THE CURIOSITY CORNER: A PLACE FOR YOUNG SCIENTISTS TO EXPLORE AND LEARN

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"Scientists learn about the world in three ways: They analyze statistical patterns in the data, they do experiments, and they learn from the data and ideas of other scientists...Recent studies show that children also learn in these ways." (Gopnik, 2012)

A young child sits at a table, face in deep concentration, as a puppet show is performed just for her. In it, a frog and a penguin place small colorful blocks on the surface of a toy box one at a time. When the frog is playing the box lights up and makes music, and when the penguin plays it doesn't. "Here are some more blocks," says a friendly adult. "I want to know which ones make the toy play music. Who should I ask?""Froggy!" Says the child, smiling, "Because Froggy knows how it works!"

The child watching the puppet show had fun, but she was also learning. Researchers are also learning from the child. She, and others like her, can easily infer from a few observations that the frog made the toy light up because he knew how, and the penguin did not.

This is an example of a now familiar scene at the Sciencenter in Ithaca, New York. Part science research, part science exhibit, this study is part of an NSF-funded project on early childhood learning taking place at Cornell University. In this study, a team of researchers are trying to find out how children use their developing "Theory of Mind"—their ability to think about the mental states (knowing, thinking, feeling, wanting) of other people—to learn new things.

Why Science Museums as Research Centers?

By working at the Sciencenter, Cornell researchers are able to simultaneously recruit and interview child participants for their studies into how children learn, which allows them to do much more than would be possible by asking parents to come in to a university laboratory. But this partnership also greatly benefits the Sciencenter and its visitors. The research takes place on the floor of the Sciencenter's early childhood exhibition-—the Curiosity Corner. Parents, caregivers and educators have the opportunity to see scientific research in action. They can interact with researchers and discuss current theories about how children learn, while observing as children "play" with researchers.

Research in the Curiosity Corner

Across the country, science museums, children's museums, and even natural history museums have been teaming up with researchers at major universities to create "living laboratories" such as ours. These partnerships lead to scientific discoveries while at the same time increasing awareness on the part of parents, caregivers, and educators about the role of science museums in fostering early cognitive and social development.

Children learn everywhere—at home, in playgrounds and preschools. Many adults remember local neighborhoods, playgrounds, and parks as the safe places where, as children, they explored and learned about the world. These days, especially in urban settings, science centers such as ours are the new safe, social space for exploration and learning to take place. Moreover, science and children's museums provide particularly rich environments where learning through exploration is encouraged and expected. When children and their families visit interactive, hands-on museums they find creative, engaging learning experiences. Thus, science and children's museums have for yearsbeen putting the most cutting edge research in developmental science into practice.

The Child as Scientist – Examples at the Sciencenter

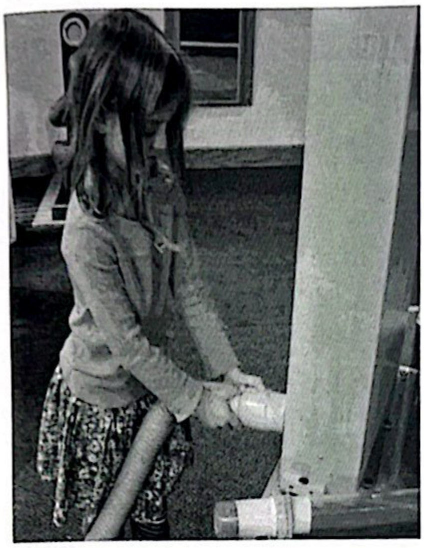
Cognitive scientists have for decades been interested in how children learn, and have studied the specific strategies and mechanisms of learning in early childhood. The most recent research shows that children learn much as scientists do: through their play they are experimenting, testing hypotheses and generating causal explanations. Moreover just as scientists do not make discoveries alone, children discover many things through social interaction with one other and by asking for information from helpful, interested, and engaged adults.

The critical lesson from decades of research is that children's scientific minds develop through *exploration*of both the physical and social world. The process of children's scientific learning can be broken down into four interacting learning mechanisms—curiosity, persistence, imitation, and explanation—all of which emphasize either or both *exploratory play* and *social interaction*. Science centers can facilitate this learning by providing interactive exhibits and programs for preschool educators, parents, caregivers, and children. In particular, for our youngest visitors, the Curiosity Corner features safe, hands-on activities, suitable for small bodies, which are specifically designed to facilitate the development of scientific skills through exploration.

