Boxed and Ready to Travel:
Taking Learning on the Road

by Kathleen Ryan, Kathy Dawes, and Dana Dawes

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Providing engaging outreach with minimal resources for rural communities can be a real challenge, especially for small science centers. During the past five years, the authors have developed three successful, portable exhibitions for the Palouse Discovery Science Center (PDSC) that provide interactive explorations of cognitive skills *(BrainBuilders)*, math skills *(MathBuilders)* and the fundamental principles of light and optics *(Light in Action)*. These exhibitions are designed to be used at the science center and also in the PDSC Educational Outreach program, which seeks to increase STEM literacy in the mostly rural areas of eastern Washington and northern Idaho. Use of these exhibitions in 33 rural outreach settings serving over 4,567 participants has demonstrated the value of single-concept interactive exhibitions for youth and family participants of all ages. We term them "portable" to distinguish them from the more traditional "traveling" exhibitions. They are designed to be transported without specialized equipment and to be installed quickly (under 30 minutes) with minimal (one to two) staff. These portable interactive exhibitions have become a cornerstone of the PDSC's Educational Outreach program.

Motivation

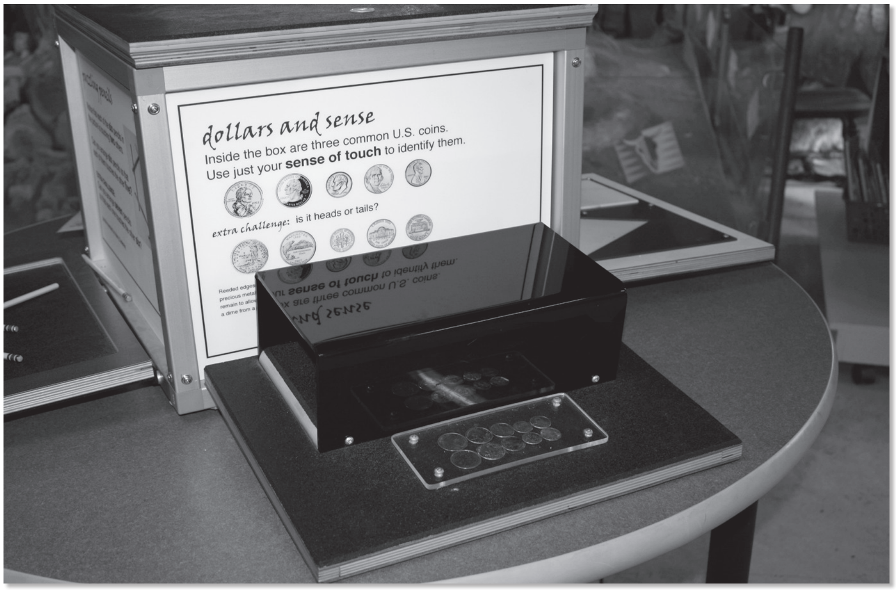
As local school districts began to face budget constraints, we realized the potential of portable exhibitions as a way to increase our audience and reach more underserved communities. Overall expense as well as travel time to rural venues influenced the strategies undertaken to develop resource-efficient exhibits that allow efficient transportation and set-up time. The exhibitions, funded by modest grants, are attractive, durable, and economical to fabricate. Two unique designs were developed: one style is self crating, while all components of the other style fit into inexpensive carrying cases. Several sets of interpretive signage were developed for each exhibition. These labels accommodate different skill levels and can be changed easily. Each exhibition is designed to be installed very quickly in a wide variety of venues and can be transported in a mid-sized SUV or van. These designs have enabled the PDSC to reach dozens of rural, underserved communities.

Evolution of Our Design Strategies

The initial concept for our portable exhibits came from the *Brain Teasers* exhibition developed by Glen Mills for the Oregon Museum of Science and Industry (OMSI). We were struck by the fact that, while the components are assembled on site from a collection of parts, the final appearance is similar to a box on a table, with a single exhibit at each face of the box. Several years later, as we were developing the idea of portable exhibits, we pursued that concept with a series of prototypes.

