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ABSTRACT

Increased recognition of the need to study child development outside of research labs in naturalistic contexts has led to the formation of partnerships between researchers and museums. Researcher–museum partnerships provide researchers access to families and naturalistic contexts in museums to study learning and social development. Although benefits for researchers are well established, benefits for the museum and museum visitors are less clear. To investigate the potential benefits of research exhibits for museum visitors, we compared the impacts of a research toy exhibit and permanent museum exhibits on parents and caregivers attending a children's museum. Although caregivers reported that their children had less fun at the research exhibit, caregivers learned more at the research exhibit and reported that the research exhibit raised more questions and had greater relevance to them compared with permanent exhibits. Caregivers who visited research exhibits were also more likely to be reminded of and to apply ideas from the exhibit to their daily life compared to those who visited permanent exhibits. Our findings support the unique benefits of research exhibits for caregivers and indicate a need to showcase potential learning opportunities for visitors in future researcher–museum partnerships.

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Researcher–museum partnerships; science outreach; science communication; children's museums; visitor experience

Interest in the science of child development has increased dramatically in recent decades. At the same time, research on child development has broadened the focus from the individual child to the child in naturalistic contexts.[1] In museums, children engage in learning and reasoning about materials, tools, and scientific concepts. Museums can also facilitate spontaneous peer and family interactions, making the museum context a more naturalistic and child-driven environment for studying development than the lab or school.[2] For example, observations and manipulations of the style of family interactions during museum visits have shown how family conversations contribute to children's learning and development.[3] Thus, museums provide an important window into experiences and interactions that shape children's learning and development that are not easily observed or constructed by researchers.

Researcher–museum partnerships

In response to the growing recognition of the unique research opportunities afforded at museums, developmental scientists are forming partnerships with children's museums to conduct research on child development.[4] Researcher–museum partnerships provide clear and direct benefits to researchers and scientists. In most partnerships, museums provide researchers access to children and families for child development studies, allowing them to recruit population samples that are larger and less costly than studies conducted in the lab.[5] Museums also provide researchers a rich source of naturalistic contexts within which to study child development.[6] Researchers also gain experience conducting field research by conducting studies outside of the lab and communicating with lay audiences, including museum staff.[7] Studying children in museums also allows researchers to map development across a wide age span and establish norms with large and diverse samples.[8]

In contrast, direct benefits to museums and caregivers whose children participate in museum-based studies, and the immediacy of such benefits, may be less clear. Research partnerships bring developmental scientists into museums; these scientists can engage families and museum staff to discuss findings on child development with individuals who could most benefit. Prior research on researcher–museum partnerships showed that caregivers of children who participated in a research exhibit reported positive experiences, that they learned something new, and found the research to be relevant to their own lives and the museum experience.[9] In this prior work, participating families were recruited by indicating a desire to provide museum feedback, and interviews were conducted in person with the researchers and museum staff. These interview dynamics may have encouraged participating families to give more positive feedback to please researchers and museum staff, whereas they might have been more critical if the interviews had been anonymous or conducted with a non-museum-affiliated third party. Moreover, caregivers were only asked about research exhibits, so it remains unclear whether such exhibits provide unique benefits to caregivers relative to permanent museum exhibits.[10]

The goals of the present study were to identify the benefits of research toy exhibits for caregivers and to test whether such benefits are unique relative to those of permanent museum exhibits. Research toy exhibits are temporary museum exhibits constructed within the museum that incorporate toys to demonstrate and communicate findings in child development research with museum visitors. We adapted an exhibit developed for the National Living Lab Initiative[11] in which staff and caregivers encourage children to complete a puzzle-building activity while researchers communicate findings on different types of child praise with caregivers.[12] We surveyed caregivers on their experiences with the museum, the research exhibit, and a permanent museum exhibit. Importantly, caregivers were recruited for the survey by a separate team member wearing a museum staff shirt and not visibly associated with the research project. Caregivers completed the survey online and after their museum visit to encourage more honest reporting. We hypothesized that research toy exhibits stimulate caregivers' interest in the science of child development and that caregivers find such exhibits to be uniquely relevant to their daily lives compared with permanent museum exhibits. If so, this would provide evidence for the direct benefits of researcher–museum partnerships to museums and their visitors.

