

The Emergence of Diagnostic Reasoning and Scientific Thinking

The Providence Children's Museum in partnership with Brown University

Summative Evaluation Report
by Rockman et al
November 2015



Acknowledgements

Thank you to Robin Meisner, Director of Exhibits at the Providence Children's Museum, for helping to conceptualize the evaluation and for working tirelessly to ensure that the resources developed for this project highlighted children's metacognitive behaviors. We also want to thank Suzy Letourneau for her formative work around parents' and educators' conceptions of children's learning and play within a museum context and Jessica Neuwirth, exhibit developer, for her role in the creation of Mind Lab. Robin, Suzy, and Jessica's contributions to the study design and instrumentation made this work more comprehensive and robust. We also want to acknowledge David Sobel from Brown University for spearheading the grant under which this work was conducted. Finally, a huge thank you to the families who participated in this study at the Providence Children's Museum. We enjoyed watching you learn through play.

- Camellia Sanford & Claire Quimby
Rockman et al



This report is based on work supported by the National Science Foundation under Grant No. 1223777. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Table of Contents

- Acknowledgements 2**
- Tables and Figures 4**
- Project Overview 5**
- Key Findings 6**
- Mind Lab and ThinkSpace – Design and Purpose 8**
- Methods 11**
 - Participant Demographics 12
- Impact on Children..... 13**
 - Learning and Play 13
 - Variety of Learning Outcomes 16
- Impact on Adults 20**
 - Adults’ Interactions and Play with Children 20
 - Using the Observation Sheet..... 24
 - Parent Reactions to the Observation Sheet* 28
 - Effect of the Observation Sheet on Play* 29
 - Suggestions for Future Use* 30
 - Mind Lab Signage..... 31
 - Paying Attention to Signage*..... 32
 - Parent Reactions to Signage*..... 33
 - Suggestions*..... 35
 - Adults Thoughts on Play and Learning 36
 - What do children get out of play?* 36
 - What kinds of learning happen at the museum?* 37
 - What does learning look like?* 38
 - Changes in Parent Attitudes and Understandings..... 39
- Conclusions and Recommendations 40**
- Appendix A – Observation and Interview Protocols 43**
 - Overall Observation Protocol..... 43
 - Overall Interview Protocol 44
- Appendix B – Observation Sheet for Caregivers 48**
- Appendix C – Detailed Findings 49**

Tables and Figures

- Table 1. Sample Size by Research Condition and Museum Space 12
- Table 2. Time Spent by Research Condition and Museum Space..... 13
- Table 3. Children's Actions in Mind Lab and ThinkSpace..... 14
- Table 4. Parents' Actions in Mind Lab and ThinkSpace** 21
- Table 5. Children's Actions in Mind Lab and ThinkSpace, as Recorded by Parents 25
- Table 6. Differences in Children's Actions Observed by Parents and Researchers (N=35)..... 26
- Table 7. Observed Signage Usage in Mind Lab 33
- Table 8. Interviewees' most common responses to "What do kids, in general, get out of play?" (Mind Lab and ThinkSpace combined, all study conditions)..... 37
- Table 9. Interviewee's most common responses to "What shows you that your child is thinking or learning while they're playing?" (Mind Lab and ThinkSpace combined, all study conditions) 38
- Table 10. Size of Groups Observed by Evaluation Team by Research Condition and Museum Space..... 49
- Table 11. Target Child Gender by Research Condition and Museum Space 49
- Table 12. Target Child Age by Research Condition and Museum Space..... 49
- Table 13. Children's Actions by Condition* 49
- Table 14. Parental Behaviors Across Study Conditions** 50
- Table 15. Families' Use of the Circuit Blocks Activity 50
- Table 16. Children's Actions in Mind Lab and ThinkSpace As Originally Recorded by Parents** 51
- Table 17. Parental Behaviors With and Without Using the Observation Sheet ** 51
- Table 18. Parental Behaviors in Mind Lab With or Without Prompting to Read Signage**..... 52

- Figure 1. Mind Lab 9
- Figure 2. ThinkSpace..... 10
- Figure 3. ThinkSpace Magna-Tiles (left) and Jovos (right) activities..... 10
- Figure 4. Children's Outcomes According to Parents – All Responses..... 17
- Figure 5. Children's Outcomes According to Parents - ThinkSpace vs. Mind Lab 18
- Figure 6. Children's Outcomes According to Parents - Differences by Study Condition (Mind Lab only). 19
- Figure 7. Observation Sheets Provided in Mind Lab 25
- Figure 8. Mind Lab Signage..... 31
- Figure 9. Mind Lab Signage - Hint Placard and Guide for Adults..... 32

Project Overview

The Providence Children’s Museum (PCM), located in Rhode Island, is a dynamic institution that embraces the idea of learning through play and regularly engages in research activities to better understand the ways in which children and families learn and play in informal learning environments. In Fall 2012, the museum partnered with the Causality and Mind Lab at Brown University to launch a multi-year collaborative project funded by the National Science Foundation. The “*Emergence of Diagnostic Reasoning and Scientific Thinking*” project focused on the ways that young children develop scientific thinking and metacognition (i.e. an awareness and understanding of one’s own thought process). PCM was tasked with examining how children demonstrate their learning and thinking through their play at the museum, and how exhibits and activities can be designed to build awareness of these learning processes among children’s caregivers¹ and educators. To address this deliverable, PCM conducted a literature review of learning behaviors, as well as several rounds of research within the museum’s various exhibits to identify how these behaviors are manifested during play. Based on this background information, PCM created a set of resources that aim to encourage open-ended play, while also increasing caregiver awareness of their children’s learning. These tools include:

- an exhibit space called Mind Lab that contains signage about research on children’s learning behaviors, including research done at Brown University, and a Guide for Adults with hints on how to scaffold children’s play
- a Circuit Blocks activity, located within Mind Lab, that was designed to prompt exploratory play and learning
- an Observation Sheet designed to be filled out by caregivers, which highlights different types of behaviors exhibited by children while they play and why those behaviors are important for subsequent learning
- signage in the museum’s Play Power exhibit, drawing attention to ways in which children learn through play
- a video kiosk activity, where caregivers and their children could listen to other people’s stories about their favorite ways to play, and could record their own stories
- a photo-mission activity during which caregivers were asked to take photos of their children when they noticed them solving problems while playing at the museum
- a magnetic chart board that caregivers could add a magnet to if they saw their children engaging in a specific learning behavior while playing at the museum

Rockman et al, a research and evaluation company based in San Francisco, was asked to conduct a summative evaluation of a sample of these tools in order to determine their effect on children’s play, on the interactions between children and caregivers, and on visitors’ understanding of the metacognitive processes that occur during play and learning at the museum. To that end, Rockman researchers focused on the Mind Lab exhibit space, the Circuit Blocks activity, and the Observation Sheet.

¹ The terms “caregiver” and “parent” are used interchangeably throughout this report. Although a variety of caregivers frequent the PCM, most adult participants in the evaluation study were the parents of the children involved.

The summative evaluation was guided by the following research questions:

- How do the museum tools impact children’s learning and play?
- How do the museum tools impact caregivers’ understanding of their children’s learning processes?
- How do the museum tools affect caregivers’ understanding of their own role in supporting their children’s learning?

To answer these questions, the Rockman research team adapted a series of observation and interview protocols that were designed by PCM for its own formative testing, and deployed these modified instruments in two museum spaces - Mind Lab and ThinkSpace - in order to track differences that might occur between visitors who did or did not utilize the tools described above. The Mind Lab space was developed specifically with the goals of the “*Emergence of Diagnostic Reasoning and Scientific Thinking*” project in mind. The accompanying signage and Circuit Blocks activity were designed to be used in that location. The Observation Sheet activity for caregivers was designed to be used throughout the museum, and special signage was made to accompany it in Mind Lab. Therefore, Rockman researchers sought a secondary location within the museum to test out and compare how caregivers might use the Observation Sheet activity outside of the scaffolded Mind Lab context. The researchers, in consultation with PCM, selected an area of ThinkSpace with open-ended building experiences using various materials (Jovos, unit blocks, or Magna-Tiles) as a comparison because the exhibit area dealt with a complementary topic related to thinking and learning (spatial reasoning), had a similar physical set-up to Mind Lab (i.e. a table with multiple stools) and contained activities that allow for exploration, similar to the Circuit Blocks activity. Observations and interviews in the Mind Lab and ThinkSpace were conducted over the course of two separate site visits in July and August of 2015.

Key Findings

Impacts of Museum Tools on Children’s Learning & Play

- The Circuit Blocks activity in Mind Lab was very successful in encouraging extended play and exploration, despite the (purposeful) lack of instruction provided by the museum. On average, children spent fifteen minutes and nine seconds in the space, and many times the parents, rather than the children, terminated the play session.
- Many children started out with simple designs and moved on to more complex configurations in both Mind Lab and ThinkSpace.
- The affordances of different components or activities within the designed museum spaces appeared to elicit different learning behaviors. In Mind Lab, children were significantly more likely to be seen watching and imitating, sharing discoveries, and telling others what to do, whereas in ThinkSpace, children were significantly more likely to repeat an action over and over again.

Impacts of Museum Tools on Caregivers' Understanding of Their Children's Learning Processes

- Some parents already considered themselves experts on their children's learning, so they did not think that their views were largely altered by their experiences in Mind Lab or ThinkSpace. However, they still appreciated what these spaces were trying to achieve and had positive things to say about the activities, signage, and Observation Sheet.
- In general, caregivers who used the Observation Tool were able to recognize at least one of the listed behaviors during their children's play.
- In both Mind Lab and ThinkSpace, caregivers often marked down on the Observation Sheet that their children looked focused. In fact, several parents seemed surprised that their children had spent so much time and remained so engaged with the activities.
- Overall, parents' observations of their children exploring with their senses, thinking out loud, looking focused and sharing discoveries were not statistically different from researchers' observations. When there was a difference, parents were typically the ones more likely to take note of a child's action than the researchers. Some parents may have been conflating things that their child typically does during play with what they were doing that moment. Regardless of the timeframe, the fact that parents recognized and reflected on the ways that their children think and learn when they play supports PCM's goal of designing an educational tool to raise awareness of what children are doing during play.
- Caregivers who utilized the Observation Sheet were significantly more likely to mention learning behaviors highlighted on that sheet when discussing their children's play than parents in the signage or traditional conditions. Regardless of whether caregivers felt that the information on the Observation Sheet was familiar, it seems like the tool helped make these behaviors more explicit and remind parents of their importance to their child's development.

Impacts of Museum Tools on Caregivers' Understanding of Their Own Role in Supporting Their Children's Learning

- In general, parents seemed willing to sit back and offer other types of support, rather than play along with their children. Caregivers in ThinkSpace were significantly more likely to be seen watching their children without interacting with them than those in Mind Lab. Alternatively, parents in Mind Lab were significantly more likely to be observed teaching via verbal instructions than those in ThinkSpace. In ThinkSpace, many parents engaged in parallel play, where they were intently focused on constructing their own designs, whereas in Mind Lab most parents let their children build the circuits themselves and provided hints or encouragement during the interaction. Therefore, the design of these spaces and how their children engaged with each activity seemed to influence how parents behaved during the interaction.

- Caregivers in both spaces were most often seen scaffolding their children’s understanding of a concept or activity and encouraging them to keep exploring. They were least likely to prompt their children to verbalize what they were thinking or doing (i.e. engage in reflective metacognition). These findings align with results from PCM’s formative studies, which found that caregivers were more likely to ask questions or give suggestions, rather than try to elicit their children’s thinking. Since the materials in both museum spaces were not designed to encourage such prompting, it makes sense that caregivers did not exhibit this behavior very often.
- The use of the Observation Sheet inhibited some parental behaviors in support of learning, while encouraging others. Caregivers were significantly less likely to be seen playing along with or alongside their children or teaching using verbal instructions when they were utilizing the Observation Sheet. Yet allowing their children to play without constant adult intervention may have supported other aspects of their children’s learning, such as independent exploration or trial and error. Regardless, caregivers’ use of the Observation Sheet did not seem to impact the likelihood that parents would watch their children without interacting at all. Taken together, these findings suggest that the Observation Sheet may change the ways parents support their children’s learning, but not decrease their level of support overall..
- Most parents did not pay attention to signage on the walls of Mind Lab or on the table, even when prompted to do so, because their focus was on their children and the Circuit Blocks activity. Nevertheless, parents who did pay attention to signage had positive reactions, citing ways it had changed their thinking about how they interact with their children. In particular, parents who viewed the signage talked about both letting their children explore more without instruction, as well as feeling more inclined to play alongside their children. In practice, parents were significantly more likely to be seen playing along with or alongside their children when they had been prompted to read Mind Lab signage first.