BrainBuilders

Our initial use of portable exhibitions began in 2006, when we developed the *BrainBuilders* exhibition, funded by MetLife Foundation. This exhibition, composed of 16 interactive exhibits developed in collaboration with neuroscientists at Washington State University (WSU) and the University of Idaho (UI), consists of challenges involving cognitive skills. *BrainBuilders* has been highly successful both at the PDSC and at outreach venues largely



BrainBuilders *cube with exhibit manipulatives on four sides. Each side, when folded down, becomes an exhibit base, and the associated interpretive captions (laminated to Gator board®) are attached to the frame of the box with magnets. All photos courtesy of authors.*

because of its inter-generational nature, attracting people of all ages. The 16 interactive exhibits are grouped four to a box, a "quartet," and are displayed on a 48in. round table. Each box is 16x16x 12 in. high, with a hinged flap on each face. For travel, loose exhibit components are placed in containers inside the boxes, the caption boards are removed, the sides folded up, and hook-and-loop straps hold the sides in place and provide a carrying handle for the 32-35 lbs/14.5-16 kg boxes.

MathBuilders

In 2008, with funding from the Inland Northwest Community Foundation, we produced the *MathBuilders* exhibition, consisting of 16 interactive exhibits incorporating a wide range of math challenges. The activities were developed in collaboration with the Pullman School District and math educators at WSU and UI. Although the actual exhibits were modeled after *BrainBuilders,* this topic had the added feature of accommodating different skill levels. We used the same format for the 16 portable exhibits in *MathBuilders*, but made a few changes. As we were developing the exhibition content, it became clear that it would be more appropriate if the exhibit components and the associated instructional captions could be tailored to the age and skill of each audience. The design of the "boxes" made this a fairly straightforward process: the captions are color-coded to skill level, and are easily changed on site to accommodate different skill groups. In some cases, the actual exhibit manipulatives are changed as well. We eventually developed three different levels for some of the *MathBuilders* exhibits to accommodate ages 7 to 9, 10 to 12, and 13 to adult.

Light in Action

In 2010, we produced the Light in Action (LIA) exhibition with support from the Optical Society of America Foundation (OSAF) and SPIE. In collaboration with content advisors in the Physics Department at Pacific University in Forest Grove, Oregon we developed eight different interactive exhibits dealing with the principles of light and optics. These required a new design due to the need for 1) power, 2) energy-saving components, 3) a way to control ambient lighting, and 4) longer descriptions and directions in the signage due to the complex scientific nature of the concepts.

Solving these challenges resulted in a unique design and a new packing system for outreach use. For several of the exhibits, a specialized base was needed as well to conceal electrical components. The exhibit top and side provides controlled lighting for 12 volt-based manipulatives. To accommodate a range of venues, power

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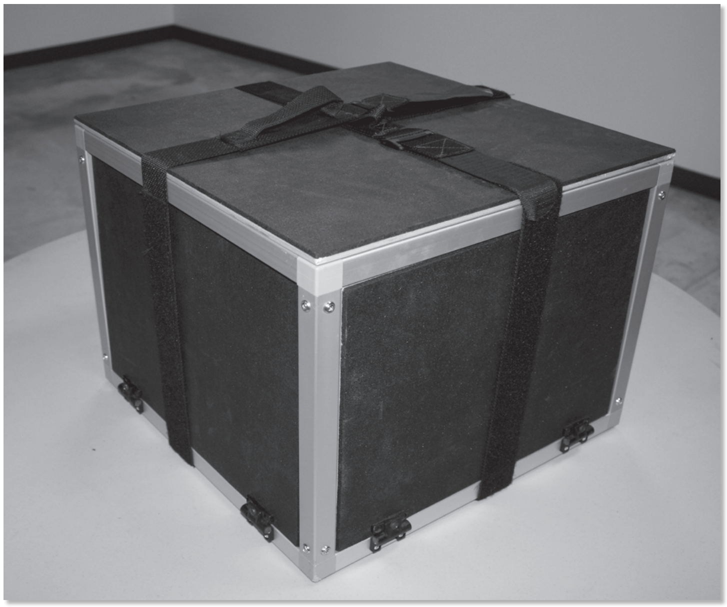

Portable exhibit cubes packed and strapped for transport.

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to the exhibits can be supplied from overhead drops or from wall- or floor-mounted receptacles.