Assessing the impact of research toy exhibits at museums

Survey respondents

Data collection spanned 16 months (November 2016 – March 2018). Table 1 provides the demographic characteristics of the respondents. Respondents were primarily female (84%), White (85%), and high-income, with the majority making over $70,000 per year. Most were well-educated, with at least a college degree. Children who visited the research toy exhibit tended to be 3–4 years old (mean = 3.7 years; range: 1–8 + years). When multiple children were present, age was coded as the oldest child in the group. Demographics of survey respondents were representative of the typical museum population.

Constructing the research toy exhibit

On days in which the museum featured the research toy exhibit, researchers constructed the exhibit on the museum floor in a centralized museum location but separated from other permanent exhibits (Figure 1). The research exhibit consisted of a table with colored blocks and cards depicting various puzzles made from the blocks. Two researchers staffed the research toy exhibit, sitting on one side of the table, and small chairs were placed on the other side for children and caregivers. A sign with "Meet a Scientist" was posted on a pole adjacent to the exhibit to attract visitors and invite discussion. Exhibits were typically constructed on a weekday and were available for 2–3 hours.

When children approached the exhibit, one researcher would engage with the child by explaining the blocks and puzzles and asking whether they wanted to complete a puzzle. Another researcher then engaged caregivers to discuss research findings on caregiver praise.[13] Caregivers were also encouraged to interact with their children while they attempted puzzles. When children lost interest, caregivers were offered an information sheet providing further details on the influence of caregiver praise in lay terms, and caregiver and children were offered a sticker for stopping by the exhibit.

Table 1. Demographic characteristics of survey respondents.

Characteristic	Percentage
Gender	
Female	84
Male	16
Ethnicity	
White	85
Asian	6.5
Hispanic/Latino	6.5
Black	2
Education	
High School Diploma	5
Some College	6
Completed College	39
Some Graduate Work	6
Graduate Degree	44
Income	
Above $70,000/year	71
Below $70,000/year	29

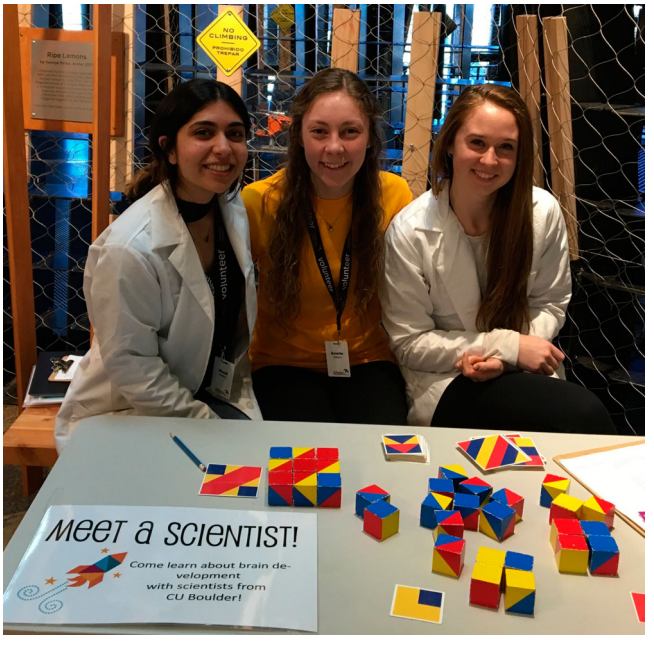

Figure 1. The research toy exhibit at the Children's Museum of Denver, Marsico Campus.

A third researcher was stationed at the museum exit. Caregivers identified as having visited the research exhibit via stickers were asked about their willingness to provide an email address to participate in an anonymous online survey about guest experiences. Those who opted to participate were provided with two museum passes and were entered into a raffle for a $100 gift card once the survey was completed. To prevent direct associations between the feedback survey and the research exhibit, researchers asking for caregiver emails wore a museum staff shirt.

Caregiver survey

We collected both qualitative and quantitative feedback from caregivers via a 41-question online survey. Caregivers were asked demographic questions and about their general experience at the museum and interest in child development research. In addition, targeted questions about our research exhibit and a permanent museum exhibit were asked to allow comparisons between the two types of exhibits. We confirmed participants had actually visited the exhibits of interest by presenting photographs of each exhibit and asking whether participants had visited that exhibit during their last trip to the museum. Three different permanent museum exhibits were available within the survey for potential use as the permanent museum exhibit comparison. These comparison exhibits were selected based on their popularity at the museum to maximize the likelihood that caregivers had visited them. These exhibits were presented one by one to caregivers at the start of the survey, starting with *Bubbles,* then *Kinetics,* and finally *Water*. The first permanent exhibit confirmed as having been visited was used for the comparison contrast.