Mind Lab and ThinkSpace – Design and Purpose

Mind Lab is a small room on the first floor of the Providence Children’s Museum that adjoins the museum’s Play Power permanent exhibition. Mind Lab was designed to be multi-functional: first, to serve as a permanent space for PCM’s outside research partners to study child development, and second, as an exhibit space when researchers are not present. When in use as an exhibit, Mind Lab contains an activity on learning through exploration (i.e. Circuit Blocks), labels on how children learn, and an Observation Sheet activity for caregivers.

The Circuit Blocks activity rests on a child-height table with chairs surrounding it, and a bench against one wall (see Figure 1).

Figure 1. Mind Lab



The Circuit Blocks activity consists of an assortment of batteries, lights, on/off buttons, and spinning discs mounted on wooden blocks, along with a pile of wires with alligator clips on both ends. The unspoken challenge is for children to figure out how to hook these pieces together to create working circuits, powering the lights and the spinning discs. Signage explaining the activity is limited to a single hint placard with no text and a picture of a simple circuit that is almost completed. A laminated “Guide for Adults” card gives examples of prompting questions that adults can ask children as they play.

In addition to the Circuit Blocks activity, Mind Lab features signage aimed at adults that describes how children learn through experience, exploration and play, and presents illustrated and non-illustrated summaries of findings from several studies on how children learn. Parents can also pick up a clipboard from the cabinet on one side of the room and fill out an Observation Sheet (see Appendix B) as they play with their children. The Observation Sheet lists different behaviors that caregivers can observe and check off, and links these behaviors to aspects of learning. The Observation Sheet activity, in combination with the signage, are designed to help adults notice and appreciate the thinking and learning that can be visible through their children’s play. A written prompt also positions the activity as a way caregivers can “help the museum learn about how kids learn through play,” if they choose to leave their completed Observation Sheets on the clipboard to share with PCM. However, the activity was ultimately designed as a tool for caregivers, not to produce data for researchers.

ThinkSpace was selected as a location to study the use of the Observation Sheet as compared to its use in Mind Lab. A specific section of ThinkSpace was chosen due to the presence of open-ended building experiences using various materials (Jovos, unit blocks, or Magna-Tiles) that allow for exploration, because the exhibit area dealt with a complementary topic (spatial reasoning), and due to its similar physical set-up (i.e. accommodates multiple children and adults and allows for collaborative or parallel play).

ThinkSpace is an elongated hallway-like area on the second floor of the museum. ThinkSpace contains several activities that highlight exploration of and experimentation with shapes, spaces, and spatial thinking, and researchers focused on three of these (see Figure 2). The first area has a round table with an under-mounted storage bin containing Jovos (flat geometric shapes that can be snapped together to create 3D forms; see Figure 3). Several stools surround the table to accommodate multiple visitors. A laminated flipbook of potential designs is available for those who want some direction for their creations. Nearby, a set of Magna-Tiles (magnetic geometric shapes) can be found in a bucket on the floor for younger visitors. A perforated metal, curved pony wall closes off this second space. In between the two spaces is a “Show-Off Shelf,” where visitors can display their creations.

Figure 2. ThinkSpace



The third area is across from the Jovos and Magna-Tiles. Here, visitors can take wooden unit blocks of different sizes off of a low shelf and arrange them within a large floor area. Each of these areas is close in proximity and the activities within them all allow for open-ended play with minimal instruction.

Figure 3. ThinkSpace Magna-Tiles (left) and Jovos (right) activities



Methods

To understand how parents and children were using the two museum spaces, Rockman et al researchers conducted observations of family groups while they interacted in either Mind Lab or ThinkSpace, followed by interviews with an adult member of the group. The observation and interview protocols researchers used were adapted from the instruments developed by the Providence Children's Museum during the formative phases of this project (see Appendix A). Due to IRB constraints, only legal guardians were recruited for interviews. The majority of participants were prompted, meaning they were invited by the researcher to take part in the study prior to engaging with the activities and being observed or interviewed, although a few were invited to take part in the study after they engaged with the activity on their own initiative (unprompted). Most participant groups were chosen via convenience sampling (i.e. selecting the first visiting family who either agreed to participate (prompted) or who entered one of the target exhibit areas on their own (unprompted) to maximize the sample size in each condition within the timeframe during which the study took place. When Mind Lab or ThinkSpace were empty, participant groups were recruited from surrounding exhibit areas by approaching any available adult accompanied by children. Participants were told that they could play in the space as long as they liked. Participants were assigned to one of three study conditions: Traditional, Signage, or Observation Sheet (see Table 1 for breakdown of participants assigned to each condition):

Traditional (Mind Lab and ThinkSpace) – After being recruited, these participants were asked to play in the space as they normally would and let the researcher know when they were finished.

Signage (Mind Lab only) – Adult participants in this group were asked to first spend some time reading the signage around the room before engaging with the Circuit Blocks activity. After the group was done playing, the adult interviews included questions about their reactions to signage and how it may have shaped their experience in the space.

Observation Sheet (Mind Lab and ThinkSpace) – These participants were asked to fill out an Observation Sheet while they played in the space. If more than one child accompanied them, they were asked to choose one child as the focus of their observations. This child also became the target child for the researcher's observations.

For groups with multiple children, the researcher selected one child to be the target of their observations (the first child to enter the room). Researchers recorded the time families spent in the space, using the target child's entry and exit from the area as starting and end points. During each observation, researchers filled out a protocol that focused on the presence or frequency of different types of child and adult behaviors and interactions. Afterward, adults who agreed to do so participated in a brief interview about their experience in the space that day, their observations of their children, and their thoughts on play and learning (for observation and interview protocols, see Appendix A). Interview questions were open-ended, allowing parents to elaborate and supply their own ideas. Adults' responses were coded according to themes that emerged and were also tracked for alignment with the museum's goals for the project - for example, evidence that they were thinking about the ways children demonstrate their learning or identifying different types of learning behaviors.

Table 1. Sample Size by Research Condition and Museum Space

Research Condition	Mind Lab		ThinkSpace	
	Interviews	Observations	Interviews	Observations
Traditional - unprompted	2	11	8	3
Traditional - prompted	19	19	8	11
Signage	20	21	N/A	N/A
Observation Sheet	20	20	15	15
Total	61	71	31	29

Participant Demographics

Families who were observed in Mind Lab had an average of three individuals in their group and an overall range of two to six individuals (see Appendix C, Table 10). Most families who were observed in ThinkSpace also had an average of three individuals in their group and a range from two to four individuals. Typically, the three individuals included one adult and two children.

Due to convenience sampling, target children selected for observation by the evaluation team in Mind Lab space tended to be boys, whereas the children selected for observation in ThinkSpace were equally likely to be boys or girls (see Appendix C, Table 11). The average age of target children overall was approximately six years old (range from two to twelve years of age) (see Appendix C, Table 12). There were no significant differences in age or gender by research condition or museum space.

Most parents or caregivers who were interviewed were female (70%, N=91). Interviewees tended to be either first time visitors (N=25) or had visited the museum once or twice already in the past year (N=37). Several were more frequent visitors, having been to the museum 3-5 times (N=13), 6-9 times (N=2), or 10 or more times (N=14) in the past year alone. Regardless, most participants had never been to Mind Lab before (85 %, N=61), since it was a relatively new space within the museum at the time of the study and is often used by the Museum’s outside research partners.

Impact on Children

Learning and Play

One potential indicator of engagement in the selected spaces was how long children spent there. Observations confirmed that children tended to stay in both Mind Lab and ThinkSpace for a very long time (see Table 2). There were no significant differences in the amount of time spent by research condition. However, it is clear that families engaging in the designed resources (i.e. visiting Mind Lab space or using the Observation Sheets in either location) spent more time there than families in the traditional ThinkSpace. Therefore, it appears that Mind Lab and its resources had some value added in terms of holding power.

Table 2. Time Spent by Research Condition and Museum Space

Research Condition	Mind Lab	ThinkSpace
	Average Time Spent	Average Time Spent
Traditional	15:23	10:46
Signage	16:52	N/A
Observation Sheet	13:12	13:37

When just the Mind Lab observations were compared to one another, no significant differences were found between conditions in terms of children’s actions. Similarly, when just the ThinkSpace observations were compared, no significant differences were found between conditions in terms of children’s actions. Therefore, the conditions within each space were combined for the purposes of analysis.

The types of learning behaviors researchers observed children engaging in within each space were closely aligned with the behaviors listed on the Observation Sheet activity developed by the museum (i.e. the tool was effective in revealing children’s thinking). However, researchers observed children engaging in certain behaviors more often in one museum space versus the other, perhaps due to the affordances of the activities present. While identifying behavioral differences between the two spaces was not a main objective of the study, doing so supports the claim that the tool can be applied to children’s play in multiple settings and might also help museum staff better understand how the Observation Sheet can potentially be used in the future as a metric for identifying whether an exhibit is eliciting certain types of learning.

When all of the Mind Lab observations (traditional, signage, and observation sheet combined) were compared to all of the ThinkSpace observations (traditional and observation sheet combined), a few trends emerged. In both spaces, children were often observed exploring with their senses and looking focused, and were rarely seen expressing frustration (see Table 3). In Mind Lab, however, children were significantly more likely to be seen watching and imitating, sharing discoveries, and telling others what to do, whereas in ThinkSpace children were significantly more likely to repeat an action over and over again. A more detailed breakdown of

children’s actions by research condition and museum space can be found in Appendix C, Table 13.

So, what did children’s learning behaviors actually look and sound like in the two spaces? In Mind Lab, many children started out trying to make simple circuits. If they were able to successfully do so, then they moved on to more complicated configurations, with several trying to combine all of the available pieces together. Children also experimented with adding or removing power sources to make the lights brighter or dimmer, and the spinners faster or slower. A few children tried to make the spinners go in the opposite direction (clockwise versus counter-clockwise), but this was typically at the prompting of an adult.

Table 3. Children’s Actions in Mind Lab and ThinkSpace

Children’s Actions	Mind Lab (N=71)	ThinkSpace (N=29)	Significance Level*
Watching and imitating	66%	34%	.003*
Repeating over and over	31%	76%	.000*
Sharing Discoveries	83%	62%	.023*
Exploring with their senses	94%	93%	.812
Thinking out loud	69%	59%	.324
Looking focused	85%	79%	.535
Telling others what to do	32%	10%	.022*
Using trial and error	73%	79%	.529
Expressing frustration	11%	14%	.728

*indicates a significant difference

In Mind Lab, children were often seen working collaboratively to help one another complete a circuit. Several found out that the clamp could simply touch the pin and work properly. Children were frequently overheard sharing their discoveries by explaining how certain pieces worked to other children and adults:

“This one stops the circuit.” - Four year-old boy in Mind Lab, Family #43

“Mom, look! If you disconnect this, it won’t spin anymore. You don’t even have to connect it. As long as this metal is touching that metal, it works.” – 10 year-old girl in Mind Lab, Family #10

In over half of the interactions, children in Mind Lab were observed thinking out loud. Sometimes, this involved letting their co-learners know what they were about to do:

“Next, I’m going to try this light right here.” - 7 year-old girl in Mind Lab, Family #44

“I think I’m going to connect it from this to this to this to this.” – 6 year-old boy in Mind Lab, Family #29

In other instances, it seemed that children were posing potential explanations aloud for phenomena that they had just observed:

“Maybe it just makes them stronger if you use two batteries.” - 10 year-old boy in Mind Lab, Family #22

Mother, Family #20: “Now, none of it’s working. What happened?”
6 year-old girl: “Because maybe I put too many [wires] off.”

Children in Mind Lab were also observed helping other children make successful circuits by either telling them what to do next or physically showing them:

“Let me try. Let me show you an idea.” – 5 year-old boy in Mind Lab, Family #23

“This leads to nothing. This needs to be connected to here.”
– 9 year-old girl in Mind Lab, Family #8

A few children were observed repeating an action over and over, such as placing a clamp against a wire and taking it away or building the same circuit again and again.

Children in Mind Lab had various strategies that they employed when they got stuck. Some children worked independently and only asked their parents for help when they could not successfully get a circuit to work. Others would watch their parents or another child and mimic what they did. Children rarely expressed frustration in Mind Lab, but when they did it was often because a feature did not interact like they thought it would (e.g. they hooked up the button, but it did not turn a light on when they thought it should). Occasionally they also had difficulty operating the clamps or were frustrated by another child interrupting their configuration.

In ThinkSpace, children began by making flat, simple designs and then moved on to more complex 3D structures. Children tended to construct their own creations without the assistance of the flipbook of designs. Several children were observed building the same structure again and again. Most children worked independently, occasionally asking an adult to hold their structure in place while they added or removed a tricky shape. Thus, children in ThinkSpace were rarely observed telling others what to do because they were so focused on making their own creations. Several children expressed satisfaction when they were done and put their finished pieces on the Show-Off Shelf.

