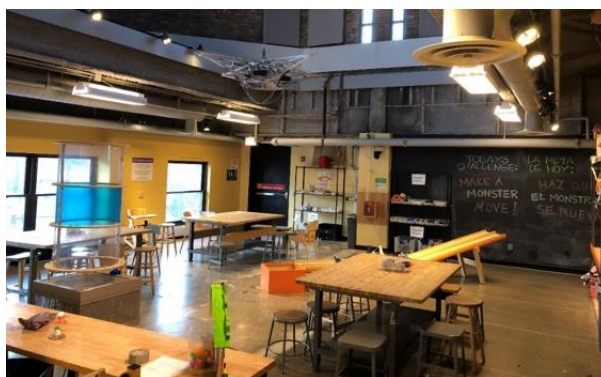


Reflection: A Tool to Deepen Learning and Make it Visible

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As educators at hands-on museums, we often assume that the engaging, playful experiences visitors have in our exhibits and programs will lead to long-term learning. But how do we know this is happening, and, moreover, how do we design exhibits, programs and interactions to maximize visitors' ability to learn from their experiences? At Chicago Children's Museum a long-standing research collaboration with Northwestern University and Loyola, Chicago University has allowed us to examine how families' conversational reflections during and after their in-museum experiences impact children's ability to process and recall what they did during hands-on tinkering experiences.

The TRAE (Tinkering, Reflection and Engineering Learning) project has provided an opportunity for museum educators and researchers to collaboratively develop and test strategies to enrich children's engineering learning. From its inception, TRAE has focused on reflection—both as a strategy to support children's learning and as a tool that allows us, as museum educators and university researchers, to document and understand visitors' experiences. The project's setting is the museum's Tinkering Lab, a simply designed exhibit space for up to 35 visitors that provides tables, seating, and shelves with materials and tools. A chalkboard wall displays an optional challenge for the day. By outfitting the space with video cameras that can be accessed from a nearby room, researchers are able to record consenting families as they engage in tinkering activities. In addition to documenting reflective conversations between children and caregivers while they are tinkering, we have recorded children's reflections as they exit the exhibit and in the museum's Story Hub exhibit (described below). Analyzing data collected in these ways has allowed the team to identify strategies that increase children's STEM-rich reflections during and after hands-on experiences.



Why reflection?

Reflection is widely known to be a critical component for how children learn. When children talk about what they've been doing—looking back and describing their experiences—they begin to process what's happened and turn it into long-term learning. Children's day-to-day activities, including those that are rich and interesting, can be hard to separate from the contexts in which they occur--the whole often gets lost in the parts. Reflecting can make children's experiences more distinct, memorable and portable. Putting words to what they've been doing allows children to connect one experience to another across time and place. Reflecting also allows children to create some distance between themselves and the specifics of

what happened. This is called “concreteness fading” and it’s important to how we take all the bits and bobs of our lives and build more abstract knowledge and concepts. For all these reasons, taking time to reflect is a critical strategy for enabling children to learn from their museum experiences.

Strategies to support children’s reflections

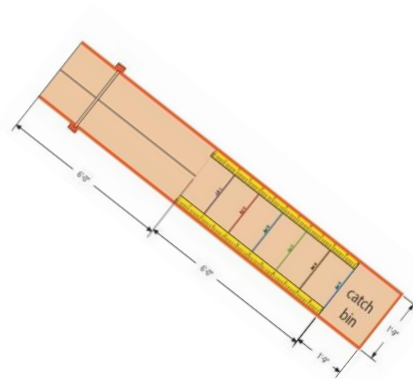
If reflection is so important to children’s learning, how do we make it happen in museums? Based on our work we offer the following tips and techniques:

1. **If you ask, they will talk.** In our experience, nearly all children are eager to talk about what they’ve been doing with an interested and responsive adult who approaches them at a natural stopping point in their making experience. Simple prompts work: *Tell me about what you made. How’d you do it? Did you try it out? What happened?* The key is listening and following in on children’s words.
2. **Structure the activity to invite problem solving.** Tinkering challenges that include a functional element lead to richer reflections as visitors engage in more iterative problem solving. When families are challenged to make something that rolls or flies, children are more likely to test what they made than when they are invited to simply make something out of wood. Testing, in turn, leads to conversations in which children reflect on what happened when they tried their creation and how they might change it after their test.



