Guided STEM Activity Kits for Parents with Preschool Children: Design, Frequency of Use, and Parent Evaluation

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Abstract

Parents boost STEM skills by scaffolding children's attention and discovery during play, but many need support to do so. Using Human Centered Design (HCD) methods, we created activity kits fostering parents' (a) involvement in and (b) valuing of parent-child play to promote preschoolers' STEM skills. Study 1 documents how HCD methods informed the design of guided activity kits. In initial home visits, we videorecorded 6 parent-child dyads playing with basic building materials. Play revealed minimal parental STEM scaffolding and talk. Collaborating with 18 families and drawing on prior research, parent interviews, videotaped play sessions, and advisory-board members' expertise, the interdisciplinary research team designed and refined activity kit prototypes. Study 2 was a randomized field test comparing use and evaluation of final guided kits (n=50) versus basic kits (n=25) which contained identical building materials and challenges but omitted scaffolding guides. Both groups received a kit by mail every other week for 10 weeks. Relative to parents given basic kits, parents given guided kits (a) reported significantly more sustained use of the kits across the 10 weeks, (b) felt more self-efficacy in fostering their child's STEM learning, and (c) judged that their child had achieved greater STEM-skill learning from program use.

Keywords: preschool STEM education; parent involvement; home learning; guided play; human centered design.

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Extensive research demonstrates that foundations for many skills needed to pursue and succeed in science, technology, engineering, and math (STEM) fields are built during early childhood. For example, preschool math (Claessens & Engel, 2013) and spatial skills (Gilligan et al., 2017; Zhang et al., 2014) predict later math achievement and contribute to future educational success. In addition, early support for STEM thinking (e.g., observation, reasoning, and inquiry skills) fuels individuals' later STEM interests and learning (McClure et al., 2017).

Parents can play a central role in supporting STEM learning in early childhood by the kinds of play activities they provide and by the way they interact with their children during play (Borriello & Liben, 2018; Strickler-Eppard et al., 2019; Thomas et al., 2020). Children's STEM learning is accelerated when adults expose them to math and spatial vocabulary and encourage STEM thinking during play, but most parents need guidance to incorporate these strategies effectively during play with their children (Rinehart et al., 2016; Strickland-Eppard et al., 2019).

The studies described in this paper were part of a larger project focused on designing and evaluating strategies to help parents scaffold their preschool children's STEM play in informal learning contexts such as homes and museums (Bierman et al., 2022). Our current paper has two major goals. The first goal is to document how we applied Human Centered Design (HCD) processes to design guided activity kits with embedded scaffolding to support parent-child STEM play and to describe the final version of those activity kits (Study 1). The second goal is to report on the frequency with which parents used the HCD-developed guided kits relative to more basic kits that included the same building materials but without the guided features and to examine parent perceptions of the educational value of the kits in terms of promoting their feelings of efficacy as STEM teachers and facilitating their children's STEM-related learning (Study 2). An ancillary goal was to expand the corpus of literature in early education that describes and illustrates the value and practice of HCD for program development, implementation, and evaluation more generally.

Research Informing the Study Focus and Learning Goals

Prior developmental research has shown that the acquisition of foundational math and spatial skills during the preschool years supports later educational attainment in mathematics and related STEM skills (Claessens & Engel, 2013; Gilligan et al., 2017; McClure et al., 2017; Zhang et al., 2014). Adults can effectively scaffold early childhood math and spatial skill learning in the context of STEM-related play (Strickler-Eppard et al., 2019; Thomas et al., 2020). Studies observing trained adults (educators or research staff) interacting with young children highlight the importance of providing play tasks that offer multiple opportunities for child application of mathematical and spatial reasoning such as block play and building challenges (Ferrara et al., 2011; Wolfgang et al., 2001) and providing adult scaffolding that focuses the child's attention on the mathematical and spatial features of play materials and models STEM thinking (LeFevre et al., 2010; Pruden et al., 2011; Szechter & Liben, 2004). However, outreach efforts designed to inform and support parent use of these evidence-based STEM play strategies have encountered challenges (Zucker et al., 2022).

Commonly used parent engagement strategies such as hosting family events at school and sending informational text messages to parents typically attract college-educated and financially well-resourced families but are less successful at reaching lower-income families (Pattison et al., 2022). Zucker and colleagues (2022) found that they attracted families representing a broader socioeconomic spectrum when they provided math and science activity kits to use at home (see also Clements & Sarama, 2008; Kaderavek et al., 2020; Reinhart et al., 2016; Strickler-Eppard et al., 2019). However, observations and interviews with parents using STEM play activity kits with young children at home revealed that most parents were unsure of the best ways to implement the kits and needed guidance to use the kits effectively (Reinhart et al., 2016; Strickler-Eppard et al., 2019).

Drawing on prior research and using an HCD approach, the present study focused on designing guided STEM activity kits for parents to use at home with their young children (age 3-6 years). Our aim was to provide self-guiding kits that would bolster parents' skills and confidence in supporting their children's STEM-related learning during their joint play with kit materials. Kits were designed to help parents incorporate the kind of play strategies linked empirically with child STEM skill learning, as detailed in the following section.

Characteristics of Parent-Child STEM Play Associated with STEM Skill Acquisition

Selection and staging of play activities. Based upon ten years of qualitative research, Pattison and colleagues (2023) identified key features of STEM-related home activities that engaged families with preschool children and that encourage sustained use. They centered their family play activities around building tasks that presented engineering design challenges and gave families simple materials that allowed children to take the lead in planning, building, and testing their ideas. They noted that most young children find these kinds of building challenges very engaging, and they can be set up in ways that offer multiple opportunities to explore mathematical and spatial features of materials and design (see also Ferrara et al., 2011; Ramani et al., 2014). Pattison's team (2023) recommended introducing building challenges with a story and incorporating stuffed animals or other characters to motivate problem-solving and spark initial design ideas. Other researchers have similarly used building challenges to set the stage for child-directed exploration and discovery learning. For example, Ramani and colleagues (2014) asked pairs of children to work together to build a house with a door and rooms, without any specific directions about how to do it. This challenge led the dyads to engage in collaborative problem-solving and elicited discussion about design, symbolic uses for the blocks, and the spatial relations of the blocks' placements. In another study, Ferrara and colleagues (2011) found that rates of adult-child spatial vocabulary use (e.g., next to, on top of, under) were elevated during block play when dyads were given a set of photographs that illustrated how to build a particular structure.

Supporting effective scaffolding of STEM skill learning. The way that play materials are prepared and presented sets the stage for discovery learning. The quality of adult comments and questions during the play then provides critical support for the child's acquisition of spatial and mathematical language and concepts (Ash & Wells, 2006; Clements & Sarama, 2008). For example, adults boost child learning when they use spatial and mathematical language during play and direct the child's attention to spatial and mathematical features of play materials (Ferrara et al., 2011; LeFevre et al., 2010; Pruden et al., 2011; Szechter & Liben, 2004).Young children learn best from guided play opportunities in which they take the lead in exploring and using play materials (Alfieri et al., 2010; Weisberg et al., 2013); the adult partner follows the child's lead and scaffolds learning by making strategic observations and asking questions to direct the child's attention to salient features of the materials and to elicit STEM inquiry and reasoning (Fisher et al., 2013; Weisberg et al. 2013). This kind of guided play also supports the child's ability to engage in collaborative, goal-oriented, STEM reasoning that encourages creative problem solving (Weisberg et al., 2016).