Perhaps because the ThinkSpace activities dealt so much with processes of making, children were frequently overheard discussing their designs:

“It’s a ramp. It’s not a car. It has no wheels. It can’t move with no wheels.”
– 4 year-old boy in ThinkSpace, Family #89

“I want to do the best I can to build a cube. I need squares.”
– 10 year-old girl in ThinkSpace, Family #74

Although children were focused on what they were making, they were still aware of what was going on in the rest of the space. Several were seen imitating a design that their siblings, friends, or parents had made. Interestingly, one four year-old boy compared his creation to his mother's and realized that she was making the same thing that he had done: "You're building what I built."

When children expressed frustration in ThinkSpace it was often because their structure fell apart. Interestingly, one family whose son did not seem frustrated at all during the activity tried to preempt any negative feelings by providing him with a strategy for dealing with a setback:

"If you get frustrated, just walk away. Remember, you don't play with these very often, so you just have to be patient with them... Remember, sometimes they fall apart - That happens and it's frustrating, but that's part of building." – Father in ThinkSpace, Family #100

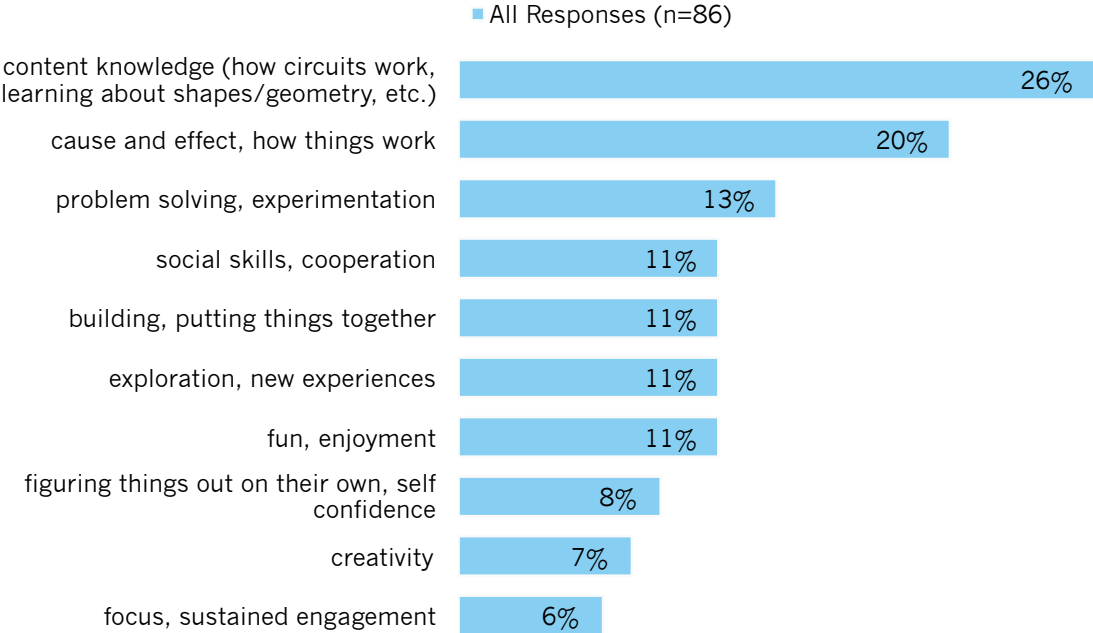
These qualitative descriptions of children's words and actions show that, although both exhibits elicited many of the same learning behaviors, the Circuit Blocks seemed to be especially effective in encouraging children to articulate their ideas in a variety of ways and strategize while experimenting with the materials. Such behaviors not only make children's thinking apparent to their caregivers but also suggest that children are actively reflecting on their own thoughts and actions. While the materials developed during this project focused on caregivers, additional materials could be developed to scaffold these skills in children and help them become more aware of their own thinking.

Variety of Learning Outcomes

One objective of the tools developed by the Providence Children's Museum is to emphasize the many different types of thinking, learning, and skill-building that children accomplish during play. The open-ended nature of the Circuit Blocks activity was designed to foster learning through exploration and experimentation. The limited number of parts available to children in Mind Lab (a set number of wires, lights, switches, and so on) was an intentional choice made by the museum in order to promote exploration and experimentation in a variety of ways — by encouraging children to strategize to make use of the available materials, to see and diagnose problems in their circuits more clearly, and to work together to design circuits and share materials.. In ThinkSpace, activities were designed to encourage spatial thinking and an awareness of what spatial thinking is.

To see if parents were picking up on the different kinds of learning happening in Mind Lab and ThinkSpace, researchers asked parents what they thought their children got out of playing in those locations. Caregivers' interview responses were coded using common themes that emerged from the dataset, and results from both spaces indicated that parents *are* picking up on varied types of learning (see Figure 4).

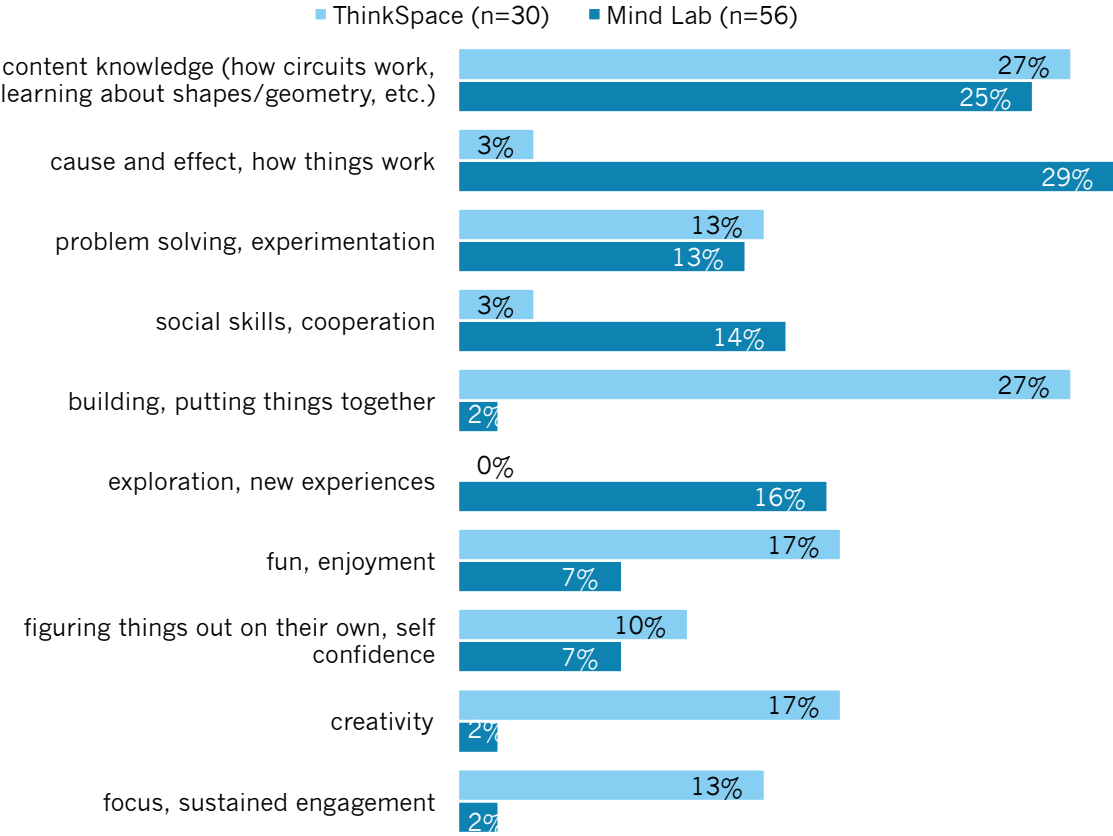
Figure 4. Children's Outcomes According to Parents – All Responses



The most common learning described by parents and caregivers was new content knowledge, such as how circuits work in Mind Lab or names of shapes and colors in ThinkSpace. Interviewees also frequently cited other learning outcomes, such as cause and effect or experimentation.

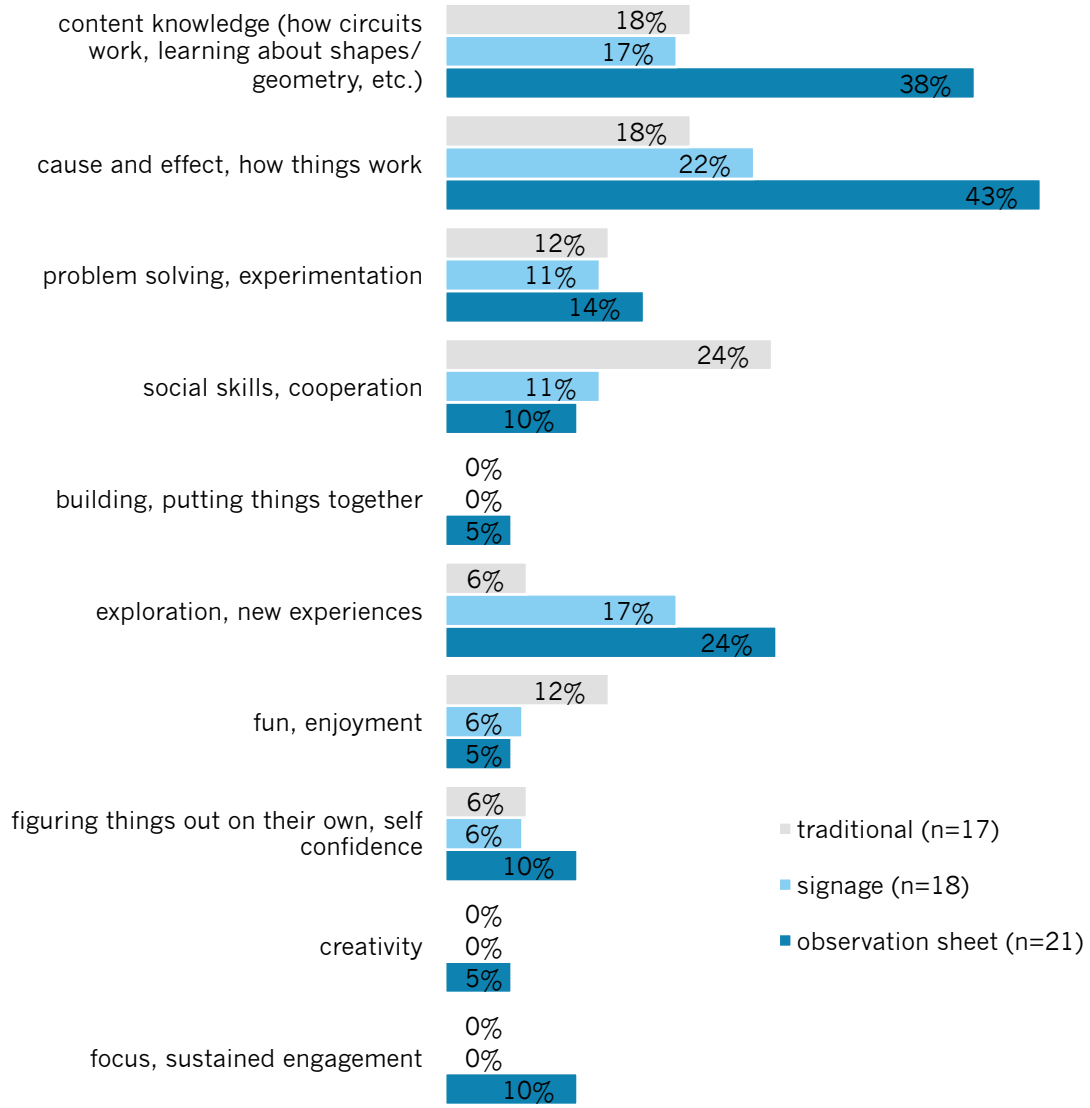
Parents’ responses also revealed interesting differences between the outcomes they observed in Mind Lab versus ThinkSpace (see Figure 5). For example, a larger proportion of parents in ThinkSpace talked about their children using creative thinking, building and creating things, and showing focus, patience, or sustained engagement. This is not too surprising since building and expressing creativity are skills that might lend themselves more naturally to the ThinkSpace activities. It is interesting, however, that not as many parents talked about focus or engagement for Mind Lab, where families actually spent a longer period of time. It’s possible that fewer parents in Mind Lab thought of “focusing” as an actual outcome, since the term implies quiet concentration. Instead, children collaborating and sharing what they were doing with others may have been more obvious outcomes to parents in this setting, compared to ThinkSpace where many participants engaged in parallel play and worked separately on their own designs. Caregivers in MindLab also mentioned “cause and effect” or “how things work” much more often than caregivers in ThinkSpace. Again, this finding aligns with the nature of the activities in the two spaces. For example, the Circuit Blocks activity naturally encourages children to explore what types of connections do or do not work, and caregivers recognized this behavior happening.

