Frames and Games in the Science Museum: A Lens for Understanding Visitor Behavior

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Abstract: Collins and Ferguson (1993) introduced the idea of epistemic games and forms to interpret repeatable patterns of expert behavior in the sciences. This framework has been extended by educational researchers to understand student activity in science classrooms (Tuminaro and Redish, 2005), in computer games (Shaffer, 2005) and informal science education (Shaffer, 2004). This work suggests productive ways that epistemic forms may be exploited in exhibit design in science museums to encourage stronger scientific conversations. However, much of the conversation at a science museum exhibit is not related to an epistemic frame—despite the intentions of exhibit designers. What other frames do parents and children use at science exhibits? Under what conditions do they enter an epistemic frame, and what are the epistemic forms suggested by exhibits? Using video, transcripts and observations of visitors at a science museum, I interpret family conversations in terms of different epistemic frames and contrast epistemic frames from other forms of interaction.

Introduction

Recent research on learning in science museums has placed increasing importance on collaborative learning and the role of parent-child conversations in this process (e.g., Crowley and Callanan, 1998; Leinhardt, Crowley, and Knutson, 2002; and Ash, 2003). As concluded by Crowley and Callanan (1998),

> Although there are times when children learn in relative isolation, much of what they learn about their world they learn in the context of parent-child interaction. Our findings suggest that the most potent hands-on exhibits are those that recognize and support the collaborative learning and parent-child interactions.

Drawing on this research, TEAMS (Traveling Exhibits at Museums of Science) collaborative, a group of seven science museums founded to create quality traveling exhibitions suitable for small science centers, has sought to draw on and contribute to the research on parent/child conversations in the science museum and the role of exhibit design in promoting substantive conversations. The collaborative set the following goals for research:

- To further explore the influence of exhibit variables on patterns of family conversations, using existing and new TEAMS exhibitions;
- To explore how the research can be translated into a widely applicable set of design principles and concrete techniques to increase social interactions around the exhibitions (e.g. parental use of conversational strategies that enhance STEM learning and reduce gender bias in museum environments);
- To refine and substantiate these principles through the TEAMS exhibit design and prototyping process; and
- To develop a set of guidelines for dissemination to the field that support design of exhibits that encourage beneficial learning conversations among visitors.

In exploring patterns of family conversations and investigating how this may inform design principles, it is necessary to establish a framework though which we can understand these conversations. This article outlines a framework that we have adopted and adapted, that of framing, and demonstrates how this framework suggests certain design principles that may foster stronger parent/child conversations in science. I begin by outlining the exhibits that have led us to this framework, then and then detail the ideas behind framing and how these are productive for understanding interactions between visitor behavior and design in the science museum. (The work presented here is ongoing: we are currently engaged in extensive transcription and coding of the conversations described below.)

Exhibits under study

The Kalliroscope

As we began our study at the Montshire Museum, we focused on one exhibit that captivated the museum's exhibit designers and explainers: the Kalliroscope (see fig. 1.). This exhibit, designed to show the movement of water, is a large (3' diameter) flat disk filled with kalliroscopic fluid and covered with clear glass mounted on a hand-operated turntable. As described by the manufacturer, the fluid is a suspension "of microscopic crystalline platelets. When…put into motion, the suspended platelets orient so as to align their larger dimensions parallel to the planes of shear. In the presence of incident light, areas of varying orientations will reflect differing intensities of light, and their evolution and movement will produce striking visual images of the currents taking place." The exhibit has two simple labels, positioned on its base. One says: "Spin Me." The other: "Please do not sit on exhibit." (Parents frequently place babies atop and spin them.)

Figure 1. The Kalliroscope.

We began looking at conversations at this exhibit because we thought it might provide insights into the kinds of scientific conversations that parents and children are capable of—thinking it our "best-case-scenario" exhibit. It is exceedingly open-ended, visually arresting, accessible to all ages, and easily accommodates a family (it has an octagonal shape, so multiple family members can observe it simultaneously).

