

Museums, Conversations, and Learning

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Abstract

In this study, 178 groups of visitors were interviewed and recorded during their visits to museums. Three clusters of elements were shown to influence learning: the *identity* of the visitors, their response to the *learning environment*, and their *explanatory engagement* during the visit. A structural equation model using these variables fit well. Further examination revealed that not all conversational behavior was supportive of learning; some actions, such as making frequent personal connections, were detrimental to learning; additionally, silent contemplation was modestly associated with learning. This paper discusses these findings through the experiences of four couples whose outcome measures placed them at the extreme high or low end of the learning distribution.

Keywords: informal learning, conversation, museums, science education.

Resumen

En este estudio participaron 178 grupos de visitantes a museos. Tres tipos de elementos mostraron una fuerte influencia en el aprendizaje: la *identidad* del visitante, la respuesta al *ambiente de aprendizaje* y el *involucramiento explicativo* durante la visita. Un modelo de ecuaciones estructurales que incluía estas variables tuvo un buen nivel de ajuste. Una revisión más profunda reveló que no toda la conducta conversacional respaldó el aprendizaje; algunas acciones, como hablar sobre historias personales, lo afectaron negativamente. Además, la contemplación silenciosa estuvo asociada con el aprendizaje. Estos descubrimientos son el resultado del análisis de las experiencias de cuatro parejas cuyo desempeño estuvo ubicado en los extremos de la distribución de aprendizaje.

Palabras clave: aprendizaje informal, conversación, museos, educación científica.

Resumo

Deste estudo, participaram 178 grupos de visitantes a museus. Três tipos de elementos mostraram uma forte influência na aprendizagem: a *identidade* do visitante, a resposta ao *ambiente de aprendizagem* e o *envolvimento explicativo* durante a visita. Um modelo de equações estruturais que incluía essas variáveis teve um bom nível de ajuste. Uma revisão mais profunda revelou que nem toda conduta conversacional respaldou a aprendizagem; algumas ações, como falar sobre histórias pessoais, a afetaram negativamente. Além disso, a contemplação silenciosa esteve associada com a aprendizagem. Essas constatações são o resultado da análise das experiências de quatro duplas cujo desempenho esteve localizado nos extremos da distribuição da aprendizagem.

Palavras-chave: aprendizagem informal, conversação, museus, educação científica.

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“WHY DID you come to the Light! exhibition at the Carnegie Museum of Art today?”

—Just walked up the steps and it was right there, so why not? (Lara and Larry)

—Well, I am interested in how the show is about, um, scientific progress in- in the arts, like, relating those two—I thought that sounded pretty interesting. And I usually go to most of the shows here anyways because I’m an art student. And you?

—Uh, actually I already saw the show once before, but I didn’t get as much time to spend on it as I really wanted to. Um, but I found it really, really interesting; and, uh, more of the art, less of the science, was a little bit more, um, new to me. So I thought it was pretty cool. (Helen and Henry)

“Discuss anything in the exhibit that challenged you, or made you change your mind, or with which you disagreed.”

We just looked at things.

[chuckle]

—Nothing really challenged us, though.

—Just really good paintings. (Lara and Larry)

—So the- I still don’t understand the whole, uh, “why the sky is blue”. I understand why the sky is red sometimes; but I still- I never did pick up that sky-is-blue bit. Um... Although maybe... I don’t know. I’ll have to go and [chuckle] find out why that actually is. Um... Besides that... Yeah, I guess again the Van Gogh and the light, y’know, um, made me aware of something I wasn’t aware of before.

—Mm-hm.

—How about you?

—Um, let’s see. [pause] It doesn’t have totally much to do with the artists but it was interesting to look at how- to look at the, um, or to think about how electricity, how radically- just how radically it did change society-

—Yeah.

—for all people.

—Yeah. Yeah. Definitely.

—I guess we take it for granted, so it’s really hard to, unless you’re looking at a photograph or something that- a first from that time, you don’t really...

—No, I think that’s definitely true especially when you have, I mean they didn’t do that in this exhibit as much, but how light cha- uh, changed sleeping habits and patterns?

—Yeah.

—I mean, long ago, what? During winter people slept 16 hours a day!? That’s nuts! [pause]

—Is there anything you disagree with?