The four learning mechanisms can be observed in the young scientist at play—whether she is in the lab or the museum. At times we, as researchers and museum educators, expect young children to explore on their own though play with objects and materials they can touch and see. We also expect that children cannot find out about everything on their own. Thus, in the lab and in the museum space, we offer opportunities for children to use their social capacities to learn—to watch, to question, and to work together.

1. CURIOSITY

The lab: Children are naturally curious about things they don't yet understand, which leads to further exploration. When at play they will gravitate towards objects and events that are unpredictable or unknown (Schulz & Bonawitz, 2007; Cook, Goodman & Schulz, 2011).



Blowing air to make "music"

The museum: Children, at first almost by accident, hold a tube of blowing air up to pipes of different lengths. The unexpected result is sound in differing pitches, a surprise that requires testing. The Curiosity Corner has a variety of unfamiliar objects—things that make unexpected sounds, that have varying textures, that can be manipulated by small hands and that encourage children to safely engage and explore with all of their senses.

2. PERSISTENCE

The lab: Children make inferences about cause and effect gathering *statistical* evidence, using that evidence to predict and explain events in the world around them (Kushnir & Gopnik, 2005; Kushnir, Xu & Wellman, 2010). Thus they often play by persistently repeating the same actions over and over again, and their expectations for the future are based on the statistics of these past experiences.

Playing with water in the Curiosity Corner

The museum: As museum educators, we often notice how children's attention spans can be seemingly much longer than that of their parents. A rubber duck floats down the moving current of the water table—an observation that requires repetitive testing. Children will ask for the same game to be played over and over again. We have designed our Curiosity Corner to have comfortable seating to encourage parents to linger as their children engage in persistent repetition.

3. IMITATION

The lab: Children are precocious imitators of others—when they can't do something themselves they observe others and imitate them. But young children do not just imitate everything they see, but rather they imitate selectively, based on various social and statistical cues. Sometimes children imitate actions with clear goals—actions that are related to interesting effects (Buschbaum, Gopnik, Griffiths & Shafto, 2011). Other times children will imitate just for fun, as a way to bond with others, leading them to learn actions that have no obvious consequences but are nonetheless important (Over and Carpenter, 2012). Thus, imitation is a powerful mechanism for both scientific and cultural learning.

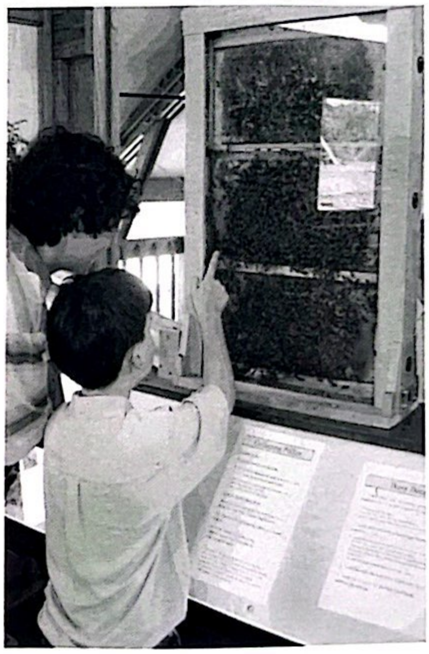
Experimenting with the vacuum tube and foam shapes

The museum: At the air station in our Curiosity Corner, it's not always obvious how the foam shapes are meant to be sucked through a vacuum tube. After failed attempts, we have seen children naturally turn to their parents for guidance; they watch as their parents experiment and figure out what to do. Then the child is ready to take on the role of young experimenter, imitating what they see until they get the desired outcome.

During story time, parents actively engage in the finger play that accompanies songs. Children mimic the adults, moving their fingers to make "itsy bitsy" spiders, clapping their hands in gleeful appreciation. In the make-believe kitchen, children share fanciful meals with their peers—setting the table, serving the "food". Their pretend play thus imitates the events of the past—the meals they've seen made and served in their own homes.

4. EXPLANATION

The lab: Many abstract scientific concepts are invisible and intangible—bacteria and viruses, the movement of planets, animal behavior—preschool children routinely ask questions and seek explanations for these abstract ideas (Callanan & Oakes, 1992; Frazier,



Making observations at the bee hive

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Gelman & Wellman, 2009). In fact, the same curiosity that motivates exploratory play also motivates explanation-seeking behavior.They ask "why" when events are unexpected or surprising (Legare, Gelman & Wellman, 2010).

