# Co-Designing with Preschoolers Using Fictional Inquiry and Comicboarding

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## ABSTRACT
In this case study, we describe a design workshop with 7 children age 4-6 using existing co-design techniques known to elicit design insights in older individuals. We found that our 5- and 6-year-old participants successfully generated design ideas using these methods, while 4-year-olds were unable to create solutions in a traditional format. However, these younger children enthusiastically offered opportunities where, with methodological guidance, the researcher could have followed the child's lead and shifted the design question to one that was potentially more meaningful for the participant. We propose future work to examine the effectiveness of giving these younger participants greater authority in defining and scoping the problem space.

### Author Keywords
Design workshop, early childhood, participatory design, fictional inquiry, comicboarding.

### ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## INTRODUCTION
Very young children are major consumers of digital media, with 97% of infants using a smartphone before their first birthday and 75% of children owning their own dedicated mobile device by the time they turn four [20]. Designing experiences that best serve these young children can be challenging, as a variety of prior work shows that design paradigms created for adults can break down when embedded in digital experiences for children [14]. Interface elements that are intuitive for adults are not always easy for children to understand [13,15], and children's needs, interests, and social attachments differ systematically from adults'.

This challenge is exacerbated by the fact that relatively few co-design methods exist for children under six as compared to other age groups. Though the post-modern conception of childhood recognizes that even very young children are independent agents, separate from their caregivers, with their own opinions and knowledge [22], surfacing their insights remains challenging. Young children are still acquiring the capacity to reflect on and articulate their impressions of the world [27,28] and are less likely to be aware of what they know. As a result, direct methods that require explicit knowledge—while often successful with adult users—are less likely to be effective with children [10].

Several prior studies have found that co-designing with preschoolers can be productive and meaningful [9,12,26], although established techniques sometimes require modifications [9,11]. The purpose of this project was to document our experiences using specific co-design techniques with preschoolers that, to our knowledge, have not been tried with this age group. Though our ultimate goal was to generate design insights for an app that helps children plan out their play time, we also wanted to explore the effectiveness of these specific methods with both older and younger preschoolers.

Here, we describe our experiences during a two-hour co-design workshop with preschoolers and kindergartners age 4-6. We used two established participatory design techniques, fictional inquiry [4] and comicboarding [24], a construction activity, and traditional user testing to elicit design insights. We found that our 5- and 6-year-old participants were able to generate and articulate ideas that designers could easily understand and build on, while 4-year-olds generated less cohesive ideas and often shifted to another topic. The contribution of this work is to add to the small existing body of research that reports on co-designing with children under 6 by documenting the effectiveness of these specific co-design techniques and describing the differences we encountered between older and younger preschoolers.

## RELATED WORK

### Co-designing with Children
In the last decade, the Child-Computer Interaction community has increasingly come to value involving children in the design process. Druin developed a widely adopted model for evaluating the role that children play in the design of a system [5], providing designers with a framework for involving their young users and representing these users' interests in the design process. This framework has been highly influential, and a variety of systems have been created with children


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as design partners and design informants [25]. However, like much research on interaction design and children [17], the majority of this work targets children age 6-12.

A smaller body of work has investigated co-designing with preschoolers in particular. Past research has shown that participatory design methods developed for school-age children can be effective with preschoolers, though they may need modifications [9]. Tikkanen et al. supported preschoolers in successfully generating design guidance for a novel musical toy using existing sketching, prototyping, and music-making techniques [29]. Separately, Borum et al. attempted to use the "Bags of Stuff" method [6] to design with 3-to-5-year-olds [2]. Though they concluded that typical prompts lacked sufficient backstory to engage children this age, they also hypothesize that further storyline development would make this technique accessible to young children.

Others have developed new co-design methods specifically with preschoolers in mind. For example, Guha et al. created Mixing Ideas [11], a technique for combining the design insights of multiple children, to specifically address preschoolers' egocentric struggles to collaboratively build on the ideas of others [21]. Einarsdottir et al. developed a technique for eliciting preschoolers' implicit knowledge by having them document their day with disposable cameras [8].

We build on this existing work by expanding the set of methods that have been studied as co-design tools for preschoolers. We also distinguish between older and younger preschoolers and describe how these methods differentially support these two different groups.