Initial efforts to support parent use of guided play strategies have identified challenges to overcome (Reinhart et al., 2016; Vartiainin & Aksela, 2018). Observations and interviews have shown that most parents rely on direct instruction to explain STEM-related home kit activities to their children and ask only a few fact-oriented questions during play, reducing the learning value of the activities and undermining parent confidence in their ability to scaffold child learning (Rinehart et al., 2016). Parents need guidance in finding ways to direct children's attention during play to the salient STEM features of the materials (such as shape, spatial orientation, size, number) and encourage STEM reasoning and collaborative problem-solving (Borriello & Liben, 2018; Callanan & Oakes, 1992; Strickland-Eppard et al., 2019). At the same time, based on their in-depth interviews, Vartiainin and Aksela (2018) concluded that parents are disinclined to spend much time studying information about how they should use learning materials at home and prefer activities that require minimal advance preparation and are fun and engaging for them as well as for their children. The implication is that home activity kits are likely to be most effective if they can support parents in scaffolding guided play without requiring advance preparation that parents perceive as burdensome. In addition, researchers have underscored the importance of designing materials that are easily accessible and practical for parents to use regardless of their levels of formal education (Pattison et al., 2022; Reinhart et al., 2016; Zucker et al., 2022).

Use of HCD to Design Guided STEM Play Activity Kits for Parents of Preschool Children

Based on prior research that identified the characteristics of parent-child play most likely to support the STEM learning of preschool children and the kind of guidance that parents sought, we moved forward with the application of HCD processes to refine the design of home activity kits. We focused on kits that included simple building challenges for parents and their preschool children to construct together (Pattison et al., 2022). The goal was to design these kits in ways that facilitated parent support for child-led discovery learning (Weisberg et al., 2016) and parent use of strategies linked empirically with child STEM skill acquisition (e.g., use of mathematical and spatial vocabulary, comments and questions that modeled and scaffolded STEM thinking; McClure et al., 2017), without burdening parents with preparatory reading or heightened literacy demands. The specific design goals were to improve parent efficacy in supporting their child's STEM learning during play and thereby increase child STEM-related skill acquisition.

Defining Features of the HCD Approach

HCD is one of several emerging strategies being applied to improve the design and implementation of educational programs and family-focused intervention services (Bauer et al., 2023; Derr, 2022; Oshio & Kupperman, 2022; Rozinsky et al., 2022). HCD provides a framework and set of processes to apply when addressing design challenges associated with program (or tool) development (Weeby, 2018). In Study 1 of the current project, the design challenge was to optimize the organization and presentation of home activity kits in ways that empowered parents to use the evidence-based strategies that prior research linked with child STEM learning as they engaged in fun building activities with their preschool children at home, thereby promoting their feelings of efficacy as STEM teachers and fostering child STEM skill learning.

Defining features of the HCD approach include the prioritization of the user's experiences in the design process and the use of rapid cycle iterative prototyping to refine the design in collaboration with users (Rozinsky et al., 2022; Weeby, 2018). HCD encourages the use of brainstorming activities with stakeholders representing multiple perspectives to promote innovative thinking through the design process (Rozinsky et al., 2022). HCD proceeds through four phases: (1) gaining insight about user needs and preferences by observations and interviews with users (i.e., identifying and understanding problems), (2) using brainstorming activities with an interdisciplinary team to generate innovative solutions that reflect multiple perspectives (i.e., creating the initial design prototype), (3) implementing a rapid and iterative process of prototyping and field-testing (i.e., testing successive designs) prior to (4) selecting a final design and evaluating users' responses to that final design (Rozinsky et al., 2022; Tantia, 2017). Researchers are just beginning to apply HCD to address challenges in the field of early childhood education (see Oshio & Kupperman, 2022) and family-focused interventions (Bauer et al., 2023). The purpose of Study 1 was to use the HCD approach to design STEM activity kits that would enable parents to be and feel effective in promoting their preschool child's discovery learning during STEM play.

Study 1: Using HCD to Design Guided Activity Kits for Parent-Child Use

Prior research informed several design parameters that we kept in mind as we moved through the HCD process with families. We wanted the kits to be self-guiding, so parents could use them at home or in other informal learning contexts without the direct assistance of trained staff or teachers. We wanted to minimize the pre-play preparation burden on parents and find ways to embed supports for parents into the kits in ways that did not disrupt the natural flow of the play. We wanted the activities to be highly engaging for parents and children and provide multiple opportunities for parents to use mathematical and spatial vocabulary and to support their child in collaborative problem-solving and STEM thinking. With these design features in mind, we proceeded to apply HCD processes to create and refine kits that, based on our observations and interviews, optimized effective parent use, parent feelings of efficacy as teachers, and parent confidence regarding child STEM skill learning.

Method

All study procedures followed the American Psychological Association standards for ethical research with the approval of the university IRB. HCD methods are exploratory, informal, and open-ended, intentionally designed to encourage multiple perspectives from an interdisciplinary design team and be flexible and responsive to user input and feedback during the iterative design process.

Participants

Family participants. The sample included 18 families with preschool children recruited over a two-year period from a prekindergarten program run by a public school serving a rural county with a large proportion of low-income families. Any family with a child attending that prekindergarten program was eligible, and families were enrolled in the order in which they indicated their interest in participating. Based on parental reports, children in the sample were an average of 4.4 years (SD = 1.0 years, ranging from 4.5 years to 5.4 years), 50% were girls and 50% boys; 83% were White, 6% Black, and 11% biracial. All but one of the participating parents were mothers; the remaining participating parent was the child's father.

Interdisciplinary design team. The local interdisciplinary design team included five university faculty members representing the fields of developmental psychology, educational psychology, public health, social work, manufacturing engineering, and industrial engineering. Also contributing to the design process were the five members of the project's external advisory board who represented the fields of science education, developmental psychology, informal education, and pediatrics. These advisors provided varied experiences from their positions as university faculty in developmental psychology and informal education, a director of a children's science museum, a pediatrician, a developmental consultant and designer in the toy industry, and the director of a consulting organization specializing in STEM-related educational programs in out-of-school settings. The purpose of these teams was to bring a diverse set of perspectives and considerations to the design process.

Procedures

This study involved the application of the four phases of the HCD process. The first phase focused on gaining insight about user needs -- understanding how families used basic STEM activity kits involving building activities with their preschool children. We conducted home visits with 6 of the families, providing each with a set of common building materials (e.g., construction paper, tape, etc.) and videotaped them as they engaged in two collaborative building challenges (i.e., building a house for a set of small plastic bears; building a road and ramp to race cars). Following the challenges, we interviewed the parents about their experiences during those play sessions. (Findings that emerged at this step and each of the subsequent steps are presented in the Results section of this paper.)

The second phase of the HCD process was to create an initial prototype of a guided activity kit. After reviewing the videotapes and interviews with the first 6 families, our interdisciplinary team brainstormed ideas about alterations in play materials, packaging and presentation, and play guides that might help parents more effectively incorporate STEM language and scaffold their child's STEM thinking (e.g., observation, reasoning, and inquiry) during play. We created three prototype kits that each contained an introductory story to set up the building challenge, wooden building pieces that could be put together to construct a building (house, playground, and treehouse), and a "parent tips" instruction sheet to highlight the strategies that parents could use to promote child discovery learning during these tasks.