Eight outcomes were examined. For the first five outcomes, caregivers responded on a 6-point Likert scale to the following questions about each exhibit: "How much fun do you think your child(ren) had at this exhibit?"; "How interesting was this exhibit to you, as a parent?"; "Do you feel that – as a parent – you learned anything new from this exhibit?"; "Did this exhibit raise any questions for you about how people think or act?"; and "How relevant or personally meaningful was this exhibit to your everyday life as a parent?". Likert responses were anchored with "Definitely did NOT [have fun, learn anything, etc.]" and "Definitely did [have fun, learn something, etc.]." Although the survey language was directed towards parents, other caregivers, such as grandparents, also completed the survey. All responses from caregivers were included.

For the three remaining outcomes, caregivers responded to yes/no questions about their experiences since visiting the museum: "Since your visit, have you talked with anyone about something related to an exhibit?"; "Since your visit, has anything that you have seen or done reminded you of this exhibit?"; and "Since your visit, have you applied ideas or information gained from this exhibit in your interactions with your child?". All eight questions included an open text box for caregivers to provide additional information about their responses. The authors reviewed these open text responses to determine whether caregivers referenced the research exhibit or permanent museum exhibit.

After completing questions on the research exhibit and one permanent museum exhibit, the survey concluded. The survey was administered using SurveyMonkey (San Mateo, CA).

Analytic approach

We compared responses to the research exhibit and comparison exhibit for the eight primary survey questions described above. For questions using a Likert scale response, we tested for significant differences between exhibits using Wilcoxon signed-rank tests, which assess the size of the difference between responses to the same question for the two different exhibits for each individual. For Yes/No response questions, we tested for differences between exhibits using McNemar's chi-square tests, which assess differences in the proportion of "Yes"/"No" survey responses for each exhibit. If participants responded "Not sure" or "I don't know," we excluded these participants from analyses. All data, analysis code, and materials can be found on the project's Open Science Framework page (osf.io/g4kn8/). All data collection procedures were approved by the University of Colorado Boulder's Institutional Review Board.

Assessing benefits of research toy exhibits for caregivers

Overall, 72 individuals responded to the questionnaire. Missing data on individual items ranged from 2% to 40%. Comparison museum exhibits included *Bubbles* ($N = 43$), *Kinetics* ($N = 15$), and *Water* ($N = 2$). Significant differences were observed between the comparison permanent exhibits for caregivers' reported learning ($F_{(2,56)} = 3.88$, $p = .027$), which was due to caregivers reporting more learning at the *Kinetics* exhibit (Mean = 3.73) than the *Bubbles* exhibit (Mean = 2.74) ($p_{\text{adjusted}} = .034$; Tukey's Honest Significant Differences test). Caregiver responses were similar across permanent museum exhibits for all other survey questions. To test for differences between the research toy exhibit

and permanent museum exhibits, all comparison exhibits were combined into a single "comparison" category for analysis.

Comparing research toy and permanent museum exhibits

Although caregivers indicated that their child(ren) had significantly more fun at the comparison exhibit relative to the research exhibit ($p < .001$), caregivers themselves were significantly more likely to learn something new ($p < .001$), have questions raised about how people think or act ($p < .001$), and find relevance and personal meaning in everyday life, in response to the research exhibit relative to the comparison exhibit ($p < .001$; Figure 2).

The majority of caregivers (71%) indicated that they found the research exhibit very interesting or extremely interesting (a 5 or 6 on the Likert scale). One caregiver reported: "I love that they were trying to educate the [g]uest on growth mindset. I find this topic so important in helping shape a growing child's mind. :)." Another caregiver stated: "I appreciated that the museum is sharing important research with parents." Another caregiver emphasized the lasting impact of the research exhibit: "The fact that I knew that the students were studying in college and it allowed me to elaborate on the experiment with my kids later. I love when I can continue discussions at home with my kids." These comments reinforce findings that caregivers were interested and appreciative of the research exhibit and that the impact of the research exhibit persisted following the museum visit. Caregiver interest in the permanent museum exhibits appeared to be focused on children's learning and engagement rather than adult experiences: "I loved the different ways to make bubbles and measuring the bubbles"; "Just the way it is set up to engage the kid"; and "Watching how big the wall bubbles could get and seeing my son make his own bubbles with the tables and wands".

