how can engagement in astronomy experiences develop age appropriate science thinking skills in preschoolers and very young children?” Through a research and development project designed to bring astronomy experiences for preschool aged children to informal venues, we discovered very young children are innately curious about the sky and the objects in it and can engage meaningfully in astronomy activities. Moreover, young children are capable of engaging in science practices, especially when provided with engaging activities designed specifically for their capabilities combined with developmentally appropriate facilitation.

But what does it mean for a very young child to be engaged in a “science practice?” We use science practices when we investigate the natural world, and in astronomy, this might include watching the motion of the sky, the changing length of a shadow, or the Moon’s waxing and waning phases. But unlike sciences where you can “try things” and manipulate the world to see what happens, astronomy relies on observation, or more specifically, on your ability to notice. Virtually all the activities developed by MST give young children opportunities to notice.

Resources and videos accompanying activities show facilitators how to ask the kinds of age appropriate questions that not only encourage noticing, but also help children notice the salient things to pay attention to; not everything you notice is important (Figure 5). The ability to pay attention to relevant things is critical in science; it is the foundational ability needed to compare, contrast, identify patterns, ask questions, and create evidence-based explanations (NRC, 2010). In MST activities, we went beyond helping children notice and encouraged them to engage in these practices as well – always in developmentally appropriate ways. Other science practices embodied in MST activities include using the tools of science (e.g. child-friendly binoculars to magnify distant objects) and creating representations and using models (e.g. through their drawings, things they construct, etc.).

IV. RESULTS FROM MY SKY TONIGHT

My Sky Tonight is currently at the end of its last year and research teams are completing their analyses. Additional information about the project, including links to research papers, educator resources, videos, and activities can be found at the My Sky Tonight website, https://www.astrosociety.org/education/early-learners-2/.

The following are a few findings relevant to educators in science museums and planetariums:

• Informal educators can leverage the significant interest in astronomy that young children innately seem to possess. Young children appear to be deeply interested in and curious about the sky. In a diary study in which 67 families with 3- to 5-year-old children were asked to record their conversations about nature over a period of two weeks, astronomy-related conversations were the third most popular topic (15% of conversations – on par with weather-related conversations). The only topics more popular were animals (32%) and plants (18%). 69% of families engaged in at least one astronomy-related conversation during the two-week period. 61% of astronomy-related conversations were initiated by children (Callanan, Solis, Castañeda, & Jipson, 2018).

• Informal educators should encourage young children to create their own representations and make models. MST researchers found that age-appropriate modeling encourages children’s engagement in other practices of science. For example, in Hide and Seek Moon, children make “X’s” on a diagram of the Moon, indicating where they spotted the astronaut’s missing objects using binoculars. In the Moon Phase Mapping activity, children are encouraged to use their
fingers to “draw” the shape of the lunar phases in a layer of salt sprinkled on black paper. Children’s use of representation and models supported the use of other practices, such as pattern recognition or creating evidence-based explanations.

- **Look for and encourage children to use gestures.** Very young children, especially those whose verbal skills are still in development, often use gestures to both develop their ideas and communicate explanations. Gesturing allows children to go beyond what they might otherwise be able to express verbally, externalizing aspects of developing knowledge. For example, children may point or use their hands to indicate size or distance (Plummer and Ricketts, 2018).

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**REFERENCES**