The third step in the HCD process was to engage in an iterative cycle of rapid prototype testing and refinement to improve the guided activity kit design. This phase extended over the next year, with a total of 22 family visits (some families participated in more than one visit) as we adjusted various components of the kits (see details in the Results section). The goal of the rapid and iterative prototype testing is to quickly and dynamically respond to the experiences of the program users to identify design problems and solutions. During this intervention refinement phase, research team meetings were held regularly to review incoming parent-child videotaped observations and interviews, discuss what was (or was not) working well, and to make corresponding modifications to the kits to include in the next set of home visits. Supplementing input from the local team during this process were two brainstorming workshops the research team held with the external advisory team. Two additional kits were designed, changes were made in the packaging of the kits, an animated orientation video and extension activities were added (details provided in the Results section.) Collectively these phases informed the fourth step of HCD – selecting the organization and format for the final version of the guided activity kit design that was evaluated in Study 2 (see summary of HCD process in Table 1).

Insert Table 1 about here

Results

The HCD Process and Guided Activity Kit Design

Phase 1: Explore the Problem

The research team's review of the initial 6 parent-child interaction videotapes and interviews revealed that collaborative building challenges were engaging and enjoyable both for parents and for children. However, consistent with prior research, the team observed relatively low levels of parent or child use of spatial or math language during play and relatively little parent scaffolding of child STEM thinking. Instead, parents tended to take the lead in directing (or taking over) the construction of the buildings and only then engaging their children collaboratively in the process of decorating and playing with the finished buildings. Parent-child conversations during the building activity often focused on the fine motor tasks of cutting and taping decorative features on the buildings, with little time spent on planning or evaluating the building structure itself.

Phase 2: Create a Prototype Design

A central focus of subsequent team discussions and brainstorming focused on how best to modify the organization, packaging, and presentation of the home activity kits in ways that would help the parent more effectively scaffold STEM thinking (observing, planning, reflective inquiry) and STEM talk (use of math and spatial vocabulary). A prototype design was used to create three activity kits, incorporating several features drawn from prior research (especially Pattison et al., 2023) as well as innovations based on the initial set of HCD observations. The prototype activity kits each included a story about a bear family that needed the parent and child to build something for them (including a house, a playground with slides, and a treehouse) with a final page that encouraged the parent and child to talk about their building plan. Puzzle-like pieces were developed for the families to use to build the different constructions rather than relying on crafting materials. The two engineers on the team provided important input regarding the design of the building pieces, with attention to the flexibility and sturdiness of the design, safety issues (e.g., size, sharp edges), durability, and materials costs, production, and mailing. We wanted to reduce the fine motor demands of the building activities that often required adult management (e.g., using tape, scissors) and increase parent-child exploration of spatial features of the building pieces (e.g., manipulating their spatial orientations, testing different configurations) as well as enhancing the on-going durability and use. An instruction page was also added for parents, providing an overview of the learning goals of the activities and tips for how parents could scaffold child learning.

Phase 3: Rapid-cycle Iterative Prototyping

Over the course of 18 home visits, the research team made successive revisions of the activity kit design. The team observed that families tended to open the activity kit, dump out all the materials, and dive into their building activities. The instruction sheet was often set to the side without attracting much attention from the parent, and the approach to building was often fast-paced and action oriented, with little planning or systematic reflection and testing of design strategies. In order to slow down the pace of the activity and give the parent-child dyad time to move through the kit in a more systematic way, the team moved away from providing all the materials and instructions at once. Instead, the kits were divided into four explicit, separate steps, each packaged separately (see Table 2). This organization slowed down the pace of the activity and gave parent-child pairs the opportunity and support they needed to spend more time planning their building activities, testing out their ideas, and reflecting on how features of their building were performing.

Insert Table 2 about here

The materials packaged for step 1 – labeled STEP 1 PLAN – were inserted at the top of the activity box. That package included the story setting up the building challenge which ended with a picture of the pieces the pair would have to build with and questions for the parent to ask the child about their building ideas (illustrations of these materials and other materials in the kits are provided in the supplementary table S1). This order of presentation increased the likelihood that parent-child pairs would begin to talk about their plans for building before initiating the build itself. A package containing the individual pieces of wood needed for the building challenge were packaged together next – labeled STEP 2 BUILD – giving dyads a challenge that inspired and supported discussions of shapes, sizes, and relative positions and orientations of pieces as they fit them together to construct the building. It was not until dyads opened the next package – labeled as STEP 3 IMPROVE – that the dyads received additional extension and crafting materials. This third step was designed to provide opportunities for the dyads to expand and refine their designs by responding to challenge questions such as, “How will the bears stay dry if it rains?” Challenge questions like this were intended to encourage discussion of ways that the building structure, function, or appearance might be modified (e.g., adding a roof to the house).

The text-heavy parent instruction sheet that had rarely attracted parent attention was replaced with a brief graphic tip sheet packaged with each step, embedding “talking points” at strategic points during the activity to help parents scaffold their child’s STEM learning. The revised tip sheets were crafted with eye-catching graphics and included only minimal text so that parents could read the tips quickly. To support parents’ use of inquiry, the individual tip sheets also suggested specific questions that parents could ask during each step of the activity.

To capitalize on the way that stories and animal characters heighten the interest of young children in building challenges (see Pattison et al., 2023), all of the kits involved the adventures of a bear family. In the first kit, families received four plastic bears (two large, two small). In addition, each guided activity kit included a storybook for the parent to read with the child. Each story described something that a bear family needed. For example, in the first story, the bear family experiences a flood and needs a new house. In another story, the little bears are bored and need a playground with slides. Each of the activity kits was designed to complement and build on earlier kits thematically. More specifically, across the five kits, parents and children were encouraged to build a house for the bears (kit 1), a playground with slides (kit 2), a wagon (kit 3), a bridge (kit 4), and a treehouse (kit 5). Many parents reported that the growing collection of structures fueled ongoing engagement as children adjusted or extended their buildings to support pretend play. Building on this interest and based on parent suggestions, we developed an introduction to the Bear Buildz program which provided an animated (video) orientation to the bear family and the activity kits. This orientation invited parents and children to watch the bears explain how to use the activity kits, including what to do at each of the four steps. The first kit also included a Bear Adventure map which parents and children could use to track their progress in completing the five different kits. All materials were designed to require no more than basic (grade-school level) literacy skills, and all included graphics designed to make the materials easy to read and absorb.

A final modification to the design was made during the iterative testing phase in response to a concern that parents might not easily generalize the suggestions and tips provided in each kit (which were specific to the item they were building with their child) to other informal learning opportunities they might have during other kinds of STEM play or in the activities of daily life. To address this concern, the team designed *extension activities* to include in each activity kit. The purpose was to illustrate how parents could generalize the scaffolding strategies introduced in that activity kit to parent-child interactions beyond the kits and to give examples of other kinds of STEM play that parents could do with their children. Thus, a fourth step – labeled STEP 4 MORE FUN – was added to each activity kit which included two items. One item was a concrete example of another STEM play activity parents could do with their children that tied thematically to the kit; the second was a list of ideas for how parents could use everyday interactions with their child to comment on or practice a STEM concept that had been exercised in the activity kit. For example, the STEP 4 MORE FUN packet of the first activity kit (house building) included a cardboard strip on which had been drawn a stone walkway which could be placed in front of the constructed house. The stones were numbered, and the kit included dice and instructions for playing a “Race to the House” game with the bear figures. The tip provided for parents explained that counting the walkway stones was a good way for children to build their number skills. The MORE FUN instructions also included examples of other things that parents might count with their children during everyday activities.