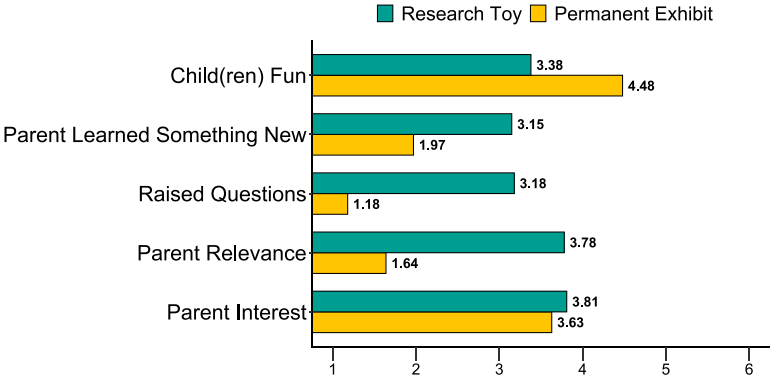

Figure 2. Caregiver responses on a 6-point Likert scale (1: Definitely did NOT [have fun/learn anything/etc.]; 6: Definitely did [have fun/learn something/etc.]) to five questions for the research toy exhibit and permanent museum exhibit. Number labels are the average response scores for each question. While caregivers reported children as having more fun at the permanent museum exhibit, they reported the research toy more highly for learning something new, raising questions about how people think or act, and relevance and personal meaning in everyday life. Caregivers rated the research toy and permanent exhibit as similarly interesting.

About half of caregivers reported that they definitely or almost definitely learned something new from the research exhibit (46.2%) and that the research exhibit definitely or almost definitely raised questions for them about how people think or act (41.5%). Caregivers' elaborations indicated that the research exhibit raised important questions about caregiver and adult behavior. For example, one caregiver noted "The importance of how the simplest word dictated to a child can have a lasting impact on how he or she will take on a challenge." One caregiver noted that the research exhibit made them more aware of interactions with their children: "It made me more aware of what I praise my girls for (and others too … other kids and even adults) and I would like to pay more attention to how other adults and teachers praise". Another caregiver raised questions about how children will be praised by people other than their caregivers: "How do I praise our daughter? How can I best phrase my praise for her effort? Which types of praise will she receive at school, activities, etc. and how can respond?" Caregivers' elaborations on the permanent museum exhibit focused on differences between children and the exhibit materials: "Made me think about just how different kids are when figuring out all of the different stations, how they work, what you can do, etc.", and "How to increase the size of the bubbles at the table! And the part that has oxygen with it!".

Finally, most caregivers (69.8%) found the research exhibit to be extremely relevant or meaningful to their everyday lives. Caregiver responses indicated that the research exhibit influenced their own behavior. For example, one caregiver stated: "I worry a lot about raising my girls with a positive attitude, hoping that they will be confident and adventurous and strong. I think that using more meaningful praise is a pretty easy step to take to get to those goals." Caregivers appreciated that the exhibit was meaningful to their lives: "Very much so! I feel not only children should develop growth mindsets but us adults too. It is so much more difficult for us to break out of our own egos at times. I must say my children have been my biggest teachers in re-learning this for myself." Another caregiver noted: "It helped me to think critically about how I respond to my children and the type of feedback I provide." For the comparison exhibit, caregiver responses focused on child exploration: "It's extremely important to me that my child always be curious and that she and I can have learning adventures together." and "It's always a helpful exhibit to encourage wondering."