Figure 5. Children's Outcomes According to Parents - ThinkSpace vs. Mind Lab



Parents’ answers also varied slightly depending on the experimental condition they took part in - traditional, signage, or Observation Sheet (see Figure 6). In Mind Lab, parents who read signage or used an Observation Sheet cited fun as outcomes less often than parents in the traditional condition, suggesting that they were perhaps more clued in to the learning going on. In further support of this hypothesis, parents who read signage or used the observation sheet mentioned exploration and new experiences more often than those in the traditional condition. Those who read the signage or used the observation sheet might have been more likely to see these kinds of activities as learning behaviors, and mirrored Mind Lab messaging in their responses. It should also be noted that caregivers who used the Observation Sheet activity tended to mention cause and effect, figuring things out, and focus as outcomes more often than caregivers in the other conditions, suggesting that caregivers who used the tool were attuned to these aspects. Given the small sample size for each condition, it is difficult to extrapolate too far from these results. Still, it is interesting to see that parents identified a wide range of outcomes, many of which were emphasized by the museum through the signage, Observation Sheet, and design of the Circuit Blocks activity.

Figure 6. Children's Outcomes According to Parents - Differences by Study Condition (Mind Lab only)



Impact on Adults

Adults' Interactions and Play with Children

Parents were frequently observed engaging in a variety of behaviors in support of learning (see Table 4, and Appendix C, Table 14 for more detailed breakdown). Parents were most often seen scaffolding their children's understanding of a concept by encouraging them to further explore the activity:

“Why don't you try hooking it up to a battery source and see if it works?... You gotta play with it to see what works. Try different combinations” – Mother in Mind Lab, Family #39

“Let's add this [button] to our circle and see what happens.” – Mother in Mind Lab, Family #24

“What if you put that one on a different one? What happens if you just hook the battery to this one? I wonder what you could do to make it slower.” – Mother in Mind Lab, Family #21

“You think you're not good at math, but you're doing geometry.” – Mother in ThinkSpace, Family #75

In both Mind Lab and ThinkSpace, some parents scaffolded the open-ended activities by posing challenges to their kids to help keep them engaged:

“Do you think you could get everything working as one big circuit?” – Mother in Mind Lab, Family #41

“Do you think you could get two of them working on the same battery?” – Mother in Mind Lab, Family #26

“Who can build the tallest tower? Who can build the highest one?” – Mother in ThinkSpace, Family #98

Parents were least likely to prompt their children to verbalize what they were thinking or doing, likely because this was not an explicit aim of either space observed. When they did so in Mind Lab, it was often tied to expressions of amazement for successfully completing the circuit or trying to figure out cause and effect:

“Look at that! How did you do that?... Why do you think it slowing down? What did you do when it started to slow down?” – Mother in Mind Lab, Family #39

“You got the light to work? How did you do it? What did [Child's Name] do that's different from what you did?” – Mother in Mind Lab, Family #42

A few parents explicitly tried to get their children to speak about the activity in which they were engaged:

“Can you think it through and talk it out?” – Mother in Mind Lab, Family #66

“You gotta think about what you’re doing. You’re just sticking things everywhere.” – Father in Mind Lab, Family #37

Table 4. Parents' Actions in Mind Lab and ThinkSpace**

Parent’s Actions	Mind Lab (N=71)	ThinkSpace (N=29)	Significance Level*
Facilitating (nonverbal, physical assistance)	1.08	1.24	.536
Teaching (verbal instruction)	1.82	1.17	.012*
Playing (along with or alongside)	1.34	0.90	.091
Scaffolding (hints, questions, encouragement)	2.20	1.97	.353
Watching (without interacting)***	0.35	0.72	.002*
Prompting their child to verbalize what he/she is thinking/doing	0.66	0.83	.463

* Indicates a significant difference

** 0 = Never, 1 = Once, 2= 2-3 times, 3 = 4+ times

*** 0 = Behavior was not observed, 1= Behavior was observed at least once

In ThinkSpace, parents’ queries centered on asking children what they were making or what they needed to do to start or complete their designs:

“You can figure it out. What do you think needs to happen?” – Father in ThinkSpace, Family #81

“These are large squares. How do you think they stick?” – Mother in ThinkSpace, Family #92

Parents in Mind Lab, regardless of condition, were significantly more likely to be observed engaging in teaching behaviors than those in ThinkSpace. Researcher observation notes in Mind Lab suggest that oftentimes parents who had prior knowledge about circuits would instruct their children on how to successfully complete the activity:

“Pay attention. When you connect something, look to see if anything changes.” – Father in Mind Lab, Family #4

“What do you think the black and red represent? Positive and negative.” – Mother in Mind Lab, Family #24

Several parents were observed explaining to their children why a light or spinner did not work:

“There’s no battery going to the circuit you set up.” – Mother in Mind Lab, Family #3

“Did you hear what he said? Too many things for one battery to run.” – Mother in Mind Lab, Family #6

“No, it's gotta be sequential. So you gotta go...It doesn't matter if it's neutral or positive...See how it goes backwards if you reverse the polarity?” – Father in Mind Lab, Family #37

“We do these at home. You’re missing something. What do you need? It goes before the switch.” – Father in Mind Lab, Family #7

By utilizing what was happening in front of them, several parents successfully discussed electricity concepts with their children:

“That [spinner’s] going double fast because we’re using two batteries.” – Father in Mind Lab, Family #37

Father: “In electricity you have to have a circle, like you said. Do you know what that’s called?”

6 year-old son: “A circuit.” – Family #25 in Mind Lab

Father: “It’s pretty cool that you have everything connected, but everything leads back to what?”

6 year-old son: “The power.” – Family #26 in Mind Lab

Parents who were observed teaching in ThinkSpace tended to focus on the purpose of the building materials and their magnetic properties or shape attributes, with only a few directing what they and their child were going to make:

“Can you find some more hexagon pieces because we’re going to build something like this.” – Mother in ThinkSpace, Family #75

“You’re supposed to build with it. Put it on top. Slide it in, kind of like a puzzle.” – Mother in ThinkSpace, Family #89

“It’s a magnet. You see the black dots? They stick together.” – Father in ThinkSpace, Family #97

“Not just a square, right? 3D is a cube.” – Mother in ThinkSpace, Family #92

A few parents in both spaces linked to their children’s prior knowledge to help explain difficult concepts:

“It’s kind of like a car battery [Child’s Name], when you want to jump it!” –Mother in Mind Lab, Family #25

“These are magnetic on both sides, as opposed to downstairs.” – Mother in ThinkSpace, Family #89

In addition, parents in both spaces provided just-in-time help for their children via non-verbal physical assistance. In Mind Lab, this often took the form of parents holding the clamps when children found them difficult to manage, untangling wires, or moving materials within reach. In ThinkSpace, parents also made the various materials more accessible for their children, held creations stable while children placed their final pieces, and helped reset the experience by taking apart shapes that were stuck together.

In general, parents seemed willing to sit back and offer other types of support, rather than play along with their children. In Mind Lab, parents tended to let their children take the lead on constructing circuits and were less likely to be seen making or completing a circuit themselves (see Appendix C, Table 15):

9 year-old girl [pats seat with her hand]: “Daddy, do it with us.”
Father: “I’ll watch. I want you to do this.” – Family #12 in Mind Lab

“That’s how they learn. They’ve got to figure things out for themselves.” – Mother in Mind Lab, Family #26

There were no significant differences in families’ use or successful completion of a circuit in Mind Lab by condition.

Some parents struggled to engage with their children in Mind Lab because they were supervising their other children in the Play Power exhibition. These parents often stood in the doorway of Mind Lab, verbally chiming in regarding what their children were doing with the Circuit Blocks activity from time to time. Several parents did offer to help their children with the activity, but their children turned down the assistance, preferring to work alone or with other kids at the table. Parents whose children did allow them to engage with the activity saw value in exploring circuits informally together:

"I think even adults get a little something out of play. It brings joy to us. It makes our brains work in ways we don't usually do." – Mother in Mind Lab, Family #44

Parents in ThinkSpace were significantly more likely to be seen watching their children without interacting with them than those in Mind Lab (see Table 4). Many ThinkSpace parents engaged in parallel play where they were intently focused on constructing their own designs, only occasionally remarking on what their children were making or doing. After building separately, one father and mother were observed reflecting back on the father’s creation to their young son:

Father: “That’s not exactly how Papa intended to do it, but sometimes that’s the fun thing.”
Mother: “That’s part of learning. You try it again and keep going.” – Family #100 in ThinkSpace

This variation in play styles may also be due to the amount of seating available in each space. ThinkSpace is more open and ample, while Mind Lab is a smaller room with only four seats around the Circuit Blocks table and a bench off to the side.

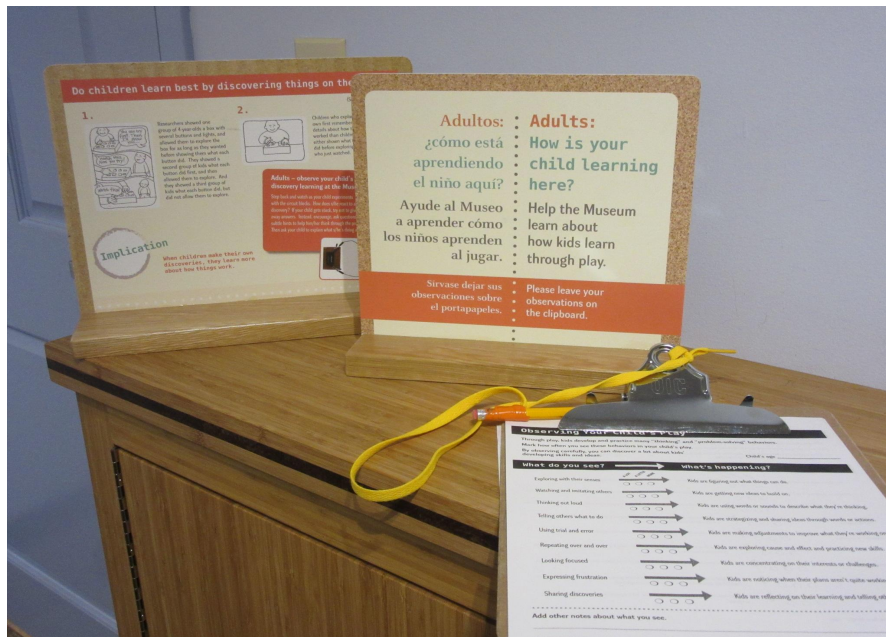
Using the Observation Sheet

Providing the Observation Sheet in Mind Lab was one way the museum hoped to encourage parents and caregivers to pay closer attention to their children's learning and to the specific kinds of behaviors that children display when they are working through problems and developing an understanding of their world. In Mind Lab, the Observation Sheets were located on a clipboard close to other signage connecting back to the Circuit Blocks activity that highlights research on children's learning (specifically a study by Sobel and Sommerville looking at how when children make their own discoveries, they learn more about how things work) (see Figure 7). For the purposes of this study, the Observation Sheet was tested in a second setting, ThinkSpace, to see whether it had an impact in other parts of the museum. Although the sheets were available for potential use in Mind Lab, all of the Observation Sheets that were used by parents during this study were handed to visitors when they agreed to participate in the research.

Parents tended to use the Observation Sheets similarly in both ThinkSpace and Mind Lab. On average, parents were seen looking at and checking behaviors off of the Observation Sheet two to three times. Based on parents' original coding, "looking focused" was the most frequently observed behavior in Mind Lab², while "looking focused," "using trial and error," and "exploring with their senses" were the most frequently observed child behaviors in ThinkSpace. "Telling others what to do" and "expressing frustration" were the least observed behaviors by parents. There was only one significant difference in parents' observations between locations – Parents observed their children "exploring their senses significantly more often in ThinkSpace than in Mind Lab. Averages of parents' originally coded observations can be found in Appendix C, Table 16.

² It is interesting to note that caregivers who used the Observation Sheet were more likely to list focusing as a possible learning outcome for their children than caregivers in other conditions AND they tended to pay attention to this behavior most often when using the sheet.

Figure 7. Observation Sheets Provided in Mind Lab



In order to test out the effectiveness of the Observation Sheet as an educational activity for caregivers, Rockman researchers wanted to find out whether or not caregivers were noticing what their children were actually doing in the moment. Here, the researchers observed the behavior of the same target children about whom caregivers were filling out the Observation Sheet, and then compared caregivers' observations to those of the researchers. However, since researchers' and parents' observations were on different scales, parents' observations were re-coded for presence (1) or absence (0) of a behavior to match the research instrumentation. There were no significant differences between parents' observations in Mind Lab and ThinkSpace once the behaviors were re-coded (see Table 5).

Table 5. Children's Actions in Mind Lab and ThinkSpace, as Recorded by Parents

Children's Actions	Mind Lab (N=20)	ThinkSpace (N=16)	Significance Level*
Watching and imitating	85%	81%	.772
Repeating over and over	80%	88%	.562
Sharing Discoveries	80%	88%	.562
Exploring with their senses	95%	100%	.379
Thinking out loud	85%	69%	.256
Looking focused	90%	100%	.204
Telling others what to do	65%	50%	.379
Using trial and error	90%	94%	.696
Expressing frustration	55%	69%	.415

*Indicates a significant difference

Overall, parents’ observations of their children exploring with their senses, thinking out loud, looking focused and sharing discoveries were not statistically different from researchers’ observations (see Table 6). For the most part, when there was a significant difference in observations, parents were more likely than the researchers to note the child’s action. Here, parents may have been reacting to what their child typically does, rather than what he or she was actually doing during the interaction, as some interview responses suggested. The one exception to this trend was in observations of children expressing frustration. The researchers observed children doing this more often than parents. In this case, perhaps parents and the researchers had different definitions of “expressing frustration,” with parents being more aware of the spectrum of their children’s emotions.