—Disagreed...uh, just maybe, like, maybe interpretations of a couple of the paintings where they brought in God. But maybe the person who designed the little card next to the painting knew- knows the artist better than I. But, I don’t know.

—Mm-hm. (Helen and Henry)

These two sets of answers are replies to, in the first set, one of eight pre-visit questions, and, in the second set, one of 13 questions asked of visiting groups after they had toured (and been recorded in) a museum exhibition on Light!. In terms of these particular responses, Helen and Henry seemed to have “learned” a lot more than Lara and Larry. The question is: What might have led to those differences? More specifically, what did their conversational activities while in the museum have to do with their engagement and memories of and observations about the exhibition after the visit?

Thinking about the activity of visiting a museum poses several challenges to the researcher. What should be the result of such a visit? Should we even be looking for learning? And, if we do look for learning, what should such learning look like? How should we measure it? How might our understanding of learning in the informal environment of the museum inform our understanding of school-based learning? The museum world itself has much to say about these issues, especially about the issue of the

relationship between a museum experience and school types of learning outcomes, outcomes that to a large extent, they eschew. It is in this context that we undertook a 6 year investigation of learning in a variety of museums (Leinhardt & Knutson, 2004).

Background to Research in Museums

While research in museums is relatively recent for educational and psychological research, it does have two distinct traditions within the museum community that have existed for at least 25 years. The first tradition involves an interesting merger of market research: preferences, demographics, and likelihood of returning; and the second consists of classical evaluation research: Did this work? Why did you come? Did you enjoy it? Does this sign work better than that one? Both lines of research tend to be proprietary, unpublished, and somewhat secretive. Neither of these approaches (market or evaluative) has traditionally been informed by cognitive or socio-cultural aspects of psychology or the learning sciences in general, but the work has revealed preferences and patterns on the part of the visiting public and as such serves as a backdrop for other kinds of questions that might be asked. A different and more recent tradition of research involves research into informal learning. This work includes rich discussions about the development of core concepts in fields such as art (Housen, 1992; Kindler, 1997); debates about the relationship of constructivism to socio-cultural theory (Falk & Dierking, 1992, 2000; Hein, 1998; Hooper-Greenhill, 1992); and the tension between free access, self-determination, and planned sequencing of experiences, as well as the ethnography of museum design and intention (Roberts, 1997). It also includes research that grows directly from research on families and their interactions in museums (Crowley & Jacobs, 2002; Schauble et al., 2002).

People come to museums for a variety of purposes and in a variety of configurations. Sometimes they come alone. If they come alone they may come to see a particular object or display or to spend a quiet afternoon in a pleasant and calm environment. Any conversations that single visitors may have occur in the form of self-reflection and analysis (see Leinhardt, Tittle, & Knutson, 2002, for a study of diaries of such individuals) or in the form of delayed discussions with friends about what the visitors experienced. Sometimes visitors come in large organized groups, such as elder hostels or school field trips. In these cases there is usually a set of learning and experiential objectives formally or less formally specified by the organizing group (a seriously understudied activity). Sometimes visitors come in small clusters of two to five people with a rich variety of purposes, from getting in out of the rain to entertaining a visiting relative; from doing something with an old friend to extending shared appreciation and knowledge of specific phenomena. In this latter group, whether formed because of family or friendship, conversations while visiting provide researchers with an opportunity to understand what they are examining and why. (But we should be cautious. We study what we can. The absence of conversation may mean a lack of engagement or it may mean contemplation.)

These conversations provide privileged moments that allow us to glimpse into the activity as constructed naturally by the participants in coordination with the intentions of the curatorial and design teams of the museum. This is an asynchronous conversation. The museum staff orchestrates a series of experiences around some specific purpose but deliberately refrains from telling the visitor what those purposes are. In order to understand the conversations that go on, we, as researchers, need to understand the purposes and intentions of the design as well as the purposes and experiences of the visitors. These differences between the research

community and the museum community are important to appreciate or we can risk serious misinterpretation. Perhaps one example may be telling: Throughout this paper, reference will be made to the catalogue for a particular exhibition as Blühm and Lippincott, 2000; however, nowhere on the outside of the catalogue can one find these names of the two authors of the 270-page exhibition catalogue—an unlikely occurrence in the academic world.