### Design Methods

We employed four different types of design activities in our workshop, two of which are existing methods that have previously been evaluated with older users. *Fictional Inquiry* [4] entails creating an immersive fictional storyline and prompting participants to brainstorm within the context of this imagined reality. By creating a fictional context for individuals to develop ideas, this method attempts to reduce the constraints of reality and free participants to be more generative. Prior work has found fictional inquiry to be effective with adults [18] and with school-aged children [3].

*Comicboarding* [24] is a participatory design technique that provides the structure of comic strips and the scaffolding of partially completed content as a method for supporting individuals in coming up with novel ideas. By providing users with a framework for ideas rather than a blank slate, comicboarding provides a springboard for participation that is particularly valuable to populations with little experience brainstorming. Prior work has shown comicboarding to be effective in eliciting design insights from school-aged children with cancer diagnoses [30] and preteens on the autism spectrum [1], among others. As this technique was designed for novice brainstormers, it is theoretically well-matched to preschool co-designers. Here we explore its effectiveness with this age group in practice.

## METHODS

We conducted a two-hour, four-part design workshop with 7 children. Three children were age 4 (4y0m - 4y3m) and four children were age 5 or 6 (5y6m - 6y2m). Four participants were female, three male. Parents identified all children as non-Hispanic White. All children were either in kindergarten or enrolled full-time in a daycare or preschool program. Participants were recruited through convenience sampling and each family was given a US$50 Amazon gift card for their participation. We divided participants into two groups by age (one with 4-year-olds, and one 5- and 6-year-olds); each group was paired with 2 adult facilitators.

### Materials and Procedures

The design goal of our workshop was to generate insights to guide the creation of a system that allows children to plan out how they will spend their time with entertainment media. Children engaged in four design activities to help us generate design ideas for this app. The first activity was a fictional inquiry session, for which we created an original story titled *Happy Birthday R2D2!* (Figure 1). The story describes characters from Star Wars™ planning out activities for R2D2's birthday party and documenting their plan with an app they call "Star Play Memory Technology." After reading the story aloud as a group, children were asked to sketch the screens of the Star Play Memory Technology. Researchers facilitated the session and asked open-ended questions as children sketched, such as, "*Can you tell me about your picture?*" and "*Oh, and how does that help Luke remember the plan?*" The Stars Wars theme was of interest to all children, as determined by informal conversations with parents in advance.

After children completed these sketches, they participated in 3 different comicboarding exercises (e.g., Figure 2). Each comicboard was designed with panel-style scaffolding [24], such that the comic was complete except for a single missing panel for children to fill in. The comicboards extended the storyline of our fictional inquiry and brought in elements of planning that were not probed in the original story. When a child was ready, a facilitator read the comicboard out loud with the child, along with a prompt at the bottom of the page explaining the missing panel. Children sat with their age-defined group as they sketched but worked individually.

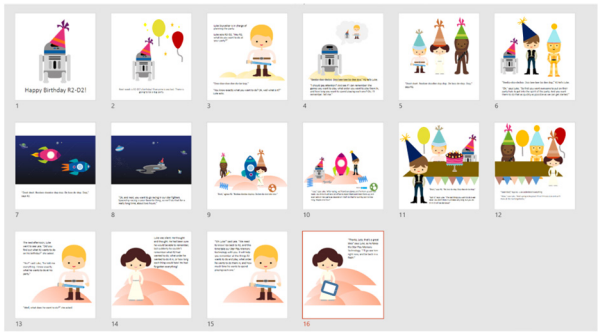


**Figure 1: Storyboard for "Happy Birthday R2D2," our fictional inquiry storyline. R2D2 plans the play activities for his birthday party. When Luke tries to relay this information to Leia, he forgets the details and uses an app to recall the plan.**

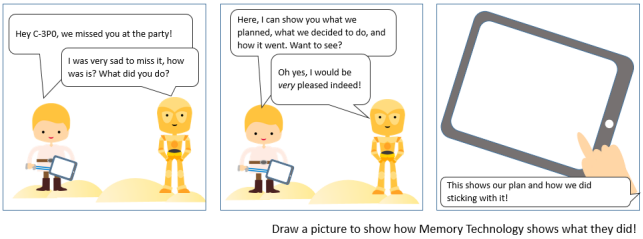


**Figure 2: Comicboard with panel scaffolding.**

After completing all three comicboards, children participated in a self-directed construction activity. A facilitator asked the child to think of something he or she would like to make and presented the child with a variety of construction materials, including art supplies and Lego blocks. The facilitator supported the child in identifying an end goal and then helped the child articulate a plan for achieving it. Each child then used an iPad to record a video of him or herself describing the construction plan. The child then had the opportunity to create the object, with adults facilitating as needed.