Table 6. Differences in Children's Actions Observed by Parents and Researchers (N=35)

Children's Actions	Parents	Researchers	Significance Level*
Watching and imitating	83%	54%	.010*
Repeating over and over	83%	49%	.002*
Sharing Discoveries	83%	69%	.169
Exploring with their senses	97%	100%	.324
Thinking out loud	77%	66%	.353
Looking focused	94%	89%	.324
Telling others what to do	57%	20%	.002*
Using trial and error	91%	74%	.032*
Expressing frustration	60%	86%	.000*

On the Observation Sheets, parents were also asked to jot down notes about the most interesting thing that they noticed, and any other information they wanted to share about the experience. Only two parents in Mind Lab and six parents in ThinkSpace chose not to write something additional down. In their notes, several parents elaborated on the specific behaviors that their children did and how those behaviors helped them learn:

“She uses verbal ‘thinking out loud’ to work things out.” – Mother in Mind Lab, Family #44

“He is trying by himself by learning from his mistakes.” – Father in Mind Lab, Family #58

Some reframed behaviors (i.e. they wrote open-ended notes that seemed to relate to the behaviors already listed on the sheet) – for example, “interest in what others are doing,” could also be seen as “watching and imitating,” while “attention was great compared to normal” and “examining and thinking in mind without sharing with words – studying” might contribute to caregivers’ observations of their children “looking focused.”

Several parents called out their children's interest in and attention towards the activity or concept:

“Excitement over battery power!” – Mother in Mind Lab, Family #54

“Very focused on building, she takes her time and is precise.” – Mother in ThinkSpace, Family #79

“Wanted to include everyone in on what interested him.” – Mother in ThinkSpace, Family #75

Parents also noticed when their children's behavior changed due to the presence or absence of other visitors in the space:

“She becomes hesitant when asked questions by a boy, but also observant of them and then will try out different things/model them.” – Mother in Mind Lab, Family #56

“She was eager to show and explain to me, but when bigger kids were here she just watched.” – Mother in Mind Lab, Family #59

“She was playing by herself, so I think I would have seen more of the above if she was playing with others.” – Mother in ThinkSpace, Family #78

A few parents commented on the strength of the activities themselves:

“My son has Aspergers. Great activity for kids who think outside the box.” – Mother in Mind Lab, Family #45

“He is an active kid and I was surprised to see him sitting for a length of time.” – Mother in ThinkSpace, Family #80

Some questioned whether their child had truly understood the activity, while others were sure that their child had learned a new concept. For example, one parent shared that her 6 year-old son was “making progressively more complicated constructs” at the Circuit Blocks table.

Parental behavior around their children while using the Observation Sheets tended to be similar in both ThinkSpace and Mind Lab. There were two exceptions. First, families in ThinkSpace who used the Observation Sheets were significantly more likely to prompt their children to verbalize what they were thinking than those in Mind Lab, $t(33)=-2.922$, $p=.006$. Second, families who used the Observation Sheets in ThinkSpace were significantly more likely to watch their children without interacting with them than those in Mind Lab, $t(33)=-2.357$, $p=.025$. However, it should be noted that parents whose used the Observation Sheets in ThinkSpace exhibited both of these behaviors more frequently than in all other conditions (see Appendix C, Table 14).

In practice, regardless of whether they were in Mind Lab or ThinkSpace, parents were significantly more likely to be seen playing along with or alongside their children when they

were not using the Observation Sheet, $t(98)=2.813$, $p=.006$ (see Appendix C, Table 17). They were also significantly more likely to be seen teaching using verbal instructions when they were not using the Observation Sheet, $t(98)=3.197$, $p=.002$. Thus, the Observation Sheet seemed to inhibit some parental behaviors in support of learning. However, it's worth noting that parents who used the Observation Sheet were not significantly more likely to watch their children without interacting than those who did not use the sheet.

Parent Reactions to the Observation Sheet

Although the Observation Sheets were available to all museum visitors (provided on a clipboard) observations in Mind Lab showed that parents did not use the sheets unless prompted to do so as part of their participation in the study. Parents may be overlooking or ignoring the Observation Sheets for several reasons. In Mind Lab, the clipboard was placed on a counter to one side of the room, and most groups who entered went directly to the table with the Circuit Blocks activity without pausing to look at the room's other features. Parents and caregivers were also usually focused on their children during their time spent in Mind Lab. However, parents who were asked to use the Observation Sheet gave mostly positive feedback on the experience. They liked that the Observation Sheets drew attention to specific learning behaviors and that it was simple to use:

"As a parent you don't always sit and just objectively observe what is happening. So having someone hand you a form to think about those individual pieces - it changes observing in a really interesting way." – Mother in Mind Lab, Family #59

"It was great. It was easy to fill out - not too many questions. So it's something nice that parents can do here at the museum. Not too time intensive." – Mother in Mind Lab, Family #46

Participants also liked the layout of the sheet and the two columns that link "What you see" (child behaviors) with "What's happening" (types of learning). Yet parents had different thoughts regarding how new or interesting the information on the Observation Sheet was. Several interviewees commented that they were already familiar with the information that the sheet was trying to convey:

"I already have a strong awareness of this sort of thing [because I work with schools]." – Father in ThinkSpace, Family #84

"I kinda know how he learns. But I think it would help a lot of parents who aren't really there all the time for their kids." – Mother in Mind Lab, Family #55

When asked if the Observation Sheet helped them find out more about how their child learns through play, 20 out of the 35 respondents said "no" or "not really." Several of these interviewees commented that they are teachers, so they were already aware of the links between learning and play. It seems likely that the museum's average visitor is fairly invested in their children's education, and therefore may have considered these types of issues before. Still, the remaining fifteen participants (43%) offered interesting commentary on the ways that the

Observation Sheet had changed their perspective on the visit. Several pointed to specific behaviors that they hadn't previously associated with learning, such as "repeating over and over" or "trial and error." Others said that it just made them pay closer attention to their children's behavior and the links between different types of play and learning:

"I thought it was interesting just to be thinking about these questions and watching her at the same time - things I may have noticed but not really thought about." – Mother in ThinkSpace, Family #73

"You come to have fun, and sometimes you don't realize how much they're actually getting out of it." – Mother in Mind Lab, Family #45

"It made me stay focused on things that I probably wouldn't have even thought to look at before." – Mother in Mind Lab, Family #44

Comments like these suggest that the Observation Sheet was having its intended effect on museum visitors who used it.

Effect of the Observation Sheet on Play

Even for those parents who said the Observation Sheet was "nothing new," it's possible that just being reminded of the information made them view the remainder of their museum visit in a different light. Although they said the sheet did not change their thinking, several of these parents and caregivers commented that it did change the way they interacted with their children during their visit to Mind Lab or ThinkSpace. Aside from just paying closer attention to their children's behavior, some interviewees also stated that the sheet encouraged them to let their child explore more on his or her own, rather than the parent providing immediate guidance. When asked if the Observation Sheet helped her play with her child in any way, one father responded:

"Well, when I was looking at this [the Observation Sheet] I stopped doing certain things because I wanted him to make adjustments on his own and do things like that, whereas if I didn't have this thing in front of me I probably would have just helped him quicker. Usually if he can't figure something out quickly, he loses attention and wants to move on to something else." – Father in Mind Lab, Family #52

Another parent described a similar reaction she had after reading the sheet:

"I was more careful to be asking questions, and not involving myself. There was a parent that walked in and just kind of took it and did it all for them, and I was like, 'Whoa, whoa, whoa!' Now there's less they're going to figure out on their own because you just showed them how to do it.'" – Mother in Mind Lab, Family #59

Interestingly, interviewees' comments show that they saw the Observation Sheet as encouraging sometimes very different kinds of parental behavior. The two parents quoted above (as well as one other) said they took a more hands-off approach after using the Observation Sheet (a strategy

for supporting their children’s learning that was evident in researchers’ observations that caregivers using the sheet were seen playing alongside and teaching their children slightly less often than those in other conditions). An equal number, however, said it encouraged them to play with their child more – another valid, but different way to support their children’s learning. Two additional respondents said that the Observation Sheet prompted them to offer more facilitating questions and encouragement to their child.

Although some parents described how the Observation Sheet changed the way they thought about playing with their child, overall, 22 out of 34 respondents said the sheet had no effect on how they interacted together. An equal number of participants said the sheet did not get in the way of playing with their child either. Twelve participants said the sheet was slightly distracting, but most of these parents also said that it was not a big issue:

“I looked at the questions, and then I played with [my son], and then I went back to it. So it wasn’t like it took away from time with him.” – Mother in ThinkSpace, Family #77

In sum, most parents did not feel that the tool prevented them from playing with their children, but rather made them more aware of how they intentionally chose to be involved in the experience. This unintended outcome is positive, since the main goal of the Observation Sheet was to support caregivers’ noticing of how their children learn through play, not change their interactions together.

Half of the participants also reported that using the Observation Sheet made them think about their museum visit in a different way. One parent said it made her want to visit the museum more often, and another said she could see how the same observations could be applied to any of the museum activities. For those who said the Observation Sheet did not change their outlook on their museum visit, many added that this was because it confirmed positive things they already thought about the museum as a place for learning.

Suggestions for Future Use

Increasing the uptake rate of the Observation Sheet might require placing the clipboards in a more immediately accessible or obvious location. In Mind Lab, this might mean moving the clipboard to the table with the Circuit Blocks activity, since this is where parents and caregivers spend the majority of their time. Combining the Observation Sheet with the Guide for Adults in some way might emphasize that this is an activity for parents to try out.

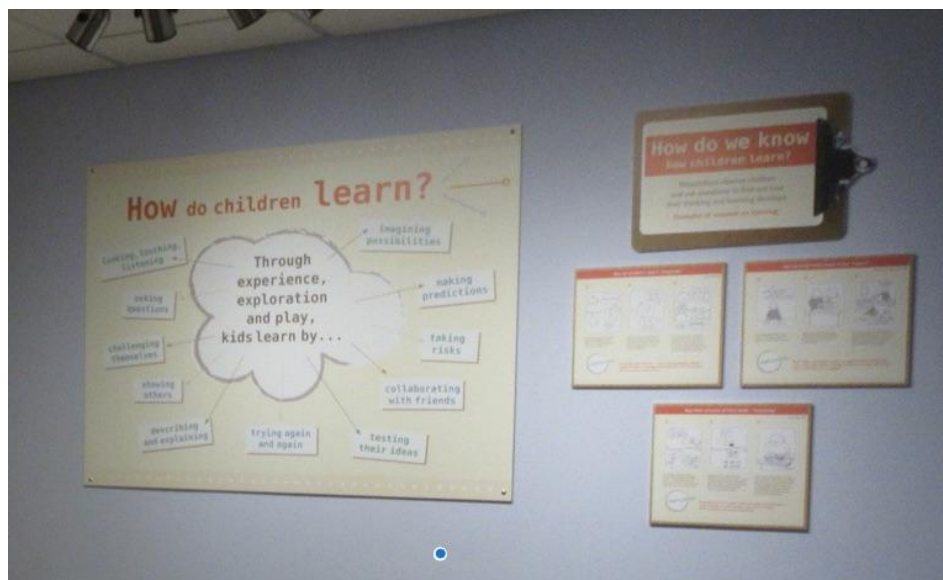
A few participants also had reactions to the Observation Sheets that were not intended by the museum. One parent reacted to the Observation Sheet as though it was a rubric for evaluating her children’s performance, and others expressed similar sentiments, commenting that the sheet identified areas where their children could improve. These parents and caregivers did not have a negative reaction to the sheet, just a different interpretation of its purpose. If the museum wishes to avoid having parents make judgments about their children’s learning, adding some simple introductory language to the sheet might help – for example, “All children express their learning differently. Which behaviors do you notice most with *your* child?”

Finally, a few interviewees in ThinkSpace commented that since their child was playing in the space alone, not all of the behaviors on the sheet applied (for example, “Watching and imitating others”). They recommended that these behaviors be placed in their own section or have a “not applicable” option that parents could check if their child was not accompanied by other children.

Mind Lab Signage

The signage in Mind Lab was another tool developed by the museum to help parents think more about their children’s learning during their visit. All signage at the museum, including in Mind Lab, is posted twice - once in Spanish and once in English. The largest sign in Mind Lab poses the question, “How do children learn?” surrounded by examples of learning activities – many of which are echoed on the Observation Sheet (see Figure 8). A series of smaller signs with the header, “How do we know how children learn?” give examples of research in cognitive development. One sign describes research on language development, another talks about the effects of different types of praise on children, and the third discusses how children help each other learn.