Caregiver experiences after the museum visit

When reporting on their experiences since visiting the museum (Figure 3), a greater proportion of caregivers (80%) had applied ideas or information gained from the research exhibit to interactions with their child(ren) or other than ideas or information gained from the permanent museum exhibit (11% of caregivers). This difference was statistically significant ($\chi^2 = 26.28$, $p < .001$). A greater proportion of caregivers also reported being reminded of the research exhibit than the museum exhibits (55% of caregiver for the research exhibit; 25% for the permanent exhibit). This difference was also statistically significant ($\chi^2 = 7.56$, $p = .006$). Caregivers did not significantly differ in discussing the research and museum exhibits with their children or others (14% discussed the research exhibit; 21% discussed the permanent exhibit; $\chi^2 = 0.50$, $p = .48$).

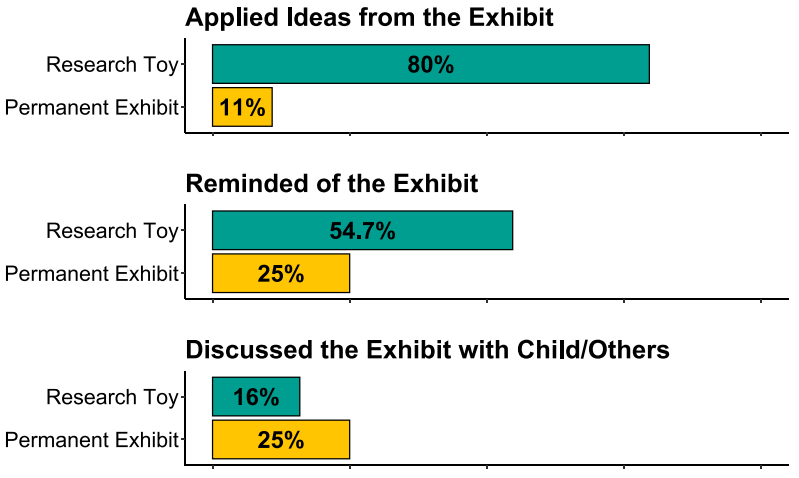

Figure 3. Comparisons of responses to dichotomous questions about experiences after the museum visit related to the research toy and permanent exhibits. Percentages of "Yes" responses are shown. A significantly higher proportion of caregivers responded "Yes" to being reminded of the research exhibit and applying ideas from the research exhibit compared with the permanent exhibit, and caregivers responded similarly to discussing the exhibit with their child or others.

Museum visitors are interested in child development research

We assessed the impact of research exhibits on caregivers' learning and experiences at children's museums. Caregivers reported high overall interest in the research exhibit. Compared with other permanent exhibits at the museum, caregivers in the research exhibit were more likely to learn something new, have questions raised about their behavior and others', and found the research exhibit more relevant to their everyday life. Caregivers were also more likely to be reminded of and remember and apply what they learned at the research exhibit in their daily lives relative to permanent exhibits. Our results support extensive prior work demonstrating that museums and well-designed museum exhibits facilitate family learning about science.[14] Here, we show that research toy exhibits provide unique benefits to museums and museum visitors relative to permanent museum exhibits and that families are receptive learners of child development research during visits to children's museums.

Stimulating caregivers' interest and engagement in the science of child development through researcher–museum partnerships could lead to a multitude of downstream effects.[15] Increasing caregivers' metacognitive awareness of children's learning processes could increase their effectiveness in facilitating learning opportunities, and as a result, children's learning.[16] Such effects could play out both in the museum and beyond. Appreciating the impact that exhibits may have on children's learning may lead to different caregiver behaviors in the museum itself.[17] For example, children learn more when caregivers discuss contents of museum exhibits with them after the visit and when caregivers find connections between museum exhibits and children's lives.[18] Engaging caregivers about child development could lead to increased engagement from caregivers while visiting the museum, as well as after the museum visit.

Researcher–museum partnerships benefit museums

Our results could support future researcher–museum partnerships by demonstrating their value to stakeholders other than the researcher.[19] Research exhibits provide caregivers with unique learning experiences at the museum that are not available through traditional permanent museum exhibits, which could thereby boost memberships and attendance. Such benefits may make museums more motivated to partner with researchers. The benefits of research exhibits relative to permanent exhibits documented here also represent a unique way in which researcher–museum partnerships serve the overall mission of museums to engage the communities they serve and improve public understanding of science.