Phase 4 – Select and Evaluation the Final Design

The contents of the final activity kit design are described in Table 2; illustrative examples of the specific materials included in the 5 kits are provided in the supplementary materials (see Table S1) and illustrated on the project website (https://bearbuildz.la.psu.edu/). The evaluation of these kits was the focus of Study 2.

Study 2: Dyadic Use and Parent Evaluations of “Guided” versus “Basic” Activity Kits

The purpose of Study 2 was to learn whether families’ engagement with and parents’ evaluation of the learning value of the activity kits varied in relation to whether they had been randomly assigned to receive “guided” versus “basic” versions of the kits. As noted earlier, the guided activity kits were the products of the HCD process; the basic kits provided families with the same building challenges and building materials but lacked the HCD-inspired modifications (i.e., step-by-step divisions and extension supplements listed in Table 2).

Study 2 was conducted during COVID when in-person research was prohibited; hence, the study used virtual methodology as described in more detail in the following sections. Families for Study 2 were recruited online and were randomly assigned to receive one of two versions of the activity kits. Both kit versions included the identical sets of materials needed to build various objects (e.g., a house, a wagon); both were described and delivered as a program that was named

“Bear Buildz”. The *guided activity kits* included the animated bear family orientation guide, a set of 4 plastic bears (2 big, 2 little), the 4-step packaging, the bear family stories with planning questions, the “test and improve” tips and materials, and the “more fun” extension games and tips developed using the HCD process. The *basic activity kits* included a letter describing each building task, a picture of the finished structure, a set of 4 plastic bears (2 big, 2 little) and all the materials needed to construct the structure.

Study 2 addressed two research questions: (1) Was the final version of the guided activity kit more effective than the basic activity kit in promoting sustained use of the materials over the study period? and (2) Did parents who received the guided activity kits evaluate the program more positively than parents who received the basic activity kits with respect to, first, perceptions of their own efficacy in scaffolding child STEM-skill development and second, with respect to their beliefs about whether the activity-kit play helped encourage the acquisition of new STEM skills by their child.

Procedures

Study 2 was conducted while COVID-19 restrictions prohibited researchers from making home visits or having other in-person interactions with families. In addition, the school closures which accompanied COVID-19 meant that we could no longer work with our school district partner. Consequently, the process for recruiting families changed: we posted announcements in the community and on social media to recruit families with children between the ages of 4 and 6 years (prekindergarten and kindergarten age). Trained research staff arranged Zoom-based interviews to collect family demographic information and to provide an orientation to the Bear Buildz program. The 75 families we recruited for Study 2 were randomly assigned to receive either the guided activity kits (N = 50) or the basic activity kits (N = 25). An unequal randomization process that assigned more families to the intervention condition was employed to provide more information about the intervention while retaining the benefits of randomization and balance across intervention and comparison conditions (Peckham et al., 2015). Kits were mailed to families via USPS every other week for 10 weeks so that each family received 5 kits. All families received the 5 kits in the identical order, ordered from roughly least to most difficult (as judged by the research team based on informal observations made during the HCD process). Families were asked to report on their use of the kits by responding to weekly texts sent over the 10-week period; at the end of the program parents were provided with rating forms to evaluate the program which they sent back to the project office.

Participants

Participants included 75 parents and their preschool or kindergarten children. Any family with a child in the pre-kindergarten to kindergarten age range was eligible, and families were enrolled in the order in which they indicated their interest in participating. Parents reported the children were 49% girls and 51% boys; 95% White, 3% Black, 1% Asian, 1% Native American. Children ranged in age from 4.0 years to 6.0 years, M_{age} = 4.8 years, SD = 0.5 years, 29% age 4.0 to 4.4 years, 39% age 4.5 to 4.9 years, 24% age 5.0 to 5.4 years, 8% age 5.5 to 6.0 years. Most participating parents were mothers; three participating parents were fathers. In two families, the participating primary caregiver was a grandparent. Most parents were married or living with a partner (92%); the others were single parents. Parent education levels ranged from high school/GED completion (27%) to 4-year college degree (44%) to some post-BA education or graduate degree (29%).

Measures

Program use. Kits were mailed from the office every other week with an expected arrival day of Saturday. Each subsequent Friday during the 10 weeks of the program, parents received a text with the question: "Did your child use Bear Buildz materials this week?" Parents replied by responding "0" to indicate no use in the prior week; "1" to indicate one use in the prior week, and "2" to indicate two or more uses. Parents reported on use of *any* Bear Buildz materials (that is, they were not asked to limit reporting to their child's use of only the most-recently received activity kit.) In analyses, we distinguished between usage levels reported for weeks in which families received a new activity kit (i.e., weeks 1, 3, 5, 7, and 9) and for the intervening weeks in which they did not receive a new kit (i.e., weeks 2, 4, 6, 8, and 10).

Program evaluation. At the end of the study, parents were asked to share their views of the program by using a 5-point rating scale to express their level of agreement (1 = *strongly disagree* to 5 = *strongly agree*) with various statements about the program. Two items tapped parents' assessments of the program's success in supporting their *own* efficacy in supporting their child's STEM skill development ("The Bear Buildz program gave me the tools I needed to help my child learn STEM skills" and "The Bear Buildz program helped me learn ways to help my child learn STEM skills," $\alpha = .89$"). Responses to these items were averaged to yield a parent-efficacy evaluation scale. Parents' responses to 9 other items were used to create two subscales assessing parents' views of the programs' effectiveness in promoting their *child's* STEM skills. One subscale assessed Bear Buildz's impact on their child's learning by averaging parents' responses to 6 items focusing on Bear Buildz in particular ("I saw growth in my child's math skills during Bear Buildz"; "I saw growth in my child's building skills during Bear Buildz"; "I saw growth in my child's attention span during Bear Buildz"; "My child got better at planning and problem-solving."; "My child learned new words and concepts by participating in Bear Buildz"; "I think what my child learned in Bear Buildz will help them in school;" α = .55). A second subscale was created by averaging parents' responses to 3 items that asked about the impact of Bear Buildz in a comparative context ("Compared to other learning activities you do with your child, how would you rate your Bear Buildz experience in terms of: How well it taught math skills . . . How well it taught spatial skills . . . How much it encouraged creativity," α = .59).

Overview of Analyses

Responses to the weekly texts about the use of the play kits provided longitudinal data over the 10-week course of the program. These data were analyzed using mixed models (Proc Mixed, SAS version 9.4). Covariates included child gender and age, to control for any gender- or age-related differences in STEM play interests or skills. Time extended over the 10 weeks of the program and was organized into five two-week units (each unit marking the introduction of a new kit). A nested binary variable indicated whether the level of use reported on Friday referred to: (1) the first week in each two-week unit when the kit was delivered and (2) the following week in that two-week unit. This analysis tested whether covariates (child gender, age) or program condition (guided activity kits vs. basic activity kits) affected overall levels of program use over time. It also tested whether families reported different levels of use in the weeks they received a new kit (i.e., weeks 1, 3, 5, 7, 9) and in the intervening weeks when they did not receive a new kit (i.e., weeks 2, 4, 6, 8, 10).