Figure 8. Mind Lab Signage



In addition to the wall signage, the Observation Sheet clipboard and a sign inviting visitors to use it rest on a cabinet against one side of the room. These are accompanied by an additional label highlighting cognitive development research that explicitly ties back to the Circuit Blocks activity. Here, an illustrated research summary describes findings from a study by Sobel and Sommerville on the effects of learning through discovery rather than instruction. The label includes a photo of the Circuit Blocks to encourage visitors to see connections to that activity. Finally, a hint placard for the Circuit Blocks activity rests on the table with the rest of the activity materials, as does the “Guide for Adults” – a laminated sheet that gives parents examples of facilitating questions and suggestions they can use with their children while they explore the activity (see Figure 9). Explanatory material for the Circuit Blocks activity is kept to a minimum on purpose, in order to encourage parents and children to investigate the materials, and see what

they can accomplish through play. Only three adults out of ninety interviews expressed a wish for more information on how to complete the activity (although several more thought the activity was a bit advanced for their child).

Figure 9. Mind Lab Signage - Hint Placard and Guide for Adults



Paying Attention to Signage

Similar to the findings on Observation Sheet use, the majority of parents and caregivers did not pay great attention to the Mind Lab signage unless prompted to do so by the researcher (see Table 7). Instead, their attention was largely focused on their children and the activity at hand, or occasionally on other adults in their party or on additional children outside the room. When asked, most interviewees said that they had referred to either the Guide for Adults or the hint placard on the table, but not to other signage around the room. About a quarter of participants said they hadn't looked at the signage at all.

In fact, even those parents in the signage condition (who were asked to spend a few minutes reading signs around the room before engaging with the Circuit Blocks activity) sometimes only gave the signs a minimal glance before taking a seat at the table. Others tried to read signage on the walls while remaining seated, which was nearly impossible for all but the largest sign. Several would help to get their kids started on the activity, and then got up to read the signs once their children were busy exploring. After their children had spent a long time in the Mind Lab or if seating at the table was limited, caregivers were sometimes seen looking around the room at the signs. While adults were about equally likely to read the signs in the traditional and signage condition, they were much more likely to read the Guide for Adults if they had been prompted by the researcher. Those in the Observation Sheet condition rarely read the signs or used the Guide for Adults, likely because they were already attending to the task of observing their child and noting his or her behaviors.

Children were even less likely to look at the signage or Guide for Adults than adults, likely due to the text and imagery being geared towards an older audience. When they did read a sign, children tended to look at the hint placard on the table, which was more visual rather than text-based, for guidance.

Table 7. Observed Signage Usage in Mind Lab

Does anyone in the family...	Traditional (n=30)		Observation Sheet (n=20)		Signage (n=21)	
	Adult	Child	Adult	Child	Adult	Child
Look at/read Mind Lab signage	13	7	3	0	18	2
Look at/read the Guide for Adults on table	5	1	1	0	14	2
Use hints from Guide for Adults	3	0	0	0	7	0

Parent Reactions to Signage

In practice, parents were significantly more likely to be seen playing along with or alongside their children when they had been prompted to read the Mind Lab signage first, $t(49)=-2.080$, $p=.043$ (see Appendix C, Table 18). Although not statistically significant, many other supportive parental behaviors such as facilitating, scaffolding, and teaching tended to occur more often when parents had been exposed to Mind Lab’s messaging beforehand. Parents who read the signage also tended to sit back and watch their children less than those who entered Mind Lab without looking at the signage.

Because many parents gave limited attention to the signs and may have only looked at the signage on the table, feedback from parents was somewhat sporadic. Thorough analysis of parents’ reactions to any one sign was not possible as interview questions asked about the wall signage as a whole. Parents’ comments, however, sometimes singled out individual signs that influenced their visit or their thinking, suggesting that there might be differences in caregivers’ overall reactions depending on the signs they read.

As with the Observation Sheets, several parents said they were already familiar with the information found in the signage (especially those who identified themselves as educators). Two parents expressed disinterest in the signage as a result, but others were happy to see their ideas reflected in the museum’s voice:

"I do that kind of stuff [from the Guide for Adults], so yeah, that was great. That's kinda how I roll." – Mother in Mind Lab, Family #2

"I especially liked the part about praising for working hard instead of praising for results. With our son, we have found the difference is important, and we try to praise the work instead of the results. It's hard sometimes." – Father in Mind Lab, Family #27

When asked if any of the information stood out to them or reminded them of their experiences with their own child, many parents referred to the message (repeated throughout Mind Lab) that facilitation through questions and encouragement allows children to explore and learn in ways that they would not do if the parent simply showed or gave them the answer:

“I try to hold myself back because, as parents, you want to tell them everything and just say how it is, and sometimes you have to just step back and let them make mistakes. Let them learn. We can give them clues. It's easier to just tell them, 'No, it's like this.' But then you're not giving them a chance to think.” – Mother in Mind Lab, Family #26

"The parent guide I thought was good... it kinda just reminded the parents, 'Let them do it. Don't jump in and do it for them.' It made me conscious of trying to let them figure it out on their own, and not just take over. Sometimes as parents, we do that."
– Mother in Mind Lab, Family #39

Several interviewees also referenced the large “How do children learn?” sign as one which stood out to them. This sign can be read at a glance, and the font is large enough to read from across the room. As a result, it's likely that more parents in the signage condition read this sign than the others on the walls. Although the sign does not provide in-depth information, parents seemed to like that it described familiar behaviors and was to the point:

“Some of the things seem like common sense...but it pretty much describes how [my daughter] does things, like testing, asking questions...so I can make a lot of connections between how children generally learn, and how I see her learning.” – Father in Mind Lab, Family #67

“I'm not fascinated with the intricacies of how kids learn, but that sort of gave it to you all in one concise diagram. So I really liked that. I looked at it when we first came in and thought, 'These are all things that [my daughter] can do with the activity.’” – Mother in Mind Lab, Family #21

Fewer parents appeared to pay attention to the smaller research signs, but some did have positive feedback to give on these – particularly the sign that referred to the way children respond to different types of praise:

“The piece about how you praise and how you use your words - I'm going to use that going forward, because how you word things is how they perceive it.” – Mother in Mind Lab, Family #28

Twelve of the twenty parents (60%) who participated in the signage condition interviews reported that the signs had an influence on the way they interacted with their children while in Mind Lab. Compared to those who said the same of the Observation Sheet (35%), it appears that the signage is fairly effective at leading parents to reconsider their interactions with their children around learning and play. Similar to the Observation Sheet, some parents reported that the signage made them step back and take a more hands-off approach while their children played, while others reported that it encouraged them to play with their child more:

"I think I might have backed off a little bit and let him experiment a little bit more without intervening. Just let him do the trial and error a little bit more." – Mother in Mind Lab, Family #66

"Maybe it makes me a little more active. Sometimes I'll be wanting to pick up my cell phone, and then when I think about the fact that instead of me doing something mindless I could be interacting with her and actually helping her learn." – Father in Mind Lab, Family #67

Other parents said that the signage had prompted them to use a different type of praise or to encourage their children to try new things. One mother said that the signage definitely affected her interactions with her child: "Of course [it had an effect], because anything that can give my child a chance to develop a little bit more I think is usable. I tend to read everything just to know how to do it for her and how to give her more chance of learning."

When asked if anything in Mind Lab made them think about their museum visit differently, many interviewees (15/21) replied affirmatively. Most simply gave positive feedback on the Circuit Blocks activity, saying that they liked its open-ended nature and that it encouraged creativity. A few, however, referred to positive outcomes for their own learning. One parent referred to the signage, saying she was pleasantly surprised because she hadn't expected to be the one learning when she came to the museum. Another parent said that it had encouraged him to be more interactive with his child. By comparison, parents who participated in the traditional condition (without prompting to read the Mind Lab signage or use the Observation Sheet) were much less likely to say that their experience changed the way they thought about their museum visit.

This feedback suggests parents are very receptive to this kind of information and are interested in research on children's learning. Finding the right way to present the information in a setting where parents are highly focused on their children remains a challenge.

Suggestions

As with the Observation Sheets, Mind Lab signage will probably not receive much attention from most visitors unless it is situated in a more prominent location (i.e. directly on the Circuit Blocks table) or if it incorporates more attention-grabbing features – featuring larger font or brighter colors, replacing text with visuals, or perhaps presenting the information in a different format, such as an activity for parents.

A few parents expressed confusion about the relationship between certain signs and the Circuit Blocks activity itself. The sign describing research on language development, for example, was seen as unrelated to the activity. The Circuit Blocks activity was perceived by parents as being central to the purpose of the room, as evidenced by their comments throughout their interviews. For example, when asked about the purpose of Mind Lab, many parents would default to describing the purpose of the Circuit Blocks activity, such as "to teach electrical concepts." It makes sense, therefore, that they would look for connections between each sign and the main

activity. The language development sign could possibly be replaced with one more relevant to the activity (i.e. similar to the sign that highlights how children learn how things work by making their own discoveries, and contains a picture of the Circuit Blocks activity for reference), or alternatively, the museum could find a different way to emphasize the multiple purposes of the space - not specifically to teach children about electrical circuits, but to highlight different aspects of children's learning for parents. By emphasizing greater awareness of what children do when they play in multiple formats, the museum can build a stronger connection between the Circuit Blocks activity and the goals of the Mind Lab.

Adults Thoughts on Play and Learning

Most parents and caregivers who took part in the study had a positive outlook on the relationship between play and learning, and on learning at the museum in particular. Parents' comments about the museum indicated that they thought of it as both a fun *and* educational place to bring their children, and most of them made multiple connections between play and learning – both within and outside of the museum walls.

What do children get out of play?

When asked what they thought children get out of play in general, many interviewees were overwhelmed by scope of the question at first, starting their responses with “everything” or “so much.” Some parents and caregivers found it hard to articulate exactly what children get out of play, while others rattled off a long list of benefits. It was clear, however, that respondents see play and learning as going hand-in-hand:

"I think that kids' brains get activated in a way that they don't get activated when they're just doing book learning or reading or any of those non-interactive type activities." – Father in ThinkSpace, Family #84

"They get to explore. They get to be wrong and it's okay. They get to learn from their mistakes and experiences, positive or negative. Role playing, sharing, cooperation, dealing with defeat, problem solving." – Mother in Mind Lab, Family #65

"My daughter who has severe autism, we do a natural play therapy with her. We don't do the traditional therapy, and it's wonderful. I think play is the best way to learn." – Mother in Mind Lab, Family #45

Caregivers' responses were coded using themes that emerged directly from the data. One quarter of interviewees cited social skills as a key benefit of play, such as sharing, taking turns, and cooperating with others (see Table 8). They also described play as an opportunity for children to use their creativity and imagination, a chance to explore their world and encounter new experiences, and a chance for important personal development such as building self-confidence or learning to express oneself.

Only a few parents referred to traditional learning goals that focused on content knowledge, such as math skills or information about history. Instead, most responses provided a broader definition

of learning, including some of the learning behaviors highlighted on the museum’s Observation Sheet (including using trial and error and exploring how things work).

Table 8. Interviewees' most common responses to "What do kids, in general, get out of play?" (Mind Lab and ThinkSpace combined, all study conditions)

What children get out of play:	Percentage of Respondents (N=89)
social skills (e.g. sharing, cooperating, communication)	25%
creativity and imagination	22%
exploration, new experiences	18%
personal development (e.g. perseverance, confidence, self expression)	16%
problem solving skills, trial and error	16%
fun, enjoyment, stress relief	13%
understanding of how things work, understanding of the world around them	11%

What kinds of learning happen at the museum?

Parents’ and caregivers’ responded almost unanimously that their children definitely learn when they play at the museum (the one exception being a parent who wasn’t sure since she was new to the museum and had not explored it yet). When asked what kinds of learning happen at the museum for their children, respondents again gave a wide variety of answers, many of which were similar answers to the types of benefits that children get through play: social skills, creativity and imagination, new experiences, how things work, and problem solving. Many parents (21%, n=87) also mentioned different types of content knowledge – for example, learning about history or science.

In talking about their experiences, several parents also drew contrasts between their children’s play at the museum and electronic entertainment such as television, video games, or iPads. These parents described museum activities as superior to electronic entertainment because they are interactive, educational, and social:

"It's educational – better than tv and such. They learn manual dexterity. They get to learn how different elements of things interact with each other." – Father in Mind Lab, Family #37

“It's interesting for them to learn different things while doing something fun – something different than sitting around watching tv or playing video games.” – Father in Mind Lab, Family #64

"Kids don't get enough play now. I think that they get very preoccupied with video games and technology the way it is today...I find that to be frustrating and that's why I like to take them here to play. I think it's important for them because it lets their brain develop in

different ways. It allows for creativity and problem solving skills..." – Mother in Mind Lab, Family #8

It's interesting to note that although almost all parents saw learning as an intrinsic part of their museum experience, the types of learning they identified covered a broad range of skills and topics. In many cases, they connected their answers back to specific activities they had done that day, showing that they noticed different types of learning depending on which exhibit they visited.