The museum: At the Sciencenter we have a live animal collection. Children watch, fascinated, as bees come and go from their hive, collecting nectar. The unpredictable behavior of the bees elicits much curiosity, and, since they cannot touch or play with them, we have seen children trying to find out more about bees by asking any adult they are with - grilling them with questions from "Where is the queen?" to "Why do they go in and out so much?" to "What's he doing?" This makes for a lively and interactive exhibit where the "expert" is the person who can read the exhibit labels.

Broader Benefits

The partnership with Cornell's Early Childhood Cognition Lab has resulted in other new programs that will benefit the youngest children entering the world of a science museum for the first time. For example, though it is helpful to have a separate space for preschoolers to safely explore and play, very young children and their parents at times would also like to try some of the more sophisticated exhibits that are intended for older kids. Working together, we designed an assignment for an advanced cognitive development seminar at Cornell. The goal was for students to use the concepts they had been studying in class to create a tool to help parents navigate the larger museum in a meaningful way with their preschool-age children. Students created a series of museum "scavenger hunts" for children and parents. Each scavenger hunt used all four of the learning processes discussed above—curiosity, persistence, imitation and explanation. We envision continued refinement of this assignment year after year. It is a good example of the future of our partnership—more ideas useful for Sciencenter guests, for researchers, and for students learning to apply their knowledge of cognitive development in the real world.

These new course projects fit in with other early childhood focused initiatives. Our "Science for Young Minds" program sends museum educators to local preschools to model inquiry-based science and science literacy for educators—giving caring, helpful adults the knowledge they need to scaffold children's scientific growth both inside and outside the museum. Our weekly Story Time, which takes place in the Curiosity Corner, encourages parents and children to explore books and activities with a science theme.

The Sciencenter's mission is "To inspire excitement for science through interactive exhibits and programs that engage, educate, and empower." The collaboration between the museum and Cornell's Early Childhood Cognition Lab has helped to engage young children as they explore and learn. Beyond that, parents, caregivers, and educators are empowered to support children's learning. Researchers and students of cognitive science have also been engaged, educated and empowered as they observe and study children's learning and apply what they've learned in the world outside of the lab.

In conclusion, we believe that partnerships such as this one benefit all-—researchers, science centers, community members, graduate and undergraduate students, and most of all young child scientists. In fact, we believe these partnerships are the premier model for scientific engagement, and can be replicated in a variety of informal educational contexts. We hope others will be inspired to make connections between the worlds inside and outside the science lab.

Future Questions:

As our museum-university collaboration has developed over the past year, we have found three primary challenges, which are listed below. We are actively seeking answers, which will benefit our visitors as well as our research partners:

1. How can we help parents feel comfortable and confident in their role as "knowledgeable" adults when answering their children's questions?
2. How can an exhibit space be designed to encourage more robust and prolonged learning behaviors in our youngest visitors?
3. What are the most effective tools and strategies to give early childhood educators for working with young children?

References:

Buchsbaum, D., Gopnik, A., Griffiths, T. L. & Shafto, P. 2011. Children's imitation of causal action sequences is influenced by statistical and pedagogical evidence. *Cognition, 120(3):* 331-340.

Callanan, M., & Oakes, L. 1992. Preschoolers' questions and parents' explanations: Causal thinking in everyday activity. *Cognitive Development, 7(2):* 213-233.

Cook, C., Goodman, N., & Schulz, L. E. 2011. Where science starts: Spontaneous experiments in preschoolers' exploratory play. *Cognition*, 120(3): 341-349.

Frazier, B. N., Gelman, S. A., & Wellman, H. M. 2009. Preschoolers' search for explanatory information within adult-child conversation. *Child Development, 80*: 1592- 1611.

Gopnik, A. 2012. Scientific thinking in young children: Theoretical advances, empirical research, and policy implications. *Science, 337:* 1623-1627.

Kushnir, T., Xu, F. & Wellman, H. M. 2010. Young children use statistical sampling to infer the preferences of others. *Psychological Science, 21:* 1134-1140.

Kushnir T.& Gopnik, A., 2005. Children infer causal strength from probabilities and interventions. *Psychological Science, 16:* 678-683.