Finally, each child engaged in a series of user tests with a prototype iPad application. This application's interface allowed children to select and organize a set of icons representing different play activities (i.e., creating art, riding a bike, reading, etc.). Children tested a series of different versions of the interface and attempted to execute specific tasks, such as picking three activities to play and specifying the order in which to play them.

### Data Analysis

All sessions were audio and video recorded. The research team transcribed these recordings into field notes that documented all dialogue as well as participant and facilitator behaviors and interactions. Our final data set was composed of these transcriptions and photographs of the artifacts children created. We used a holistic open-coding approach [16] to identify themes that were relevant to our design goal of understanding children's mental models of planning. We further identified themes relevant to the effectiveness of our design methods and the types of insights they generated. Codes were organized into categories of: 1) use of and relation to materials, 2) mental models, representations and symbols, and 3) interpretability and connection to prompts.

## RESULTS AND ANALYSIS

### Systematic Differences between Age Groups

We found that these techniques easily elicited on-topic ideas from our 5- and 6-year-old participants. For example, in the following exchange, a researcher (R) and child participant (P) discuss the child's plan for constructing an object of her choice. Though she initially is unable to articulate her plan, with scaffolding from the researcher, she is able to identify specific steps to follow.

**R**: *"What are you going to make?"*
**P**: "I am gonna make a hat."
**R**: *"Alright. And can you describe how you're gonna do it?"*
**P**: "I need to make it to see how to do it."
**R**: *"Ok. Do you remember any of the parts? Or any of the steps?"*
**P**: "I remember that first you tape a round thing around, a piece of paper around, like a crown."
**P**: "Then, I, um, put the top on it."
**P**: "And then I put a strip of paper on the top of it."

In contrast, a researcher had the following exchange with a 4-year-old participant engaged in the same activity. Despite prompts from the researcher, the child struggled to articulate actions that would lead to the desired end goal.

**R**: *"What are you going to make? Will it be a zoo? Or a house?"*
**P**: "A house!"
**R**: *"Alright, so think about all the steps you have to do, what do you have to do if you build a house?"*
**P**: "I don't know."
**R**: *"You don't know? Think about what you might do."*
**P**: "I don't know."
**R**: *"What are the different parts of a house? Does it have a roof?"*
**P:** "Yes."
**R:** *"What else does it have?"*
**P:** "Umm… a flashlight."

Similarly, all of our 5- and 6-year-old participants were able to create topical, easily interpretable design solutions to our fictional inquiry prompt (Figure 3, top). These participants described interfaces for planning a series of activities that stored a list of what to do, kept track of order, and assigned relative durations to each activity in the plan. They told us that their interfaces documented activities by "*tak[ing] pictures of different things,*" that a user changes the plan by "*exing out*" obsolete activities, and that the interface displays a star for each activity that a user completes.

In contrast, none of our 4-year-old participants created artifacts or solutions that designers could easily interpret with traditional methods (Figure 3, bottom). For example, these younger participants suggested "*Big circles,*" "*I'm gonna draw a cake,*" and, "*Break the window [of the rocketship]*" as techniques for keeping track of planned activities. Though facilitators used the same prompts and the same graduated scaffolding to break the design problem into smaller and smaller pieces, our younger participants were unable to articulate on-topic ideas in response to problems set up with fictional inquiry, comicboarding, or construction methods.

**Figure 3: Top: Interface designs by two different 6-year-olds show symbolic drawings, use number and position to represent order, and include annotations to represent duration. Bottom: interface designs by two different 4-year-olds lack this structure.**

Unlike these generative activities, we were able to extract useful findings from participants of all ages with our traditional usability tests. In this structured interface where children were locked into predefined interaction patterns, both older and younger children engaged with the interface in a way that revealed insights into their mental models of time, order, symbolism and magnitude. For example, one 4-year-old dragged out a set of icons, rearranged them, and then pointed to each from left to right when probed to explain the order in which he would perform them, suggesting that a left-to-right pattern is already meaningful to him.