What does learning look like?

One of the museum's goals for parents and caregivers was to get them to notice and value the ways that their children learn through play (i.e. When is their child learning? What kinds of learning are happening? How can you tell?). During their interviews, parents were asked about things their children do or say that indicate to them that their child is learning, as this question was found to be useful during interviews conducted by PCM during the formative phase of the project. Parents gave a wide range of responses (see Table 9). The most common responses were that their children looked focused and would spend a long time at a single activity:

"I think it's their expression, I can see a serious look. They're very focused on something." – Mother in Mind Lab, Family #17

"If they stay there awhile. I tend to know that if they stay there awhile, it really means that they're exploring each thing deeper. Whether it's the cause and effect of what they're doing, whether they really like it, whether they're getting sensory input and that's what they're seeking – it's usually how I know they're very interested." – Mother in Mind Lab, Family #69

Interviewees also frequently talked about how their children use trial and error or experimentation, will ask questions, or will talk aloud about what they are doing or thinking. Parents and caregivers also shared their observations of their children's behavior over the long term – that their children have success with an activity at which they had previously struggled. One father in Mind Lab said of his daughter's learning, "I don't see it on a small scale. I see it over the course of time," suggesting that tools like the Observation Sheet might help draw attention to learning that previously went unnoticed.

Table 9. Interviewee's most common responses to "What shows you that your child is thinking or learning while they're playing?" (Mind Lab and ThinkSpace combined, all study conditions)

How I can tell when my child is learning:	Percentage of Respondents (N=91)
They look focused.	15%
They spend a long time at an activity.	15%
They ask questions.	13%
They think aloud or talk through what they're doing.	11%
They use trial and error or experimentation.	11%
They show improvement at a task over time.	9%

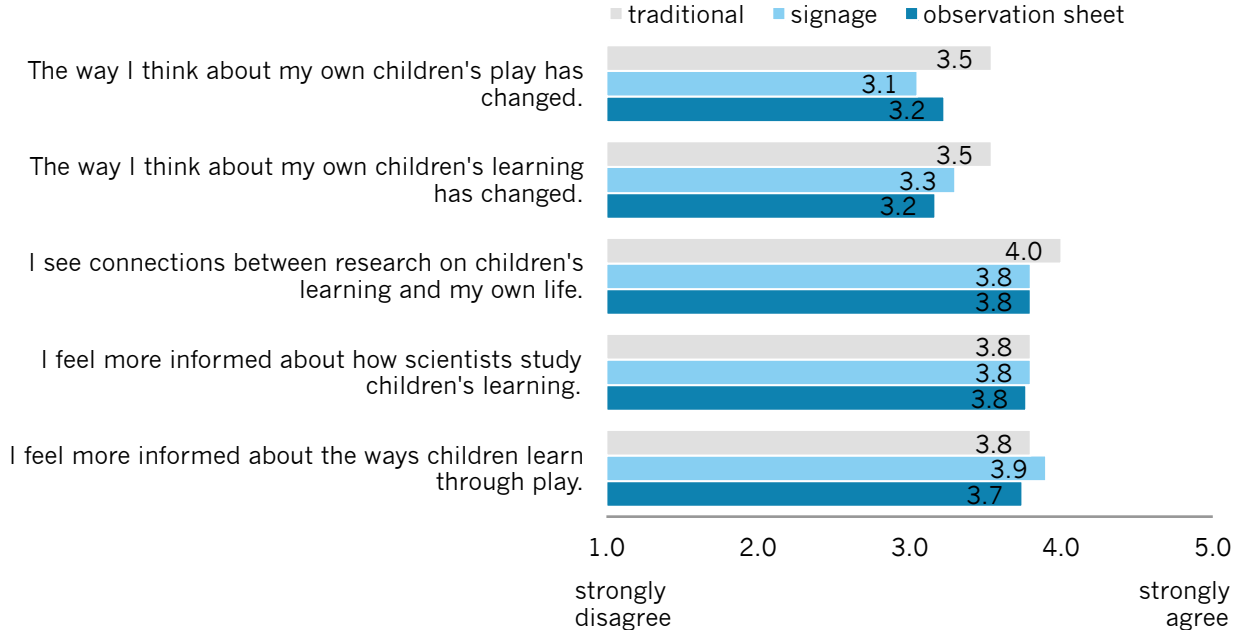
A few respondents said that when their children are learning, they are quiet and don't talk or that they will repeat an action over and over. Overall, 49 interviewees (54%) identified a behavior that was also on the museum's Observation Sheet. For those parents who had actually used an Observation Sheet, 71% (n=35) mentioned behaviors also found on the sheet, compared to 45% of parents in the signage condition (n=20) and 42% of parents in the traditional condition (n=36) (see Figure 10). These numbers suggest parents were internalizing what they learned from the Observation Sheet and that the tool reflects the kinds of behaviors that caregivers recognize as positive aspects of their children's play and learning, even if they said that the information was not new to them.

Changes in Parent Attitudes and Understandings

As a final part of the interview protocol, parents and caregivers were asked to take a brief survey to assess how their attitudes and understanding towards children's learning may have changed as a result of their experiences in Mind Lab or ThinkSpace. Parents rated their agreement with the five statements below on a five-point Likert scale, with 1 being "strongly disagree" and 5 being "strongly agree" (see Figure 10).

Overall, respondents' answers averaged between neutral ("neither agree nor disagree") and "agree" for all statements, with very little variation between the different conditions or between responses for Mind Lab versus ThinkSpace. These results are in line with participants' responses to the interview questions. Although many parents and caregivers had positive things to say about Mind Lab and the museum's tools (including signage and the Observation Sheet), many were also reluctant to say that their behavior or thinking was changed as a result, since they already were somewhat aware of the information or agreed with the messages presented.

Figure 10. Parents' Responses on Changing Attitudes and Ideas



Conclusions and Recommendations

Findings from the visitor observations and interviews suggest that the Providence Children's Museum's tools for facilitating playful learning and increasing caregivers' awareness of their children's learning are successful in several regards:

Mind Lab encourages extended and engaged play in an open-ended environment.

Children and caregivers were receptive to the Circuit Blocks activity without needing a great deal of direction or a specific end goal provided by the museum. They stayed in the space for long periods of time, trying many combinations of circuitry materials. Children appeared to progress from simple circuits to more complex configurations. Very few participants commented on the lack of instructions provided (and only parents, not children, did so). Children were content to ask for help from their parents or work collaboratively with other children. Very few children expressed frustration while playing.

The learning behaviors selected by the PCM project team are visible in children's play.

Researchers observed children in Mind Lab engaging in each of the learning behaviors through play, confirming that these behaviors are visible and have the potential to be observed by parents. However, some behaviors were observed by researchers more frequently than others, depending on the affordances of the activities within those spaces. In Mind Lab, children were significantly more likely to be seen watching and imitating, sharing discoveries, and telling others what to do, whereas in ThinkSpace, children were significantly more likely to repeat an action over and over again.

Caregivers were successfully able to identify their children's learning behaviors using the Observation Sheet

Parents who used the Observation Sheet frequently noticed their children looking focused, using trial and error and exploring with their senses. Overall, most parent observations were not statistically different from the researchers' observations. When the observations did differ, parents tended to be more likely to note a particular behavior than researchers were. Thus, the Observation Sheet helped caregivers reflect more intentionally on what their children do while they play.

Caregivers readily saw the connections between play and learning, and positioned both of these as intrinsic parts of their children's museum experience.

Whether due to their experiences in Mind Lab or with the Observation Sheet in ThinkSpace, or due to their pre-existing ideas, caregivers enthusiastically agreed that their children learn through play and that they learn at the museum.

Caregivers identified a wide range of learning outcomes for their children and often used language found in materials designed for this project to describe the kinds of learning that might happen in the Museum.

Caregivers told researchers in their interviews that learning can take many forms – from learning how a circuit works to learning how to get along with other children to learning that it’s okay to try and fail and try again. In many cases, parents described learning using language that could also be found throughout the Mind Lab signage and activities, suggesting that these resources may have helped increase parents’ valuing and awareness of the ways that children learn through play.

For example, caregivers who used the Observation Sheet in Mind Lab noticed their children focusing during play more often than those in the other conditions, even though families spent a long time in the space. Here, the tool may have helped to make this behavior visible by providing a working definition that drew parents’ attention to what to look for in their children’s play.

Caregivers described themselves as supporting their children’s learning in ways that aligned with museum goals.

Caregivers talked about offering encouragement, hints, and suggestions, and were frequently observed doing so. They talked more often about letting their children make discoveries on their own, and less often about showing their children the answers or explaining how things work. Caregivers were least likely to prompt their children to verbalize what they were thinking and doing (i.e. to reflect metacognitively), which makes sense given that increasing such behavior was not an explicit goal of the project. In the future, the museum may consider doing more targeted work in this area (i.e. more actively facilitating caregivers in support of their children’s reflection on their own thinking).

Although the information was not new to everyone, caregivers still responded positively to the messages in the Mind Lab signage and the Observation Sheet.

Most interviewees found the information relevant and useful, if not necessarily new. Many parents already saw themselves as well informed on how children learn, and how their children learn, in particular. While the information was not novel to all participants, they saw it as valuable and in alignment with their own ideas. Most participants who read the Mind Lab signage said that it changed the way they thought about their children’s learning or about their museum experience. About one third of participants who used the Observation Sheet responded this way. During their interviews, caregivers who used the Observation Sheet were much more likely to mention targeted learning behaviors than those who in the signage or traditional conditions, suggesting that this tool was successful in helping adults think about how their children learn through play. Furthermore, in Mind Lab, caregivers who read the signage beforehand were significantly more likely to play alongside or along with their children, whereas those who used the Observation Sheet were less likely to do so. Taken together, these results supports the notion that parents were absorbing the messages found in the space, and were intentionally choosing to interact or not interact with their children in ways that best supported individual children’s learning.

The evaluation study also uncovered some of the challenges to implementing these tools with children and caregivers:

Focusing caregivers' attention on signage and the Observation Sheet was difficult, as it required them to divert attention away from their children and other activities.

Unless prompted by a researcher, most parents did not read the signage on the walls of Mind Lab or pick up the Observation Sheet clipboard. Small font on some signs may have been a contributing factor, but most parents simply didn't think to read signage that wasn't directly (and obviously) associated with the activity at hand.

Using the Observation Sheet decreased interaction between some caregivers and their children.

Although most parents said that the Observation Sheet did not get in the way of playing with their children, other parents disagreed, and researchers' observations showed that parents using the Observation Sheet played with or alongside their children less often than those who did not use it. The Observation Sheet therefore does seem to somewhat affect caregivers' behavior, although not necessarily in a negative way since it also encourages them to pay closer attention to their children's learning.

Several modifications might help the museum make the most of the project's tools, and come closer to achieving all of its goals for Mind Lab and the Observation Sheet:

- **Increasing the size of signage** that highlights museum research may increase the likelihood that caregivers stop to read this information.
- **Rotating signage** may also increase caregivers' interest. Since most participants in this study were repeat visitors, having fewer (and larger) signs that change periodically might encourage them to stop and read. Interactive signage might accomplish the same objective.
- **Placing materials strategically** might increase the likelihood that caregivers use them. Moving the clipboard of Observation Sheets to a more obvious location or using larger signs to draw attention to it could help with uptake rates.
- **Offer adults the chance to be experts.** Since many parents already agree with the museum's stance on play and learning, offering them a chance to give feedback to the museum or other parents (such as a "talk back" board) within the Mind Lab space could increase their engagement in the conversation around children's learning.

Appendix A – Observation and Interview Protocols

NOTE: The protocols below are adapted from the instruments used by the Providence Children’s Museum during the formative phases of this project.

Overall Observation Protocol

Mind Lab Observations ID#: _____ Date Collection: _____

Date: _____ Start time: _____ End time: _____

Adults in group: _____ Gender/approx. age of children in group (circle target child): _____

Condition (circle one):
 Mind Lab traditional – prompted ThinkSpace traditional - prompted
 Mind Lab traditional – unprompted ThinkSpace traditional - unprompted
 Mind Lab signage ThinkSpace Observation Sheet
 Mind Lab Observation Sheet

Does anyone in the family...	Adult	Child
Look at/read the Mind Lab signage		
Look at/read the Guide for Adults on table		
Use hints from Guide for Adults		
Use Circuit Blocks		
Successfully connect a circuit		

How often do adults...	4+ times	2-3 times	Once	Never
Prompt their child to verbalize what he/she is thinking/doing				
Discuss electricity concepts with their child (Note: not just how to connect circuit blocks)				
Look at the Observation Sheet				
Check off behaviors on the Observation Sheet				

Additional notes (when/how did this happen?)

What do you see the child doing?

