

The overall goal of this project was to design and evaluate guided play activity kits to help parents foster the STEM skills of their preschool children. Many preschool STEM toys involve mastery-oriented challenges such as completing puzzles or constructing models that position parents as instructors, directing children in how to complete the task. Our goal was to design complementary play activities that helped parents foster the collaborative and creative problem-solving skills that children need to become innovative STEM thinkers. We focused on designing home activity kits that helped parents scaffold the discovery learning of their preschool children during creative play.

Using a human centered design (HCD) process, the first year of activities focused on understanding the experiences of parents during STEM play. Families with preschool children were visited at their homes, videotaped as they engaged in collaborative building challenges, and interviewed about their experiences with STEM play. These observations and interviews informed an initial design for STEM activity kit organization. This design was refined during a subsequent process of rapid cycle iterative prototyping and field testing. The HCD process led to 5 activity kit design features:

- 1) Kits were organized to divide the activity into four distinct steps. This slowed down the pace of the activity and made it easier for parents to engage their young children in the activity phases of planning, building, testing and refining, and extending learning.
- 2) Each kit started with a story that introduced the building challenge and supported parent-child planning. There were questions at the bottom of each page that set the tone for positive parent-child collaboration and discussion prior to starting the building activity.
- 3) Each kit included construction materials to build a core structure for a family of small plastic bears. These buildings were designed with features that encouraged parent-child talk about spatial concepts and math concepts. There was a brief set of tips that provided parents with sample questions they could use to support the child's exploration and learning during this construction.
- 4) Each kit included a separate "test and improve" step that provided parents and children with materials they could use to expand and refine the build. The additional building materials were packaged with a list of questions that helped parents and children consider and design improvements and test their functioning.
- 5) Each kit included extension activities to help the parent generalize support for STEM learning outside of the play session.

There was also an animated orientation video for parents and children and a written brochure for parents designed to provide an overview the activity kits and how to use them. All written materials were designed with reduced text and multiple illustrations to make them easy to read and absorb.

A formal field test was conducted to evaluate the design of the guided play STEM activity kits. Due to COVID-19, this field test was conducted virtually. 75 families with preschool and kindergarten children (ages 4-6 years) were recruited via social media and community flyers. Interviews with parents and assessments of child STEM skills were conducted over zoom. All

families then received 5 Bear Buildz activity kits mailed to their homes every other week over a period of 10 weeks. 50 of these families received the guided build activity kits and 25 (randomly assigned by lottery) received kits with the same building projects without the guided organization and structure. The goal was to determine whether the guided organization had value added beyond the building materials themselves in supporting parent STEM scaffolding and child STEM learning.

Results showed high rates of program use for both the guided build kits and the non-guided kits. Over the 10 weeks of the program, however, rates of use declined for families who received the non-guided kits whereas use remained stable and high for families who received the guided build kits. Parents also evaluated the activity kits more positively when they received the guided play kits relative to the non-guided kits. Parents thought the guided kits were more effective at building child STEM skills and helping parents learn ways to support child STEM learning. Observations of parent-child play after the end of the program showed that parents who had received the guided play kits did a better job scaffolding their child's STEM learning than parents who had received the non-guided kits; these effects were strongest for parents with less formal education.

In the final year of the grant, we tested the use of the guided play activity kits in the Discovery Space children's museum. Museum staff adapted the kits for use in a small group format and provided positive feedback along with additional ideas for expanding on them with group activities.

More information about the project along with videos illustrating the project activities and home activity kit design are available at the project web-site: <https://bearbuildz.la.psu.edu/>