Legare, C. H., Gelman, S. A., & Wellman, H. M. 2010. Inconsistency with prior knowledge triggers children's causal explanatory reasoning. *Child Development, 81* (3): 929-944.

Over, H., & Carpenter, M. 2012. Putting the social into social learning: Explaining both selectivity and fidelity in children's copying behavior. *Journal of Comparative Psychology, 126*: 182-192.

Schulz, L.E. and Bonawitz, E. B. 2007. Serious fun: Preschoolers play more when evidence is confounded. *Developmental Psychology, 43*(4): 1045-1050.

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Commentary

REFLECTIONS: INTEGRATION OF NEW TECHNOLOGY IN BOTH FORMAL AND INFORMAL EDUCATIONAL SETTINGS

Alexander Zwissler

[Editor's Note: This article was initially published on October 2, 2012, as a blog on the website of the California Association of Museums.]

This past year I had the opportunity to sit on the California State Superintendent of Education's Education Technology Taskforce. Comprised of primarily educators and school administrators (I was an outlier), we had the charge of providing Superintendent Tom Torlakson with a series of strategic recommendations that would help shape his California Education Technology Blueprint; essentially a plan for how to transition, if not transform education in the era of modern technology. Our report can be found here: California State Superintendent of Education's Education Technology Taskforce Report (http://myboe.org/cognoti/content/file/resources/documents/68/6888f59f/6888f59f10eb3403fb69e00110c12515bb735e3a/FinalETTFMemo.pdf).

Some fascinating facts to set the context for our work...currently, it can take up to six years for the State to adopt a new textbook into the approved curriculum. Technologies are born, mature, and then die within that timeframe. A newly introduced text today would not even mention the IPhone, let alone Twitter or the whole App phenomenon. How can a traditional textbook keep up with this pace? Second, while most students, and nearly all by the time they reach high school, are digitally savvy and connected, utilizing and indeed developing new ways to integrate technology into their everyday lives, they are required to turn their devices off in school. So one of the most powerful tools for communication, creativity, information, and learning is shut off by policy in the very setting it could and should be most useful. Finally, instruction continues to be measured and indeed funded by formulas that value hours of time students are sitting in the classroom rather than the quality of the learning.

Clearly some daunting challenges... Combine these with reduced resources, pockets of resistance to change from every corner (teachers, school boards, administrators, textbook publishers, etc.), and an ever changing playing field, more and more at an accelerating pace, one can appreciate the depth and breadth of the challenge for formal education.

And while I encourage you to read our recommendations, and indeed take the opportunity to engage in the process of transformation, for the purposes of our field I think there are some interesting lessons and parallels from these challenges that we should be paying attention to.

First, there needs to be the simple recognition of the fact that the world outside is moving at a pace of change and innovation that our institutions are rarely able to adequately adapt to. I'll use some recent work here at Chabot Space and Science Center as an example. In conjunction with our Bill Nye's Climate Lab, we developed a highly engaging interactive website designed to connect and integrate the visitor experience with the Climate Lab. We used an award winning design firm and indeed created a rich and wonderful site...in fact we were nominated for a Webby for our work....One problem...at the time we started the development of the site, the only robust option for the integration of video into the content (and we had lots of it) was to use Adobe Flash. By the time it was launched, the IPhone and IPad were well on their way towards market dominance, and Apple had made the decision to not support Flash...oops.

So back to the drawing board, we have decided to abandon the site, and migrate the entire online experience to a mobile game format that will be available across all platforms...but here again, even during the time of development, IOS 6 is launched and Amazon comes out with the Kindle Fire. We'll be able to deal with this, but the point is, what will happen 6 months after we launch...after one year? Look around your institution...how many cool digital exhibits or interactives look dated or downright ancient, at least by modern tech standards. The point is, I feel we need to seriously rethink how we go about integrating technology into our exhibit development cycles. One approach is to figure out how to best use our visitor's devices, rather than trying to impose our judgment on which platform will best serve the user...unless we do so, my feeling is that we'll be wrong more often than we'll be right.

Another point from the task force is that in formal education we need to ensure that there is a connection with learning and the real world. A short hand way of thinking about this is moving from theory to practice or applicability. A simple example might be that rather than having lectures on chemistry, have the student work in a lab or a brewery to see and experience the application of chemistry in the real world...Beer! For our field, I feel that too often we do a great job of laying out the theory, and even compelling examples of it, yet rarely connect back out to current applicability. The challenge here is that

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