- | | | |
|--|--|--|
| <input type="checkbox"/> watching and imitating | <input type="checkbox"/> exploring with their senses | <input type="checkbox"/> telling others what to do |
| <input type="checkbox"/> repeating over and over | <input type="checkbox"/> thinking out loud | <input type="checkbox"/> using trial and error |
| <input type="checkbox"/> sharing discoveries | <input type="checkbox"/> looking focused | <input type="checkbox"/> expressing frustration |

How often are adults involved in their children’s play during the interaction?	4+ times	2-3 times	Once	Never
Facilitating (nonverbal, physical assistance)				
Teaching (verbal instruction)				
Playing (along with or alongside)				
Scaffolding (hints, questions, encouragement)				
Watching (without interacting)				

Overall Interview Protocol

Date: _____ Participant #: _____ Data Collector: _____

My name's _____, and today we're asking for some feedback about the activity that you just did/Mind Lab/Circuit Blocks Activity. We're asking families to check out the space for as long or as little as you like, and then we'd like to interview you about your visit. The interview will take about 10/15 minutes and is completely anonymous. As a thank you for participating, you'll get a free pass to come back to the Museum at another time.

Signage Condition: Before you begin, we'd like you to take 3-5 minutes to look at the signs on the walls and on the table. Your child can go ahead and get started while you are looking around and then you can join him/her if you wish. However you two normally visit museum exhibits together. If you need to help your child right away, go ahead and do so and then take a look at the signs. Do you have any questions before we get started?

One more quick question: Are you their legal guardian?

If no: Okay, we'll just be observing you today. No need for an interview.

1.) So, who did you come with to the museum today?

2.) How old are the children who are with you today? (circle all that apply)

Toddler / Preschooler (3-5) / 5-7 year-old / 8 and up

3.) Approximately how many times have you been to the museum this year?

First time visitor / Once or Twice / 3-5 times / 6-9 times / 10 or more times

Mind Lab Traditional & Signage Conditions Only:

4.) Had you ever been to the Mind Lab before today? *Yes* *No*

5.) So what did you think about the Mind Lab?

- a. What was the most interesting part of the Mind Lab for you and why?
- b. What was the least interesting part of the Mind Lab for you and why?

6.) What do you think about the Circuit Blocks Activity?

- a. What was the most interesting part of the Circuit Blocks Activity for you and why? For your child?
- b. What was the least interesting part of the Circuit Blocks Activity for you and why? For your child?
- c. Was there anything about the activity that helped you play with your child today?
- d. Was there anything about the activity that got in the way of playing with your child today?

Mind Lab Signage Condition Only:

7a.) We asked you to look at the signs in the room at the beginning of your visit to the Mind Lab.

- a. Did any of the information stand out or remind you of your own child? If so: Like what?
- b. Was there any information that was confusing or that you wanted to find out more about?

c. Did reading the signs change how you interacted with your child in the Mind Lab in any way? If so, how?

Mind Lab Traditional Condition Only:

7b.) Did you read any of the signs or the Guide for Adults around the Circuit Blocks Activity today? (circle all that apply) *Signs* *Guide for Adults* *None*

a. If yes: Did any of the information stand out or remind you of your own child? If so: Like what?

8.) What do you think the purpose of the Mind Lab is? What is it trying to show you or your child?

a. Did anything in this room make you think about your museum visit in a different way?

b. What did you get out of your Mind Lab visit today?

Mind Lab Traditional & Signage Conditions Only:

9.) What do you think the purpose of the Circuit Blocks Activity is? What is it trying to show you or your child?

a. Why do you think they museum placed this activity here in the Mind Lab?

b. Besides maybe learning something about circuits, what do you think your child got out of playing with the Circuit Blocks Activity today? [Prompt: What did you see or hear that makes you think so?]

Mind Lab Observation Sheet, ThinkSpace Observation Sheet, & ThinkSpace Traditional Conditions Only:

10.) What was your role while your child was playing in this space today?

11.) What do you think your child got out of playing in this space today? [Prompt: What did you see or hear that makes you think so?]

All Conditions:

12.) Did you notice anything about how your child was playing in this space/with the Circuit Blocks Activity today? Like what? [Prompt: What was he/she doing? What was he/she trying to accomplish?]

a. What did you get out of playing in this space/the Circuit Blocks Activity today?

Now, I'd like to ask you some questions about how your kids play at the museum.

13.) What do you think, in general, kids get out of play?

a. Do you think your kids learn when they play at the museum? *If yes:*

i. What kinds of learning do you think happens when they play at the museum?

ii. What shows you that your kids are really thinking or learning when they're playing? [Prompt: What do you see them do or hear them say?]

Mind Lab Only:

iii. Was there anything about the Mind Lab that helped you find out more about how your child learns through play? Like what?

iv. Was there anything about the Circuit Blocks Activity that helped you find out more about how your child learns through play? Like what?

v. In what ways, if any, did the Circuit Blocks Activity help your child learn through play?

All Conditions:

If no: Can you explain a bit more?

14.) Have you heard anything about the research that goes on at the museum? Like what?

If you have time before you go, I have a brief survey for you to fill out.

Please rate your level of agreement with the following statements:

<i>After visiting the Mind Lab/Circuit Blocks Activity/this space...</i>	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
I feel more informed about the ways children learn through play.					
I feel more informed about how scientists study children's learning.					
I see connections between research on children's learning and my own life.					
The way I think about my own children's learning has changed.					
The way I think about my own children's play has changed.					

Observation Sheet Condition Only:

I have a few more questions about the observation sheet that you used today.

15.) So, what did you think about the observation sheet?

- a. What was the most interesting part of the observation for you and why?
- b. What was the least interesting part of the observation sheet for you and why?

- c. Was there anything about the observation sheet that helped you play with your child today?
- d. Was there anything about the observation sheet that got in the way of playing with your child today?
- e. Did any of the information on the observation sheet stand out or remind you of your own child? If so: Like what?

16.) What do you think the purpose of the observation sheet was? What is it trying to show you?

- a. Did the observation sheet make you think about your museum visit in a different way?
 - i. Was there anything about the observation sheet that helped you find out more about how your child learns through play? Like what?
 - ii. In what ways, if any, did the observation sheet help your child learn through play?

Thanks for your help today!

Appendix B – Observation Sheet for Caregivers

Observing Your Child's Play

Through play, kids develop and practice many “thinking” and “problem-solving” behaviors.

Mark how often you see these behaviors in your child's play.

By observing carefully, you can discover a lot about kids' developing skills and ideas.

Child's age 5

What do you see?



What's happening?

	A LOT	A LITTLE	NONE	
Exploring with their senses	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Kids are figuring out what things can do.
Watching and imitating others	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	Kids are getting new ideas to build on.
Thinking out loud	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	Kids are using words or sounds to describe what they're thinking.
Telling others what to do	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Kids are strategizing and sharing ideas through words or actions.
Using trial and error	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Kids are making adjustments to improve what they're working on.
Repeating over and over	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Kids are exploring cause and effect and practicing new skills.
Looking focused	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	Kids are concentrating on their interests or challenges.
Expressing frustration	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	Kids are noticing when their plans aren't quite working out.
Sharing discoveries	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	Kids are reflecting on their learning and telling others about it.

Add other notes about what you see.

She was eager to show and explain to me but when bigger kids were here she just watched

What's most interesting to you about what you noticed?

When adults get involved it's less interesting

Appendix C – Detailed Findings

Table 10. Size of Groups Observed by Evaluation Team by Research Condition and Museum Space

Research Condition	Mind Lab		ThinkSpace	
	Avg Number of Adults	Avg Number of Children	Avg Number of Adult	Avg Number of Children
Traditional	1.27	2.03	1.21	1.71
Signage	1.33	1.81	N/A	N/A
Observation Sheet	1.40	1.80	1.33	1.60

Table 11. Target Child Gender by Research Condition and Museum Space

Research Condition	Mind Lab		ThinkSpace	
	Male	Female	Male	Female
Traditional	17	13	7	7
Signage	13	8	N/A	N/A
Observation Sheet	15	5	7	8

Table 12. Target Child Age by Research Condition and Museum Space

Research Condition	Mind Lab	ThinkSpace
	Average Age	Average Age
Traditional	6.07	4.14
Signage	5.57	N/A
Observation Sheet	6.20	5.87

Table 13. Children's Actions by Condition*

Children's Actions	Mind Lab			ThinkSpace	
	T	Ob	S	T	Ob
Sharing discoveries	80%	75%	95%	64%	60%
Watching and imitating	53%	70%	81% ^a	36%	33% ^a
Repeating over and over	37%	30% ^b	24% ^{cd}	79% ^{bc}	73% ^d

Exploring with their senses	87%	100%	100%	86%	100%
Thinking out loud	73%	70%	62%	57%	60%
Looking focused	77%	90%	90%	71%	87%
Telling others what to do	40%	25%	29%	7%	13%
Using trial and error	70%	60%	90%	64%	93%
Expressing frustration	10%	5%	19%	14%	13%

abcd indicates a significant difference at the $p < .05$ level

* T= Traditional, S = Signage, Obs = Observation Sheet

Table 14. Parental Behaviors Across Study Conditions**

How often are adults involved in their children's play during the interaction?	Mind Lab			ThinkSpace	
	T	Ob	S	T	Ob
Facilitating (nonverbal, physical assistance)	1.03	0.80	1.43	1.57	0.93
Teaching (verbal instruction)	2.00	1.25	2.10 ^a	1.36	1.00 ^a
Playing (along with or alongside)	1.23	0.85 ^b	1.95 ^{bc}	1.14	0.67 ^c
Scaffolding (hints, questions, encouragement)	2.07	2.00	2.57	1.79	2.13
Watching (without interacting)*	0.43	0.35	0.24	0.71	0.73
Prompt their child to verbalize what he/she is thinking/doing	0.90	0.20	0.76	0.64	1.00

abc indicates a significant difference at the $p < .05$ level

* Was a significant difference at the $p < .05$ level with no clear pattern within posthoc comparisons; 0= Behavior was not observed, 1 = Behavior was observed during interaction

** On a scale from 0 to 3, with 0 = Never, and 3 = 4+ times; T= Traditional, S = Signage, Obs = Observation Sheet

Table 15. Families' Use of the Circuit Blocks Activity

Does anyone in the family...	Traditional		Observation Sheet		Signage	
	Adult	Child	Adult	Child	Adult	Child
Use Circuit Blocks Activity	16	28	9	20	11	21
Successfully Connect Circuit Blocks	11	25	7	19	10	18

Table 16. Children's Actions in Mind Lab and ThinkSpace As Originally Recorded by Parents**

Children's Actions	Mind Lab (N=20)	ThinkSpace (N=16)	Significance Level*
Watching and imitating	1.30	1.00	.204
Repeating over and over	1.25	1.31	.806
Sharing Discoveries	1.30	1.44	.598
Exploring with their senses	1.50	1.94	.011*
Thinking out loud	1.30	1.06	.375
Looking focused	1.70	1.75	.797
Telling others what to do	0.85	0.69	.532
Using trial and error	1.40	1.75	.111
Expressing frustration	0.65	0.69	.852

* Indicates a significant difference at the $p < .05$ level

**0 = Never, 1 = Once, 2 = More Than Once

Table 17. Parental Behaviors With and Without Using the Observation Sheet **

How often are adults involved in their children's play during the interaction?	Parents w/o Observation Sheet (N=65)	Parents w/ Observation Sheet (N=35)	Significance Level
Facilitating (nonverbal, physical assistance)	1.28	0.86	.080
Teaching (verbal instruction)	1.89	1.14	.002*
Playing (along with or alongside)	1.45	0.77	.006*
Scaffolding (hints, questions, encouragement)	2.17	2.06	.637
Watching (without interacting)***	0.43	0.51	.478
Prompt their child to verbalize what He/she is thinking/doing	0.80	0.54	.230

* Indicates a significant difference at the $p < .05$ level

** On a scale from 0 to 3, with 0 = Never, and 3 = 4+ times

*** 0 = Behavior was not observed, 1 = Behavior was observed during interaction

Table 18. Parental Behaviors in Mind Lab With or Without Prompting to Read Signage**

How often are adults involved in their children's play during the interaction?	Traditional Mind Lab Condition (N=30)	Mind Lab Signage Condition (N=21)	Significance Level
Facilitating (nonverbal, physical assistance)	1.03	1.43	.223
Teaching (verbal instruction)	2.00	2.10	.783
Playing (along with or alongside)	1.23	1.95	.043*
Scaffolding (hints, questions, encouragement)	2.07	2.57	.100
Watching (without interacting)***	0.43	0.24	.252
Prompt their child to verbalize what he/she is thinking/doing	0.90	0.76	.653
Discuss electricity concepts with their child	0.93	0.85	.804

* Indicates a significant difference at the $p < .05$ level

** On a scale from 0 to 3, with 0 = Never, and 3 = 4+ times

***0= Behavior was not observed, 1 = Behavior was observed during interaction