Parent ratings on the three program evaluation scales (impact on parent efficacy, impact on child STEM skill learning, comparative impact on child STEM skill learning) were collected just once, at the end of the Bear Buildz program. They were analyzed using linear regression (with covariates of child gender and age) to determine whether parents evaluated the program differently based on assignment to program condition (guided activity kits vs. basic activity kits).

Results

Program Use

Mean levels of program use by families in the two conditions (guided or basic activity kits) were analyzed as explained above in the section entitled "Overview of Analyses." Program use varied significantly by child gender (greater use in families with daughters than sons, $\beta = 0.21$, $p = .004$) and week type (greater use in the weeks families received a new kit than in the weeks in which they did not receive a new kit, $\beta = 0.22$, $p < .001$). There was a significant interaction between condition and time, $\beta = 0.09$, $p = .03$. Figure 1 shows the rates of program material use over time, with rates of use during the weeks when families got a new activity kit (weeks 1, 3, 5, 7, 9) shown with dark lines and rates of use during the following week when no new kit arrived (weeks 2, 4, 6, 8, 10) shown with gray lines. Families in the guided activity kit condition showed sustained use of the materials across the course of the program, whereas those in the basic activity kit condition showed decreasing use of the materials over time, $\beta = -0.08$, $p = .03$.

Insert Figure 1 about here

Program Evaluation

In general, parents' evaluations of the program were positive, averaging over 4 on a 5-point scale. However, parental ratings were significantly more positive on all three scales among families who received the guided activity kits than among families who received the basic activity kits. For ratings of program impact on parent efficacy in supporting their child's STEM skill development, $\beta = 0.38$, SE = 0.14, $p = .008$, $M = 4.44$ versus $M = 4.04$, see Table 3. Parents' ratings of program impact on child STEM skill learning similarly favored the guided activity kit, $\beta = 0.20$, SE = 0.08, $p = .023$, $M = 4.04$ versus $M = 3.85$. Parents' relative evaluations (in which they were asked to compare the impact of Bear Buildz kits on child STEM skill learning to other learning activities they do with their children) showed a similar pattern: parents who had received the guided kits rated the activity kits significantly more positively than did parents who had received the basic kits, β = 0.39, SE = 0.13, p = .005, M = 4.16 versus M = 3.76.

Discussion

Many of the toys recommended and sold as materials to support or encourage preschoolers' skills and interests in STEM are toys which promote structured play activities such as putting together puzzles, copying models, or counting out spaces during board games. These kinds of toys tend to elicit highly directive parent-child interactions in which parents tell their child how to reach the goal (e.g., complete the puzzle) or follow the rules (e.g., in board games). Parent-child play of this kind is likely to provide valuable practice in specific skills (e.g., rotating puzzle pieces so they connect) but is unlikely to promote more generalized STEM habits of mind such as proactively identifying problems to be solved, imagining multiple solution strategies, persisting through failures, engaging in collaborative problem solving, and the like. The goal of Study 1 was to design activity kits in ways that guided parents in their efforts to engage their preschool children in open-ended discovery learning and to advance their children's collaborative STEM thinking and problem-solving skills. The goal of Study 2 was to determine how parents used and evaluated these guided activity kits in comparison with how parents used and evaluated the same building activities that were presented in more traditional ways (i.e., as provided in the basic activity kits). In the following sections, we first discuss the findings of Study 1 and Study 2, and then address the overall implications and limitations of this research and the broader potential of HCD methods to inform educational material design.

Study 1: HCD Process and Guided Activity Kit Design Features

In Study 1 we applied HCD methods to create activity kits to guide parents in the presentation and scaffolding of their child's discovery STEM learning during play. Prior research suggested that parents need help to increase the range of interactions and discourse during STEM play with preschool children (Reinhart et al., 2016; Vartiainin & Aksela, 2018). Parents can scaffold child learning by using spatial and mathematical vocabulary as they play, which helps the child notice and label spatial and mathematical concepts (Ferrara et al., 2011; LeFevre et al., 2010; Pruden et al., 2011; Szechter & Liben, 2004). Adults stimulate STEM thinking skills when they make observations and ask thoughtful questions during play, eliciting child curiosity and reasoning (Strickler-Eppard et al., 2019).

The HCD process employed here focused on the experiences of parents and children while using different versions of activity kits. Each member of our interdisciplinary design team (which included researchers with backgrounds in developmental psychology, science education, public health, social work, industrial engineering, and mechanical engineering) was encouraged to share opinions about how each version of the proposed activity kit would likely support (or fail to support) engaged, enjoyable, and well-scaffolded parent-child play. The HCD approach involves iterative interaction with and input from the intended users and seeks to elicit multiple perspectives on product design strengths and limitations and then to encourage multifaceted brainstorming about possible solutions (Rozinsky et al., 2022; Weeby, 2018). The purpose is to encourage diverse perspectives and insights and thereby catalyze rapid innovations in design during iterative testing with the intended product users – in this case, parents and their preschool children.

The HCD process influenced the way the activity kits were presented and packaged. Our initial observations were consistent with prior research findings that noted parent overuse of direct instruction when engaging in STEM-related activities with their young children, with limited inquiry or scaffolding of child planning and collaborative problem-solving (Rinehart et al., 2016). We also observed that parents and children quickly became engaged in the building challenges and often rushed to complete the basic structure, thereby further attenuating the time they spent in collaborative planning or discourse. In the early design phases, we included instruction sheets for parents that provided a list of suggestions for how to scaffold the play, but these instructions were often set aside in the excitement of using the kit. To address these issues, the final design of the guided activity kits divided each kit into four separate steps with corresponding instructions and materials. These steps were packaged in separate envelopes to slow down the pace of movement through the activity. The slower speed and marked "steps" gave parents more opportunities to support child discovery during individual phases of the activity by encouraging thoughtful planning, building, testing and refining, and generalizing. Prior research suggests that inquiry, especially the use of open-ended "wh" questions (e.g., Where should this one go? What will happen if you put it there?) during STEM activities stimulates complex reasoning and promotes the development of inferential thinking (Birbili & Karagiorgou, 2009; Danis et al. 2000; Reinhart et al., 2016). The tip sheets included in the guided kits at each phase were designed to be skimmed effectively by parents, a quality achieved by limiting the amount of text and by providing simple graphics as well as a small number of specific examples which suggested ways to support inquiry at each phase. We observed more parent use of the suggested questions and tips when they were simplified and presented sequentially in this manner than when they were presented as a complete list at the start of the activity earlier in the HCD process.

The HCD process also generated parent observations and suggestions that informed the final design. For example, some parents commented that their child had become engaged by the story narrative and had gone on to incorporate the kit-constructions into further pretend play. These parental comments led us to add design features that would capitalize on children's interest in pretend play related to the bear family and narrative while also enticing families to engage together in more STEM play. For example, we provided an "extension" game which involved the house for the bears and required counting; we created a map depicting the "Bears Adventures" and asked dyads to track and record their building activities on that map as they completed building the structures for each of the adventures (i.e., the construction challenges contained within each of the five kits).