Several caveats apply for generalizing our findings on the benefits of research exhibits for caregivers and caregivers in children's museums. First, the effects we report here could be driven in part by the specific research toy used, which focused on caregiver behavior and also may not apply when research exhibits focus strictly on data collection or other research topics. Further, the research exhibit involved direct interaction with research staff, whereas the other comparison exhibits typically did not involve direct engagement with museum staff. Interactive interventions with permanent exhibits could show similar benefits. Because most caregivers reported a high level of education, they may have been more familiar with the concept of growth mindset or have more experience engaging with psychological research than other populations. However, our findings do indicate that caregivers willingly and meaningfully interact with scientists in museum settings. Although we attempted to minimize associations between the research exhibits and the survey to preserve honest responses, the survey's focus on the research exhibit and survey recruitment (which occurred only on days in which the research exhibit was present) could have influenced survey responses. Future studies can help to elucidate whether developmental research less relevant for caregiving is similarly beneficial to museum visitors. Direct communication with research staff with caregivers could lead to greater caregiver interest in permanent museum exhibits. Staffing permanent museum exhibits could increase caregiver engagement at these exhibits, even when the exhibit themes are not directly related to caregiving or child development. These possibilities, as well as their downstream impacts on child learning while at museums, should also be explored in future work.

Our findings support the unique benefits of research exhibits beyond permanent museum exhibits. Researcher–museum partnerships can provide unique educational opportunities for museum visitors, which helps to serve a common aim of museums. Caregivers visiting the children's museum were a receptive audience for research staff and the research exhibit. These caregivers were very interested in learning opportunities not only for their children but also for themselves. When visiting the museum, caregivers were able to engage directly with scientific research and reported discussing and applying ideas they learned at the research exhibit in their daily lives after the museum visit. Our findings indicate that children's museums provide good settings to maximize the impact of research findings on child development by sharing developmental research with interested audiences. Showcasing potential learning opportunities for caregivers at research exhibits should be a priority for future researcher–museum partnerships.

Notes

1. Bronfenbrenner, "Toward an Experimental Ecology of Human Development"; Rogoff, "The Cultural Nature of Human Development."
2. Henderson and Atencio, "Integration of Play, Learning, and Experience"; Tõugu et al., "Connecting Play Experiences and Engineering Learning."
3. Callanan et al., "Exploration, Explanation, and Parent–Child Interaction in Museums"; Callanan and Valle, "Co-Constructing Conceptual Domains"; Chandler-Campbell et al., "Investigating Science Together"; Gelman et al., "Beyond Labeling"; Williams and Sparks, "Collaborative Inquiry at a Children's Museum."
4. Beaumont et al., *National Living Laboratory*; Callanan, "Conducting Cognitive Developmental Research in Museums"; Corriveau et al., *Living Laboratory*®; Doctors and Carter, "Small Museums and Community Partnerships"; Sobel and Jipson, *Cognitive Development in Museum Settings*.
5. Beaumont et al., *National Living Laboratory*.
6. Benjamin, Haden, and Wilkerson, "Enhancing Building, Conversation, and Learning"; Letourneau et al., "What Do Caregiveres Notice and Value"; Song et al., "Parents' and Experts' Awareness of Learning Opportunities."
7. Williams and Sparks, "Collaborative Inquiry at a Children's Museum."
8. Frank, Vul, and Saxe, "Measuring the Development of Social Attention."
9. Lussenhop, Cahill, and Kipling, *National Living Lab Broad Implementation, Year 1*; Lussenhop et al., "Social Participation of Families with Children."
10. Lussenhop, Cahill, and Kipling, *National Living Lab Broad Implementation, Year 1*.
11. https://livinglab.org/.
12. Beaumont et al., *National Living Laboratory*; Mueller and Dweck, "Praise for Intelligence Can Undermine Children's Motivation and Performance."
13. Mueller and Dweck, "Praise for Intelligence Can Undermine Children's Motivation and Performance."
14. Burun, Chambers, and Cleghorn, "Families are Learning in Science Museums"; Borun et al., "Enhancing Family Learning through Exhibits."
15. Wood and Wolf, "Between the Lines of Engagement in Museums."
16. Thomas and Anderson, "Parents' Metacognitive Knowledge."
17. Knutson and Crowley, "Museum as Learning Laboratory."
18. Anderson et al., "Children's Museum Experiences"; Benjamin, Haden, and Wilkerson, Enhancing Building, Conversation, and Learning; Haden, Talking about Science in Museums.
19. Haden, "Talking about Science in Museums."

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