3. **Testing stations are strong communicators of what to do.** Along with signage inviting visitors to make something functional, large, well-positioned testing stations send a message that making something that rolls or flies is possible. Centrally located testing stations also allows visitors to observe other families’ efforts.





Adding a way to measure success and incremental change also encourages more testing and remediation. A measuring tape and pictures are two strategies that can support visitors' ability to compare and reflect on the success of their creations.

4. **Providing a facilitated introduction supports rich caregiver-child conversations.** Visitors' tinkering and reflections can be supported through brief orientations that provide essential vocabulary (axel, wheel, balance, weight, etc.) while keeping the focus on the engineering process itself. When families receive an orientation, children talk more about STEM during tinkering and afterward.



5. **Having the product present leads to richer reflections.** When children have their creation in front of them, their reflections include more engineering language. Once we saw this relationship, we started encouraging more children to take their products home where they might have additional opportunities to talk about what they made. Each round of processing through reflection can deepen and expand children's learning from their museum experiences.
6. **Documentation supports visitors' reflections.** Taking a picture of what children are making is one way to stop time and give children a chance to reflect, even while they're still tinkering. When staff use this strategy to begin a reflective conversation with children, it also models this practice for caregivers. Having a photographic record can support families' ability to reprocess their experiences once they go home.
7. **Examples of rich reflections are a powerful training tool for staff.** Sharing examples of children's reflections made learning visible to our museum's facilitators who sometimes see their primary role as maintaining materials in the exhibit. Workshops in which staff shared insights about these examples reinforced the important role they could play by

asking children to reflect during and after their tinkering experiences. Below is a picture of a child's creation and an excerpt from a conversation with one of our museum facilitators.



STAFF: So this is really, really neat. How did you put this together?

CHILD: At first I tried it on the ramp but the wheels were too wobbly so then I thought mm...maybe it would glide if I taped the wheels on.

STAFF: Awesome.

CHILD: and then it wouldn't work. Then I tried... I put wings on it but it still wouldn't go because I had already...because it's too much... because it's way too heavy.

STAFF: What would you do to change it so that maybe it could fly?

CHILD: I would change it so it was much less heavy.

STAFF: Good idea.

CHILD: And it wasn't like these wheels don't make good wheels because they're wobbly.

8. **A culture of reflection supports change.** Throughout the TRAEEL project, museum staff and volunteers were asked to write daily notes on how well the Tinkering Lab was supporting children's engineering processes. These insights have been applied in modifying our practice, including the choice of challenges, materials and facilitative strategies. In addition to contributing to the development of new programs in Tinkering Lab, museum facilitators reflect individually on their skills and behaviors as part of their on-going job training.



Self-Guided exhibits to support reflection

In addition to facilitated strategies to elicit children's reflections about their experiences, Chicago Children's Museum has two self-guided exhibits to support families' ability to create and record narrative reflections. The first "Skyscraper Challenge" (NSF #0452550) is a multi-media exhibit that allows families to select time-lapsed photos of their efforts to construct a tall, stable structure using small-scale building materials and then prompts them to add audio reflections about their experience.

The second exhibit, “Story Hub: The Mini-Movie Memory Maker” (IMLS #MA-10-13-0157-13) provides two small multimedia stations at which families can record their conversational reflections about any exhibit they visited and select photos of that exhibit to accompany their narrative. In both exhibits, families can access and share their photo-narrative product once they go home.



Skyscraper Challenge



Story Hub

While these exhibits provide a resource for families visiting the museum, they also provide an opportunity for the museum to better understand how children learn during their visit. Observation and data from both exhibits reinforce the importance of reflection following a hands-on experience, as well as the critical role adults play in children’s meaning making.

Interaction is key

At the heart of children’s reflections is a conversation with their caregiver, one of our staff, or someone on the research team. If there’s a single take-away from our research and practice over the last twenty years, it is how important it is to give children opportunities to talk about their experiences in our museum. Talking makes learning happen.



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