We did not begin by targeting any one hallmark of scientific reasoning and conversation (such as Crowley's work on CVS or Callanan's on analogy). Rather, we were looking for general habits of science, such as noticing patterns, categorizing patterns, offering hypotheses, theory building, controlling variables, and generalizing to other phenomena.

We set up audio and video recorders and requested permission from all visitors to the museum to participate in the research. The researcher (author) sat with a television screen by the exhibit, recording visitors who had given permission to be taped. These tapes were then downloaded and reviewed with museum staff, and are being transcribed and coded.

Surprisingly, families said very little at this exhibit. Patterns of conversation were repeatable: one family member approaches and spins the disk; she calls over family members ("Come look at this!"); the second family member (usually an adult) remarks, "It looks like a _____" (hurricane, tornado, solar system, etc) or, "Isn't that pretty!" And then they leave. Variations on this pattern exist, with a few groups entering into deeper, more scientific conversation. However, the bulk of the conversations were quite repetitious.

While reviewing the data from these and other tapings and beginning to make adjustments to the exhibit, we (the researchers and exhibit designers) commented on the frustration of finding no "best case scenario" exhibits. Hearing this, several of the museum explainers (staff who work on the exhibit floor, explaining and guiding visitors) pointed out that a recently arrived traveling exhibit, Crime Lab Detectives, had prolonged parent/child collaboration and discussion. This exhibit is detailed below.

Crime Lab Detectives

Crime Lab Detectives is a traveling exhibit designed by Arkansas' Museum of Science and History. As described by the museum, "The crime is a break-in and theft. The exhibit consists of the crime scene… Adjacent to the scene are six lab tables where 15 clues are examined. There is also a suspects area and a solutions wall." Lab tables include DNA analysis, cell-phone records, fingerprint analysis, and analyzing the tool used to pry open the window. Visitors are provided with "Detective Notebooks"—a clipboard with activities to guide the visitors through the lab stations and suspect testimonies. It is important to note that the data from the stations do not frame just one suspect. Rather, the data is contradictory, and part of the task for visitors is to use this data to tell various stories about the suspects to infer who must have committed the crime and why.

Figure 2. Crime Lab Detectives.

At this exhibit (which we were not able to videotape), parents and children indeed were highly focused, often spending an hour or more visiting the various stations. Parents guided children through the exhibits, asking the children questions, assisting them with the notebooks, and using the data to construct a theory of how the crime was committed.

Why here? What about this exhibit promoted such deep, prolonged conversations? What was lacking in the Kalliroscope exhibit so that these same families stayed only briefly with stilted, short conversations? A framework that may suggest answers to these questions, that of framing and epistemic frames, is detailed below.

Frames, Games and Forms

Framing was introduced by Bateson in "A Theory of Play and Fantasy," in which he argued that communicative moves are only understood in reference to a metacommunicative message about the kind of activity that participants are engaged in. For example, only by first conveying, or framing, an activity as "play" can a monkey behave aggressively toward another without it being interpreted as hostile behavior. The idea of frames has been adopted extensively in other fields and by other researchers, initially by Goffman (1974, 1986), who observed that "we can hardly glance at anything without applying a primary framework, thereby forming conjectures as to what occurred before and expectations of what is likely to happen now" (p 38). Once a frame is entered into, participants in the activity have access to a script (or schema): a frame that guides how we behave in social situations and is frequently considered an ordered sequence of expectations or behaviors, with roles for participants. In summarizing the many approaches to framing (including the related structures of scripts and schemata) that various fields have taken, Tannen (1993) notes,

> What unifies all these branches of research is the realization that people approach the world not as naïve, blank-slate receptacles… but rather as experienced and sophisticated veterans of perception…who see events and objects in the world in relation to each other and in relation to their prior experience. This prior experience…then takes the form of expectations about the world and in the vast majority of cases, the world, being a systematic place, confirms these expectations, saving the individual the trouble of figuring things out anew all the time. (p 20 – 21)