Background

The activity of visiting and enjoying a museum is at its very heart both a social and a cultural one, not only in the sense of what is inside a museum but also in terms of what the museum is about. These institutions are instantiations of the ideas and objects that reflect particular cultural values. We value, for example, our past; but what parts? We value art; but what sorts of things constitute art? We value natural life; but is it the exotic (lion, tigers, sharks) or commonplace (woodchucks, raccoons, salmon) we want to show? We value inventiveness and inventors in a uniquely North American take on things, a stance that has resulted in the establishment of dozens of museums of technology, science, and invention. Museums are to some extent our premier locations of cultural values. For the historian, what is not present in a museum is almost as interesting as what is. For the visitor, going to a museum is similarly reflective of a particular set of norms and interests. Indeed, not everyone chooses to go to these cultural repositories and gathering spots.

Museums are places of social gathering for those who choose to go there. Even if one goes to a museum alone, one is immediately enmeshed in the asynchronous conversation between the curatorial design team for a given exhibition and all the other professionals involved in its creation—curators, designers, subject-matter experts, and tradition of the museum itself—which all

merge together in the silent drama that constitutes the exhibition. More often, people visit the museum with friends or family and then become engaged in their own activities of design-decision (How should we go through this experience?), conversation (talking about personal as well as exhibition topics), and meaning-making (What's this supposed to be?). Visitors engage in such activity at an intersection of their own histories and the institution's. Visitors' own history is reflective of previous trips to this and other museums, of other outings with the particular configuration of people with whom they are visiting, and of beliefs and attitudes toward specific contents and places.

Institutions, too, have histories that play themselves out in the placement, signage, and significance of objects and ideas in an exhibition. Two examples might serve to illuminate this point. At the Carnegie Museum of Natural History (which adjoins the Carnegie Museum of Art), two objects have been oddly placed. The first is a beautiful Egyptian head carving that is located in Egypt Hall. What is peculiar is not the presence of the head itself but the fact that, in deference to the neighboring Museum of Art, the curators for Egypt Hall have left the sculpture almost unlabeled. Unlike the other objects and displays in Egypt Hall¹, this artifact is intended to be appreciated as "art," not examined as artifact. But this decision is an insider's joke; to the visitor, the minimalism of the label may be noticed as inconsistent with the informative and thoughtful nature of the text in the rest of the exhibition hall, but they would be unaware that the decision to present in this way grew out of a long series of discussions between the two institutions' curatorial staffs about the purposes of signs and objects in art as contrasted to natural history Museums. A second object of that

¹ Walton Hall of Ancient Egypt (www.carnegiemnh.org/exhibits/walton.htm).

exemplifies the history of Carnegie Museum of Natural History is a life-sized, somewhat moth-eaten diorama of a Middle Eastern man who is riding a camel that in turn is being attacked by a lion; a second lioness is dead on the ground and a rifle, presumably used to kill the lioness has fallen out of the riders hand and is also on the ground. This display had long fallen out of favor with the staff and no longer fit into any of the redone exhibitions that focused on Africa, animals, or anthropology. Yet this was an iconic display for long-time museum visitors, remembered by many adults from their childhood; and popular demand simply did not allow for its disposal or disappearance. Thus, it sits oddly around a corner near a staircase. The halls of most museums have similar histories as well, involving internal communications about meaning and value and historical obligations to patrons and visitors.

We were engaged, at the request of the Institute for Museum and Library Services, on a difficult quest to explore the ways in which learning might take place in museums. We considered a wide range of meanings of learning and situations that might lead to learning (Leinhardt & Knutson, 2004). These included individual learning over the course of a year involving visits to different museums as well as group learning done in a more limited, bounded afternoon visit (Leinhardt, Crowley, & Knutson, 2002).

We examined the nuances of personal, written diaries and the instructional activities designed by future teachers after a museum visit (see Leinhardt, Tittle, & Knutson, 2002, and Leinhardt & Gregg, 2002). We looked at how experts at exhibit interpretation behaved when they were examining exhibitions from a different field of expertise (e.g., from anthropology to art; Abu-Shumays & Leinhardt, 2002). We examined how people who knew an enormous amount about a particular exhibition behaved and talked with their family and friends when they were thrust

into the role of knowledge specialist (Fienberg & Leinhardt, 2002; Stainton, 2002). We also watched and examined how groups might use the museum experience to develop and design instruction that made use of such visits (Leinhardt & Gregg, 2002). We explored how visitors' identity played itself out through the interaction with art (Stainton, 2002) and how families incorporated ideas from different museums into their daily lives (Ellenbogen, 2002).

