

# Epistemic Agency Shifts Between Children and Parents During Inventing with Robotics at Museum-based Makerspace

Yong Ju Jung, Devon Purington Whalen, Heather Toomey Zimmerman  
yyj5102@psu.edu, dmp28@psu.edu, heather@psu.edu  
Penn State University

**Abstract:** Epistemic agency is situated within social, cultural, and material contexts of learning; it is constantly changing as learners build knowledge. We examine how the epistemic agency of children and parents shifted as they invented a prosthetic hand using robotic elements in a museum-based makerspace.

## Understanding epistemic agency through social and embodied practices

Agency is a learner's initiative actions and attitudes toward certain learning experiences, and it depends on social, cultural, physical, and personal contexts surrounding the learner (Calabrese Barton & Tan, 2010). Epistemic agency describes how people act as epistemic agents (i.e., knowledge-builders or invention-creators). During a making activity, for example, children and families' epistemic agency is situated and expressed through their embodied interactions with social (e.g., family members, facilitators) and material resources (e.g., tools) (De Freitas & Sinclair, 2012) as they invent together. Thus, understanding learners' embodied and material practices is critical to examine the transformations of epistemic agency (i.e., who is building inventions) during making.

Scholars have examined agency through a socially shared practice across multiple individuals. For example, in some school-based settings, scholars demonstrated that epistemic agency was shared between youths and their teachers throughout youths' science learning experiences (Stroupe, 2014; Zimmerman & Weible, 2014). Also, Tzou et al. (2019) considered a family as one collective subject whose agency could transform during making experiences based on indigenous storylines related to each family. However, while social and collaborative practices transform agency, and epistemic agency is expressed through these practices, the focus of agency is still on individual learners (Mercer, 2011). In other words, even during a collaborative, socially-shared family learning activity, each family member may have different degrees and expressions of their epistemic agency, or in our case, the ability to act as the lead knowledge builder/inventor. Moreover, considering that relative positions among multiple learners matter to a learner's agency (Calabrese Barton & Tan, 2010), we posit that a child's epistemic agency is relative to their parent's agency and vice versa during a collaborative making activity.

By exploring four families' collaborative making activities at a museum-based makerspace, we ask the following question: *How do children's and parents' agency shift among them during making activities?*

## Methods

This study was conducted at an inventing space in the National Museum of American History of the Smithsonian Institution. This inventing space, akin to a makerspace, included various inventing stations where children (targeted audience age: 6-12) and families create novel inventions. This study focused on one station in the exhibit called *Prosthetic Hand*, where families created a prosthetic hand by using robotic fingers and different types of circuits, pegs, blocks, and other prototyping tools. Because this makerspace was designed for a child and adult working together during impromptu visits rather than as a workshop-type making project, participants did not have any time restrictions. Families worked at their own discretion, prompted only by sign instructions to contextualize the activity. Museum staff or volunteers were present so that families could seek help if needed. This study particularly focused on four families, strategically sampled because they worked as parent-child units. Names used in this paper are all pseudonyms.

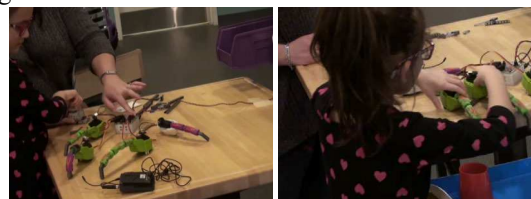
Video recordings were collected, transcribed by professional transcribers, and then reviewed by the authors. We conducted video-based interaction analysis (Jordan & Henderson, 1995) and multimodal analysis (Kress, 2011) to examine families' interactions in relation to their agency during the making activity to deduce common patterns of how children's and their parents' epistemic agency shifted (i.e., who was the lead inventor).

## Findings

Our findings illustrate the families' interactions type and how their relative epistemic agency between parents and children constantly changed during their *Prosthetic Hand* making activities. Overall, many parents in our dataset initiated the activity as the lead inventor. Parents often read the instructions aloud to their children to share the

goals of the station. Indeed, a large majority of these moments when the parents' epistemic agency was at the fore were when the parent was coaching the child through completing the activity or modeling the making experience—these moments were especially in the beginning.

While most parents began with more agency, their use of questions for coaching and prompting often led to shifting significant amounts of epistemic agency to the child, who began to act as the lead inventor as shown in the case of Amanda (mother) and Maddie (daughter, 7-year-old). Amanda asked many “how” questions, for example, “how are you gonna connect all these pieces together?” “how are you going to make this one [robotic hand]?” These moments were often brief thought-provoking questions that ultimately helped children manipulate the tools by themselves. Amanda also used more active embodied interactions with the physical tools (e.g., pointing, touching, making) for coaching while Maddie was mainly watching (see Figure 1, left). As they proceeded in the activity, however, the parent's question-prompting sometimes faded, and she demonstrated less coaching; Maddie began to demonstrate more epistemic agency later in the museum interactions (see Figure 1, right).



**Figure 1.** Amanda (mother) and Maddie's (daughter) engagement with the robotic hand making. The left photo shows Amanda leading the activity, while the right one shows that Maddie demonstrated more epistemic agency on manipulating the tools.

However, in some other cases, we found that children's own persistence and interest allowed them to hold more epistemic agency without parents' intentional fading unlike Amanda's case. Furthermore, sometimes parents gave up trying to figure out the robotics sooner than their children.

## Discussion

Our findings show that relative epistemic agency shifted in five parent-child dyads, from four families, during their making activities at a museum-based makerspace. The epistemic shifts were moment-by-moment during the short-term making experiences at one inventing station as different family members took over the inventing and knowledge-building. Our empirical microanalysis of the active and dynamic nature of epistemic agency during learning expands conceptions of how creative work occurs in family interactions. Moreover, we developed a coding framework that focuses not only on verbal indicators of agency but also embodied interactions to document how epistemic agency at the museum was expressed. While small-scale, our study begins to suggest implications for designing activities at inventing spaces and makerspaces in order to support families' epistemic agency — allowing for more equal participation in making activities.

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