Framing, then, involves the (usually tacit) identification of features that cue particular frames and thus expectations of subsequent activity. For example, there are repeated events for someone engaged in a dining-in-a-nice-restaurant frame: you wait to be seated, you are handed a menu, the waiter pours a touch of wine, you try it, you proclaim it good, etc. Several cues suggest such a frame, including the décor of the restaurant and the manner in which you are greeted by the staff, among other cues. And by framing the activity thusly, a diner taps into a script: a progression of steps that one expects to occur, from being seated to requesting the bill.

Such a recurring pattern is ubiquitous and, of course, found as scientists engage in constructing knowledge. As detailed by Collins and Ferguson (1993), scientists engage in epistemic games to construct certain epistemic forms. These *epistemic forms* are "target structures that guide inquiry" (such as stage models, hierarchies, and axiom systems), and the set of rules that guide the inquiry are *epistemic games* (p. 25). Their framework has been used in science education: as a guide to epistemologically appropriate instruction (White and Frederiksen, 1998; Hammer, 1995); a guide for scaffolding student inquiry (Sandoval, 2003); and a lens

through which to interpret Crowley and Jacob's (2002) "islands of expertise" in informal education (Shaffer, 2004). The *epistemic frame* is a concept coined by Shaffer as "the ways of knowing, of deciding what is worth knowing, and of adding to the collective body of knowledge and understanding of a community of practice" (p.1). "That is, practice, identity, interest, understanding, and epistemology are bound together into an epistemic frame" (on p. 2 of innovate).

The language of epistemic games, frames and forms may be a fruitful way of interpreting visitor conversations in the science museum and attention to the frames that visitors enter into and the design elements that cue these frames may suggest powerful design principles. Before analyzing visitor conversations as epistemic games, however, it is important to note that only a fraction of visitor conversations are concerning the construction of knowledge and hence part of an epistemic game. What are the other ways in which visitors structure their conversations?

Patterns of visitor conversations: Common frames in the science museum

While parents and children navigate and discuss an exhibit, their conversations seem to fall into noticeable frames, with all the signatures of frames and frame shifts (including body languge/posture, tone, and vocabulary). The following common frames are unrelated to the particulars of the exhibit. This list is not meant to be exhaustive, but to establish the genre of frames that we are *not* primarily interested in and suggests markers for identifying these frames:

1. *Adult conversation*: Adults stand tall, face one another, speak in lower tones using sophisticated language. Children's interjections are bids for attention (requests to shift frames): "Mommy! Look!" The frame is instantiated by adults as one faces another and speaks in low tones.
2. *Planning conversations*: Family discusses where to go next, when to eat, how long they will stay, who needs to use the bathroom, etc. Parents and children face one another, not the exhibit. Parents often instantiate the frame by standing up, facing the child, speaking directly, and asking children about needs ("Are you hungry? Where do you want to go next?") or telling child about plans ("We need to go change Molly's diaper.")

The above frames are largely unrelated to design or the specifics of the exhibit. They occur at multiple kinds of exhibits. These are entered into and stepped out of quickly, as parents and children often juggle multiple ongoing frames.

In addition to the above frames, there is also a more structured pattern of activity: parent and child approach and briefly enter a "framing" frame in which the parent, child, or both together negotiate what kind of frame is appropriate for this exhibit: what am I supposed to do here? Is it a puzzle? A demonstration? A vocabulary lesson? A construction activity? A competition? If the exhibit is easily framed as an understood and familiar activity, the framing frame will be brief and often unconscious, and the family quickly moves into puzzle-solving, building, racing, etc. If not, the "framing" frame may be prolonged and vocal, as in the following transcript from a father and daughter's interaction at the Kalliroscope. (If the Kalliroscope is spun at a continuous speed the fluid inside may rotate with the disk and hence display no gradations in color, as happened for this pair. The daughter is about 9 years old.)