Study 2: Use and Parent Evaluations of the Guided Activity Kits

Findings from Study 2 revealed that at the start of the program, families used the activity kits frequently irrespective of whether they had received the guided or the basic version of the kit. However, whereas the families who received the guided activity kits sustained their high level of use over the full course of the 10-week program, families who had received the basic activity kits gradually decreased their frequency of use across the same timeframe.

Several factors may have contributed to the higher and more sustained use of the guided activity kits than the basic activity kits. The guided kits included more activity suggestions than the basic build kits and the kits contained more supplemental materials which could be used to test and refine the constructions (i.e., step 2 of the guided kits). As explained earlier, the guided kits also included extension activities (e.g., a learning game or activity, and ideas for generalization in daily life). Having more to do in each kit may have increased the chance of having activities that were appealing to a particular child or parent, and the novelty of linking kits to other activities may have contributed to higher rates of sustained use. The parent evaluation ratings in Study 2 suggest that parents also felt more efficacious in using the guided kits (relative to the basic kits). Results of Study 2 also showed that parents who received the guided kits evaluated the program impact on child STEM skill learning more highly than did those who received the basic activity kits. These findings suggest that parents recognized and valued the design features that helped them effectively guide and scaffold their child's STEM learning during their collaborative play. Enhanced feelings of efficacy and child benefit may also have motivated higher levels of sustained use.

Study Limitations

It is important to acknowledge that our work is limited in several ways, some unanticipated when we began. Our first goal was to apply HCD methods to design activity kits that could be used comfortably by parents from a range of socio-economic backgrounds, especially those less likely to have STEM-play resources at home. The second goal was to learn if these families found the resulting activity kits useful and if they boosted parent efficacy and child STEM learning. In keeping with the first goal, during Study 1, parents and children were recruited from a school district which serves predominantly low-income rural families. However, consequences of the COVID pandemic (e.g., school closures; regulations limiting research contacts) prevented us from continuing to recruit through our original partner school district. Thus, for Study 2, we substituted online recruitment and activities. This change resulted in a sample with a smaller than planned proportion of families with less formal education (27% of the final sample without formal education after high school.) This proportion mirrors the percentage of Americans who do not pursue education after high school (national average is 25%, Schaeffer, 2022) but we had hoped to over-sample this segment of the population given that they are often under-represented in STEM research. Our sample also lacked the desired racial/ethnic diversity. Additional research is needed to determine whether larger and more diverse samples would evidence high levels of use and offer positive evaluations of the activity kits like those we observed in Study 2.

Our study also used a necessarily constrained approach to assessing families' use of the activity kits: we relied exclusively on parents' responses to 10 texted inquiries about the frequency with which the program materials had been used during the prior week. The reliance on parent report to estimate use may have introduced bias into the reporting (although likely this bias was similar for parents in both the guided activity kit and basic activity kit conditions). Expanded measurement strategies such as observations and expanded interviews are needed to learn more about the quality and frequency of parent-child interactions while using both guided and basic kits.

It is important to note that this study focused on one kind of preschool STEM learning activity (building challenges) and one aspect of parental facilitation (scaffolding math and spatial skill learning during discovery play). Researchers have also documented the value of other kinds of parental facilitation of STEM learning, including the multiple roles parents play in supporting early computational toys and kits with young children (Yu et al., 2021).

Implications for Future Research and Practice

Study findings highlight the value of the HCD approach in designing guided play activity kits that enhanced parent-child engagement and preserved high rates of use over time, preventing the gradual decline in use observed with the basic activity kits, as well as supporting more positive parent evaluations of their educational value. The next step in this research program is to evaluate whether the guided kits had the intended effect on parent-child interactions and on children's STEM skills. That is, did the guided activity kits facilitate parents' scaffolding of their children's discovery-learning STEM play even when using STEM games and activities encountered apart from the activity kits themselves? Did the guided activity kits have a greater impact than the basic activity kits on children's STEM-building behaviors (e.g., increased use of mathematical or spatial language)? Additional work in which parent-child play interactions are observed as much as a year or more after the conclusion of the 10-week program will be needed to learn if the guided play kits have a sustained effect on parent-child play interactions and children's STEM skills and interests beyond the preschool years.

Future research should also address the extent to which experiences with guided activity kits build parent understanding of the general principles and strategies for scaffolding child STEM learning in ways that might extend over multiple contexts of parent-child interaction and over time. Researchers have suggested that parent scaffolding during everyday activities (such as cooking and grocery shopping) could support child STEM learning if parents are able to use STEM talk and inquiry effectively in these contexts (McClure et al., 2017). Additional research might address questions about the extent to which and ways in which parent exposure to guided play activity kits fuels their interest in and efficacy for scaffolding child STEM learning in these kinds of everyday activities and other STEM-related interactions.

The guided activity kits designed in this study focused on promoting children's STEM thinking and early math and spatial skills, but the guided discovery learning approach should also support growth in cognitive flexibility and executive function skills more generally (see Fay-Stambach et al., 2014; Gropen et al., 2011). For example, when parents use inquiry to elicit the child's thoughts, let the child lead the exploration, and give children choices rather than relying primarily on instructions, they foster their children's flexible, self-regulated, and goal-oriented problem-solving skills, the hallmarks of EF (e.g., Bindman et al., 2013; Hammond et al., 2012). Interestingly, there is evidence that early spatial and mathematical thinking skills are developmentally intertwined (Verdine et al., 2014), and evidence that EF skills both contribute to and are fostered by gains in these two types of skills (Clements et al., 2016). Future research is needed to explore the degree to which parent-child interaction using guided play activity kits like those designed in this study supports growth in the broader set of EF skills that support creative and collaborative problem-solving and goal-oriented learning as well as the targeted STEM skills (Gropen et al., 2011).

The work we have reported in the current paper also carries important implications for educational practice insofar as it offers a model of how the HCD method might be used to refine many other educational activities in ways that would increase parents' capacity to scaffold their children's discovery learning. Our work focused on home activity kits because prior research suggested that home activities offer considerable promise for engaging a broad and diverse range of parents in STEM-related play with their young children (Clements & Sarama, 2008; Kaderavek et al., 2020; Reinhart et al., 2016; Strickler-Eppard et al., 2019). Our project was also designed to explore the possibility of adapting Bear Buildz for family programming offered by children's museums. To this end, we discussed possible applications and adaptations of the approach with the museum experts on our Advisory Board and ran a small pilot event with our local children's museum. In this event, museum staff incorporated the guided activity kits into a family workshop they held and led for preschool children and their parents. The feedback from museum staff following these events was encouraging. The experience gave support for the idea that Bear Buildz activity kits could be incorporated into museum settings, although the museum restrictions and closures necessitated by the COVID pandemic limited our ability to conduct formal research to design and evaluate museum-based applications within the current study. Both home and informal learning venues are particularly important because they have the potential to reach a diverse range of families, including families of lower socioeconomic status, rural families, and families of color (Pattison et al., 2022; Zucker et al., 2022).