### Highly Suggestible Responses

We also saw that children in both groups were easily influenced by our ideas and materials. For example, one 6-year-old created a representation in which he ordered a series of activities by aligning their icons in left-to-right order (Figure 3, top left). He did so by first drawing them on paper in order, cutting out each one, and then taping them onto a new sheet of paper in the same order, suggesting his cutting and taping were inspired more by the materials than by his own goals.

Similarly, participants consistently incorporated literal details from the materials we used and from facilitators' comments, regardless of their relevance. One comicboard included pictures of a wrench and screws as superfluous details in the illustration. Several children filled in this comicboard with a solution that also contained a wrench and screws (Figure 4). In our user testing, multiple children specified the duration of an activity by pinching to make the icon for the activity very small and saying things like, "*Each one is gonna be for NO minutes!*" suggesting their behaviors were driven more by the options presented than by goal-directed choices.

Our results suggest that designers should anticipate children drawing on all aspects of their surroundings and context when generating ideas. Using fewer, more open-ended materials and interpreting children's solutions with this limitation in mind may lead to more fruitful sessions for this age group.

## DISCUSSION AND CONCLUSION

Fictional inquiry, comicboarding, and constructing were all productive techniques for our 5- and 6-year-old participants. These children were able to construct novel solutions in response to our prompts and, with scaffolding from facilitators, broke down problems and engaged with them piece-by-piece. They understood the storyline we provided, asked questions that were pertinent to the topic, and articulated solutions that could be incorporated into our designs. One contribution of this work is the empirical demonstration that, within our small sample, these specific techniques are useful for soliciting design input from older preschoolers and involving them in the design process.

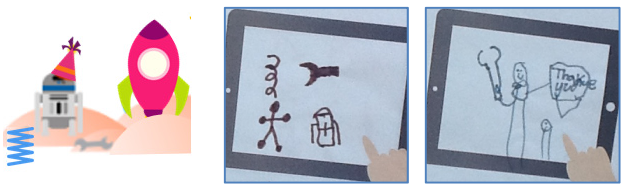

**Figure 4: Children add superfluous wrenches to their comicboards (middle, right) after seeing our wrench (left).**

Our 4-year-old participants, however, responded to prompts from these methods with what we at first experienced as creative but wildly off-topic comments. Yet despite the fact that they could not present easily interpretable, traditionally packaged artifacts, these younger children remain experts on being children and have design insights that are not obvious to adults [5]. Had we supported our participants in creating a house made of a roof and a flashlight, or in designing an app to break the window of a rocket ship, we might have shifted from our preconceived design question to a question of greater meaning and relevance to the child.

Our very conception that these children's responses were "off-topic" presupposes the idea that adult facilitators are the authority on which topics are up for discussion. But as Iversen et al. explain, true design partnership with children requires that children have equal voice in defining and scoping design problems [19]. Probing to understand why the flashlight had high salience for our participant may have given us greater insight into her experience with and interest in this particular tool. Prior work shows that young children's playful interactions with the world have deeper meaning, though this meaning is not always obvious [23].

Though our results do not directly show that 4-year-olds can act as productive design partners, they reveal a systematic way in which we failed to accommodate them in partnership. This experience has led us to ask what might happen if we commit radically to following their lead in problem definition, and we intend to explore this further in future work. New methods to support facilitators in translating these design contributions would also be of great value.

Our study is limited in that we worked with a small set of children, addressing a specific design problem, during a one-day session, in one cultural context. We also chose a design problem (planning a sequence of play activities) that poses its own cognitive challenges for preschoolers. The age differences we saw may be specific to our small sample. Future work remains to understand if the gap between 4- and 5-year-olds is an important inflection point for these methods, or if the struggles of our younger participants were specific to the context in which we used them.

We found that older preschoolers used fictional inquiry and comicboarding prompts to generate design insights that were easy to understand and adopt, and children of all ages were easily influenced by their environment. Younger children offered solutions that, on the surface, appeared to be wild non-sequiturs but might, with a deeper commitment from facilitators to follow the child's lead, give us better insight into their experiences and values.

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