Dad: What's that?
Girl: I don't know. I don't know how to work it.
Dad: 'Spin me' it says.
Girl: I spinned it. What's so great? Nothing's happening.

Dad: I don't know what it does. It says 'spin me.' [3 second pause.] I don't know what it is. What are these things? Speakers. Is there a button here?
Girl: Yeah. 'Fifteen.'
Dad: Hit it.
Girl: It's not a button.
Dad: If you stand back here, Annie, it looks kinda cool.

The pair then left, never seeing the kalliroscope change its pattern. Even when the interesting patterns are seen, visitors have difficulty structuring and understanding the activity and speak of in terms of unmet expectations. Another pair spun the exhibit, and the mother comments to her daughter, "I'm not sure what I'm supposed to learn. Is it water? Is there an explanation?" The daughter looks for a label, and, finding none, they leave.

These families' difficulties can be understood in terms of framing: the exhibit, as it stood, was not easily framed as any kind of expected activity. They expect that the "framing frame" will be readily resolved by the exhibit and its signage. (Of course, all exhibits are understood and already framed as "science museum exhibit" and so expectations already exist that suggest a menu of possible frames. The visitors know that they don't "understand" the exhibit when they cannot frame the exhibit and they react in a way that conveys this.) But the exhibit suggested no epistemic form—no "target structure that might guide inquiry"—and hence no epistemic game to be played. The exhibit designers' hope that parents and children would spend time at the exhibit creating patterns in the water and speculating on the causes of the patterns and the structure of the fluid inside was not born out because there were no cues provided by the exhibit to suggest "games" to play that might help parents and children structure activity and conversations.

Contrast this with Crime Lab Detectives. The exhibit has several strengths in terms of epistemic forms and framing. First, and perhaps most significantly, the role of "detective" is a highly structured and common role in our society, thanks to games like Clue and common television shows, from Dragnet to CSI. The structure of investigation—from interviewing witnesses to collecting evidence to correlating evidence to finger a suspect—is common cultural knowledge. The script associated with "solve a crime" is well known.

Furthermore, the exhibit suggests a final epistemic form: through framing the activity as a detective's case and scaffolded through the "Detective Notebook:" a worksheet-like structure with questions to answer at the various lab stations. And parents entering the exhibit can easily understand their role and how to aid their children: not by knowing and giving the right answer (for surely parents cannot be expected to know who perpetrated the crime prior to visiting), but by explaining the various activities and combining the evidence to tell the story of the crime.

Using epistemic forms in the science museum

This research, still in its preliminary stages, suggests directions for future research and investigation. At the Kalliroscope, we have tried several modifications of the exhibit that, ideally, will cue familiar frames: demonstration (pictures of turbulence and the Kalliroscope as an example), vocabulary lesson (the definition of turbulence), and pattern-matching (a label with pictures of patterns the Kalliroscope can make with a prompt to try and make these patterns). We are currently reviewing the data from these modifications and it suggests that such modifications do significantly alter visitor behavior and conversations.

As we continue in this study, the modifications to the Kalliroscope have been taped and transcribed. Teams of student researchers are coding the video data with attention not only to determine the frame, but also the nature of social interactions at the exhibit—whether they are

adult-directed, child-directed or collaborative—and correlations between these. Attention to indicators of frames and frame shift, such as gesture, posture, and use of the space, are being used in addition to the verbal.

Questions this research raises are: what frames are productive for parent/child learning in the science museum? Are they identical to the epistemic frames that practicing scientists use? Are there other frames, such as playing detective, that promote scientific reasoning skills? And what cues can be provided to promote these frames? Our current research is addressing these questions by modifying exhibits and exploring the effects of those modifications on conversations.

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Photos from www.montshire.org/exhibits.html and http://www.amod.org/traveling-exhibits-

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