More generally, there has been a recent call to incorporate the HCD approach when designing educational materials (Weeby, 2018) and addressing challenges in early childhood education (Oshio & Kupperman, 2022). The HCD process prioritizes a focus on the needs, preferences, and feedback provided by the intended users. In the current project, we found the second HCD phase of product refinement to be particularly valuable, that is, the phase which involved rapid cycles of iterative prototype refinement and testing with observations of parent use and elicitation of parent input. Parent-child reactions informed changes in low-cost prototypes which could then be tried out with additional families prior to making decisions about final production. Furthermore, input from our interdisciplinary team proved especially useful at this phase, because it elicited a wide range of ideas about how user needs could be addressed while encouraging the kinds of activities and parent-child interactions shown to be important in developmental and educational research and while maintaining realistic (and cost-efficient) designs as judged by the team's engineers. Our findings are consistent with Weeby's (2018) call to expand the use of HCD processes in education program development more generally and support further research efforts to incorporate and evaluate this approach. Several core features of the final guided activity kit design have implications for the design of parent support materials in other informal learning contexts, such as the segmenting of the activity into separate steps that guide parent-child dyads in a systematic approach to discovery learning; the use of brief, graphic-rich parent tips embedded at each phase in the activity to support strategic scaffolding; the use of an animated orientation video that parents and children can watch together; and the use of thematic stories about animal characters to engage and motivate young children in sustained and collaborative problem-solving. These are strategies that could be integrated into multiple kinds of adult-child playful learning activities in varied contexts.

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Table 1

Phases of HCD as Applied to the Current Project

Phase	Goals	Method	Results
Explore the problem	• Understand parent experiences with & feelings about STEM play. • Identify activity kit features that increase or reduce parent/child engagement, STEM language and scaffolding of STEM thinking.	• Conducted 6 home visits with parents and their preschool children. • Videotaped parent-child interactions as they built a house & car race ramp. • Interviewed parents about their experiences during play sessions and with other STEM toys.	• High engagement of parents and children in building activities. • Parents often led the play rather than scaffold child planning and reflective thinking. • Parents rarely used STEM vocabulary. • More time was spent on craft decoration than planning, testing, and refining the building.
Create a prototype design	• Generate ideas about play materials, presentation, and guides that could help parents scaffold child STEM learning in engaging and fun ways. • Design initial prototypes of guided activity kits	• Reviewed videotapes and interviews from the initial home visits with an interdisciplinary team • Applied HCD brainstorming activities to suggest and select innovative strategies to improve kit design and embed guidance for parents.	• Developed 3 prototype kits with: 1) a story that set up a building challenge and prompted a planning discussion; 2) building pieces designed to focus the dyad on engineering issues rather than building decorations; 3) a parent tips page with “talking points” to support parent STEM talk and scaffolding.
Rapid iteration to refine the design.	• Engage in a rapid and iterative process of prototyping and field-testing. • Use user input to direct innovations and modifications in the play session design. • Include the observations and suggestions of stakeholders representing multiple disciplines. • Finalize activity kit design for formal evaluation.	• Conducted 18 home visits with low-income parents and preschool children. • Videotaped parent-child interactions of prototype guided activity kits and interviewed parents for input • Regular reviews by local team and external advisors led to ongoing kit refinements over the course of 18 visits.	• Added an animated video to model STEM processes of planning, constructing, testing, and refining building design. • Packaged kit materials separately in four steps to slow down parent-child activity and prompt discovery learning. • Added extension activities and tips to show how STEM skills can be supported throughout the day. • Replaced text-heavy parent guides with brief graphic cue cards at each step. • Created 2 more kits (total: 5 kits)
Evaluate the final design	• Evaluate the use and parent evaluation of final guided activity kit design.	• Conducted a randomized field test to compare parent use and evaluation of guided kits relative to basic kits.	• Finalized the guided kit designs. • Evaluation findings summarized in Study 2 report.

Table 2

The Four-Step Organization of the Final Activity Kit Design

Phase	Purpose	Key Features
Plan 	Step 1 included a storybook that introduced the building challenge and supported parent-child planning.	• Families received a family of plastic bears in the first kit. • The stories featured the adventures of these bears, giving the family someone to build for and adding continuity across the kits. • A few questions were included at the bottom of each page to set the tone for positive parent-child collaboration and discussion prior to beginning work on the building challenge. • The final page featured a picture of the building pieces included in the kit with questions designed to elicit joint planning prior to opening the package of pieces.
Build 	Step 2 provided the wooden pieces needed to build the designated structure.	• Pieces were designed with features that encouraged parent-child talk about spatial concepts and math concepts. • A brief set of tips came with the building materials to provide parents with sample questions they could use to support the child's exploration and learning during this building task.
Test and Improve 	Step 3 included questions and materials to test and improve the building.	• A list of questions about the build helped the parent and child consider and design improvements to the build and test the functioning of the construction. • Additional materials supported parent-child testing and creative additions or refinements to the structure.
Extended Learning 	Step 4 provided a game along with ideas to extend STEM learning and apply skills in everyday life.	• The extension game or learning activity gave children more opportunities to discuss and apply STEM concepts that were featured in the building kit. • An illustrated tip sheet showed parents how they could generalize support for child learning to other times and activities outside of the building challenge.

Table 3

Program Evaluations in the Guided Activity Kit and Basic Activity Kit Conditions

Program Evaluation	Guided Kit		Basic Kit		Tests of Intervention Effects		
	Mean	(SD)	Mean	(SD)	Effect	(SE)	*p*-value
Impact on Parent Efficacy	4.44	(0.53)	4.04	(0.64)	0.38	(0.14)	.008
Impact on Child STEM Learning	4.04	(0.33)	3.85	(0.36)	0.20	(0.08)	.023
Relative Impact on Child STEM Learning	4.16	(0.49)	3.76	(0.63)	0.39	(0.13)	.005

Note: SD = standard deviation. SE = standard error. Evaluation ratings were made on a 5-point scale. Tests of intervention effects controlled for child gender and age. Scores represent the average item rating for each scale, with a range from 1 = *strongly disagree* to 5 = *strongly agree.*