When using both the *BrainBuilders* and *MathBuilders* exhibitions for outreach, we noticed that students could generally do only about four to eight of the 16 exhibit activities in the 45 minute time frame that was most requested by teachers. For LIA, we wanted students to experience all of the exhibits, so we decided to develop only eight exhibit activities and duplicate them to make two sets. This way, we still provide a total of 16 spots to accommodate up to 32 students at a time, working in pairs.

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Prototyping

In the early development of the *BrainBuilders* exhibition, we created a full-size mockup with functional exhibit components and observed visitor interactions. We also interviewed selected visitors for their input, especially in regard to interpretive graphics and instructional text. The process of prototype, observation, and revision provided essential information in modifying each exhibit for maximum clarity.

As the *MathBuilders* exhibits were being developed, we consulted with content advisors from the University of Idaho and the Pullman School District. After further refinement, the protoypes were displayed in an undergraduate course on math methods for pre-service teachers. The exhibits were modified further based on their feedback related to instruction sequence and terms. Finally, the exhibits were taken to two local elementary schools, where the pre-service teachers observed and recorded data regarding student misconceptions, realizations, and strategies as they interacted with the exhibits. Further refinements to manipulatives and interpretive signs were made based on those observations.

Early in the development of the *Light in Action* exhibits, we concentrated on topics suggested by our principal content advisors. The initial exhibits debuted at two area schools, and changes were made in interpretive and instructional signs based on observations that identified areas requiring clarification.

Broader Applications

There are several aspects of our approach that others might find helpful. Two of us (Kathy Dawes and Dana Dawes) are also involved in the outreach events for the PDSC. Having exhibit developers tour with the exhibitions makes for a very short feedback loop. We observe, firsthand, what issues arise with our exhibits. Secondly, the modular nature of all three of these exhibitions allows us to make changes to the components very quickly at minimal cost. Thirdly, and perhaps most importantly, collaboration with experts as content advisors in each topic field ensures that concepts are portrayed accurately and in challenging and novel ways.

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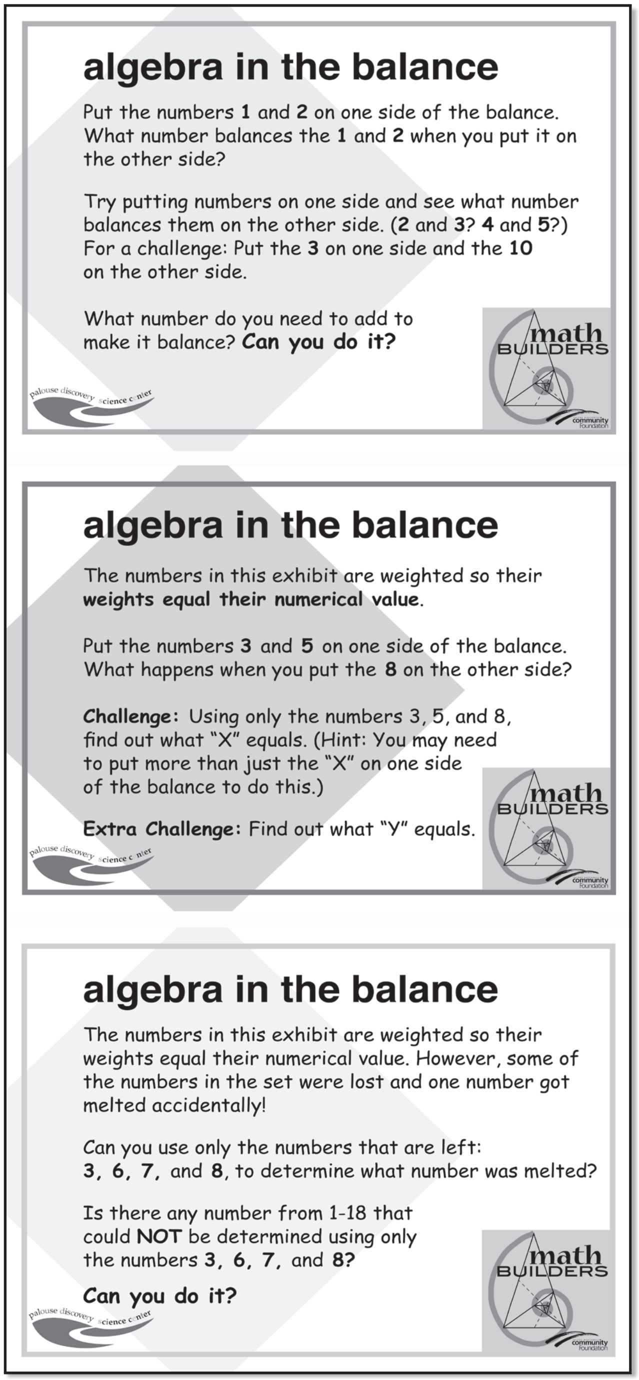