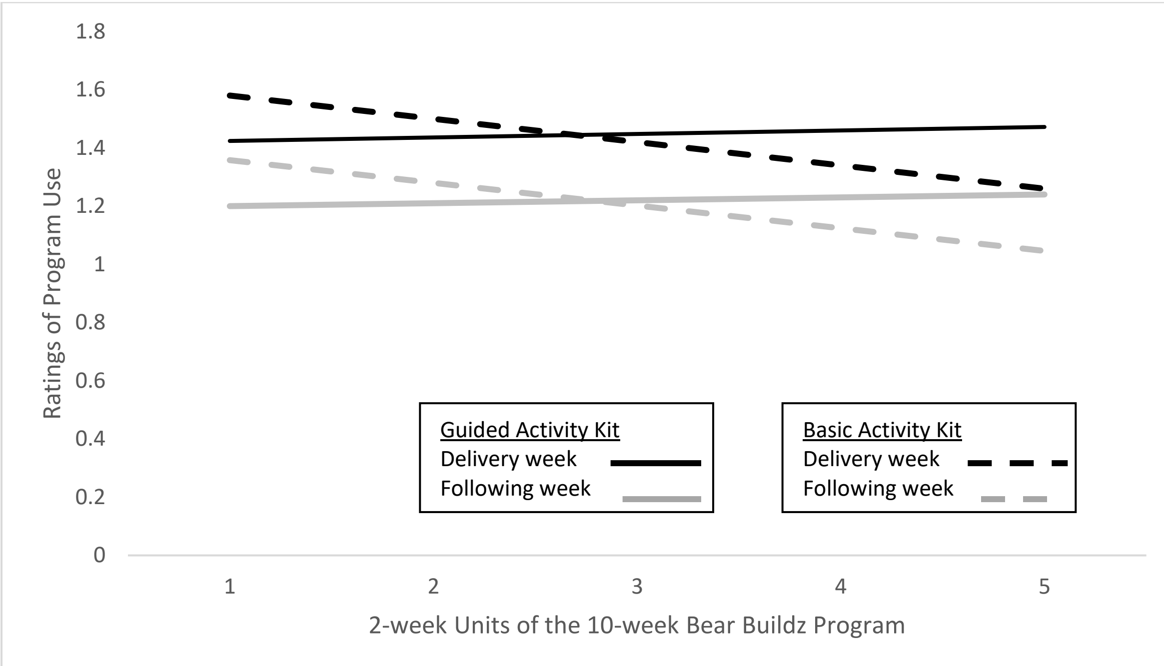
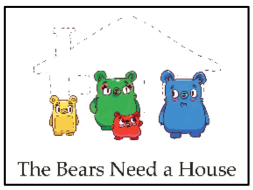
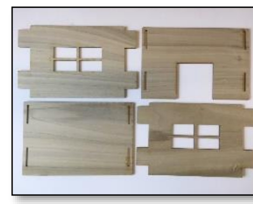
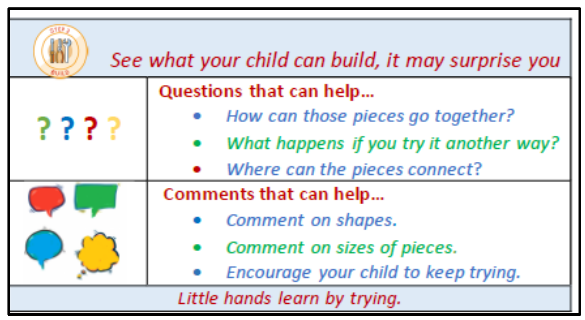
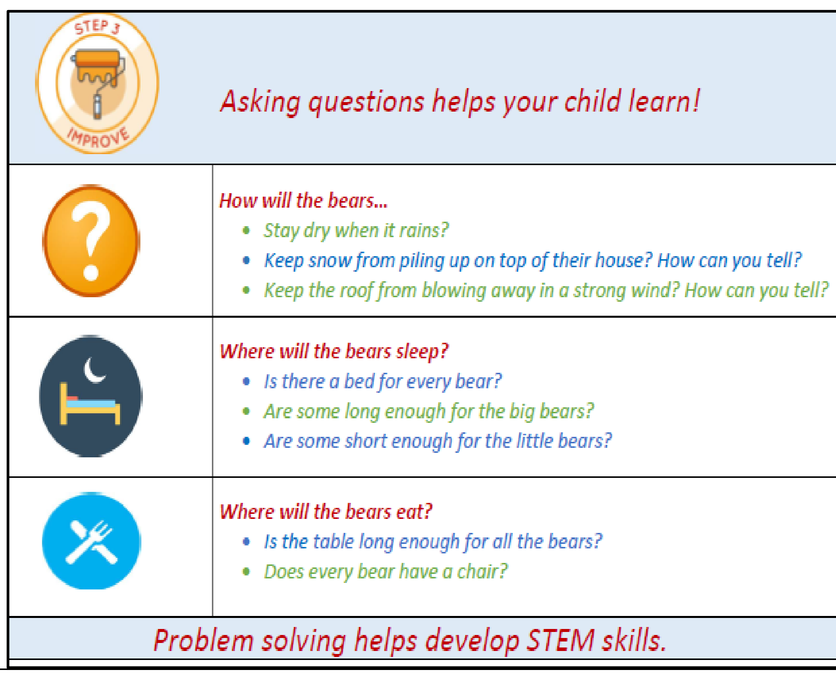


Figure 1. Ratings of Program Use over Time in the Guided and Basic Activity Kit Conditions

Note: Use was rated 0, 1, or ≥ 2 times per week. Each family received 5 activity kits, delivered every other week, over a period of 10 weeks. The analytic model represented time in 2-week units, with a nested variable indicating the week the kit was delivered and the intervening week that followed delivery. The dark lines labelled "delivery week" show family reports of program material use across the 5 weeks when the activity kits were delivered. The light lines labelled "following week" show family reports of program material use across the intervening 5 weeks when no new kit was delivered. Models adjust for child gender and age.

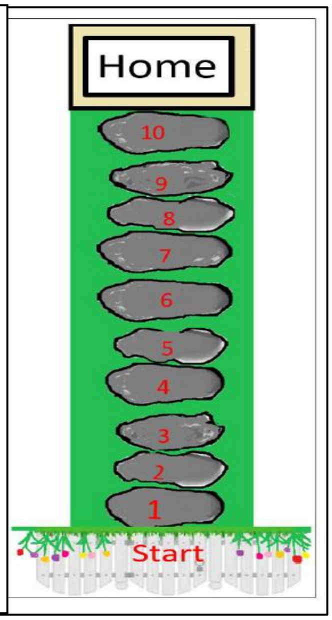
Table S1. Contents of a Guided Activity Kit

Phase	Kit Contents
Mailed Box	 Each kit is packed in a box. Four envelopes with stickers hold materials needed for Steps 1 – 4. The first kit has a bag with the plastic bear family and a "tool bag" of general supplies (crayons, scissors, glue dots, tape, card stock) to use over the course of the program.
Plan  	The Step 1 envelope includes a storybook that sets up the building challenge. The last page has a picture of the building pieces and questions to generate planning.  **Look at the pieces you will get to build the house. Q: What does a house look like? What shapes do you see here? How can you put these pieces together to make a house?** 
Build  	 The Step 2 envelope contains the building pieces and tips to help parents scaffold the building process.  *See what your child can build, it may surprise you* Questions that can help... • *How can those pieces go together?* • *What happens if you try it another way?* • *Where can the pieces connect?* Comments that can help... • *Comment on shapes.* • *Comment on sizes of pieces.* • *Encourage your child to keep trying.* *Little hands learn by trying.*
Test and Improve  	 *Asking questions helps your child learn!* *How will the bears...* • *Stay dry when it rains?* • *Keep snow from piling up on top of their house? How can you tell?* • *Keep the roof from blowing away in a strong wind? How can you tell?* *Where will the bears sleep?* • *Is there a bed for every bear?* • *Are some long enough for the big bears?* • *Are some short enough for the little bears?* *Where will the bears eat?* • *Is the table long enough for all the bears?* • *Does every bear have a chair?* *Problem solving helps develop STEM skills.* Step 3 includes a checklist to "test and improve" the building. For the house, the checklist asks: "How will your bears stay dry when it rains?" "Where will the bears sleep?" "What will the bears eat?" with follow-up tips for parents. Additional building materials in this envelope include foam shape stickers and cotton balls.

Extended Learning

RACING HOME GAME

How to play: Place this walkway in front of the Bear's house. Put your bears at the start. Take turns tossing the dice and moving bears the number of spaces you rolled. Count each space out loud. Take turns until all bears get home. Play this game a few times this week. Counting spaces will build math skills!



Step 4 includes a counting game (number line walkway with dice to "race home") and graphic tips for using math language throughout the day.