Example from one MathBuilders exhibit showing labels that can be changed on site to accommodate different audiences (ages 7-9, 10-12, and 13-adult).

these exhibitions help minimize both labor and material costs for their fabrication. Each of the 16 interactive exhibits in the *BrainBuilders* and *MathBuilders* exhibitions can be fabricated in less than two days; material costs average less than $250 per exhibit. The material costs for the *Light in Action* exhibition, while still modest, are slightly higher: approximately $350 per exhibit. Fabrication times are also slightly longer: two to three days per exhibit.

The PDSC serves many rural, underserved communities over a very large geographical area. These three traveling exhibitions have enabled us to bring a wide variety of science and math experiences easily to these audiences. The exhibitions can be set up quickly in

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Light in Action: *The design that emerged was a box, 12 x12x18 in. high, with a sign panel extending 15 in. from each corner. A 48 in. diameter disc sits atop each box to reduce the light levels within each exhibit.*

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a classroom, library, multipurpose room, or gym where they stay for the entire school day. Teachers typically schedule 30 to 50 minute visits for their classes, so we can often accommodate up to six classes during the day. Two facilitators travel with the exhibitions and help guide students if necessary. We have found that allowing students to sit with a partner to do the activities together results in good discussion and creative problem-solving. It also increases the time that students are engaged in the activities.

The portable nature of these exhibitions also makes them ideal for exchanging with other science centers. The PDSC conducted a very successful exchange of the *MathBuilders* for a space exhibition from ScienceWorks in Ashland, Oregon. The response from staff there was positive: "Having everything fit into one compact cube = fabulous" (Isabel Van Dyke, personal communication, Nov. 4, 2011). Although these exhibitions have been used on the exhibit floor of science centers and in traditional outreach settings, their compact size and rugged nature would lend themselves to use in non-traditional informal science education operations such as "science centers without walls" or mobile science centers. In fact, the signage could be done in different languages to accommodate international travel.

Use and Reactions

We use both observation and survey to evaluate exhibition effectiveness. On surveys given to students in randomly selected classes during school visits and to visitors at the science center who interacted with *MathBuilders*, an average of 80% of participants indicated that the exhibits increased their understanding of one or more math concepts. Observed time spent at these exhibits ranges from a few minutes to up to an hour per exhibit. Observations of family interaction indicate engagement at multiple levels where

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children and adults confer on strategies to solve the exhibit questions. ScienceWorks reported that adults spent more time at a single exhibit while their children would interact with multiple exhibits. The inter-generational interest in these interactive exhibits is an unexpected benefit and has influenced current exhibit design work for our next project related to beginning physics concepts. The collaboration of educators, content experts, designers, and fabricators will continue to be a focus of future efforts, due to our past success with this approach.

Although we could have anticipated the ease of transport and accessibility of these exhibitions, we never could have anticipated the positive responses of students, teachers, and others to the individual exhibits. During a visit with *MathBuilders,* we heard, "It was kind of neat to see them do algebra, especially since they had not done algebra before." Many students who had always thought they were terrible at math discovered that they were experts at solving those problems that didn't require computation, as in the logic and spatial relations exhibits. When experiencing one of the *Light in Action* exhibits, a 5th grade girl exclaimed, "Hey you guys! You've got to see this. This is awesome!", while a 5th grade boy said quietly to himself, "Wow, that's just crazy!" Reactions of the students and comments like these are what energize and encourage us to continue to create and develop new exhibitions.

We would like to acknowledge our content advisors: Dr. Rob Ely (Department of Mathematics, University of Idaho, Moscow, Idaho); Lisa Cartwright (Math Professional Development Coordinator, Pullman School District, Pullman, Washington); Dr. Andrew Dawes, Dr. James Butler and Dr. Juliet Brosing (Department of Physics, Pacific University, Forest Grove, Oregon).

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