From this period of rigorous exploration we developed a model of how groups of people might learn in museums: the Museum Learning Model (MLM). The MLM is a model of both process and consequence. It has at its heart *conversations* about the content of the museum exhibition that are engaged in by visitors. The model draws heavily on some of the core ideas of socio-cultural theory, most notably that the participatory activity of learning in a museum is mediated through conversations among visitors as well as between visitors and the curatorial premises, all in response to the affordances designed into the exhibition (Lave & Wenger, 1991; Wertsch, 1991). The actual use of these affordances is itself highly dependent upon the identity and intentions of the visitors themselves.

Visitors come to the museum with particular agendas, expectations, knowledge, and previous experiences both with the museum itself and with each other. These personal histories shape in many ways the specifics of the experience they will have in a particular museum at a particular time. This combination of motivations, past experiences, and knowledge and connections with the material at hand is captured in the MLM as *identity*.

On the museum's side of the conversation, a variety of experiences have been planned and thought through in depth. The wording of signs, the exact color of wall paint, the lighting, various sight lines, the height and size of plinths, the placement of benches, and the implicit paths to

be taken by the visitor are all elements of deep consideration and discussion by curatorial and design teams. These elements and others go into the staging and crafting of the experience developed for the visitor. By tradition, museums should show, not tell; so, the amount of print is generally minimized. However, in most, if not all, exhibitions there is a conscious layering of print material—for example, there may be large sign posts that explain major sections in an exhibition (one such panel at the Carnegie Museum of Art's *Light!* exhibition was titled *A Ray of Light*, in which a description of Newton's theory of light was briefly explained); there may be large-font wall labels of just a word or two to segment the total exhibition (e.g., *Refraction*); and finally there is exhibit-specific label copy that describes in the fewest words possible and the smallest font possible the specifics of a particular object or display (e.g., for Chardin's painting, *Glass of Water and Coffee*, the label copy included, "ca. 1761, oil on canvas, Carnegie Museum of Art, Pittsburgh, Howard A. Noble Collection, 66.12"). This combination of elements and labels constitutes the planned, designed, layered, *learning environment* that shapes and influences the experience of visiting the museum. Many of these elements go unnoticed by visitors and their influence on visitors is quite hard to determine. However, to the extent that visitors do pay attention to these specific elements, such attention (whether spoken or indicated by extended silence) is included in the MLM model as response to the learning environment.

As museum visitors move through the space of the exhibition they engage in talk—to themselves, to guards, to docents, or to friends or family members with whom they have come to the museum. Some of the talk reflects their own planning and design activity ("Should we go here or there?" "We need to be done by four" "My feet are tired, I've had it!"); but a good deal of the talk is devoted to conversation about the

objects, activities, or sights with which they are confronted. The conversation that relates to the material or activities of the museum itself may be cursory or deep, it may be in the service of an evolving understanding or simply of making personal connections and reminiscences. Fienberg noticed a pattern in these conversation—namely, that as visitors approached an exhibit they tended to identify or label it, to make an evaluative comments (it's nice, yuk), and then to continue in one of several directions—either to connect it to something they already knew about, to look at it closely part by part, to question it in some way and consider an answer, or to use the object as an opportunity to tell a familiar tale (Fienberg & Leinhardt, 2002). Some strands of these conversations reflect thoughtful engagement with the exhibits, particularly talk that analyzes objects, synthesizes across multiple objects, or attempts to explain by answering an implicit or explicit query. This particular set of conversational actions is included in the MLM as *explanatory engagement*. Other strands of conversation may center on the ways in which the objects or experiences resonate with visitors' personal histories or values. Further, one may also engage in silent, intense observation and consideration of objects and ideas or simply identify or list the exhibit elements without further engagement.

The frequency, depth, and meaningfulness of visitors' explanatory engagement is in part a function of their particular identities and in part a function of the details of their responses to the learning environment. These three interrelated elements—identity, learning environment, and explanatory engagement—are what we claim lead to learning in and from a museum exhibition. What we mean by learning is that the conversations about and in response to significant thematic ideas represented in the exhibition are greater or more elaborated after experiencing that exhibition than they were before such a

visit. In both cases these responses are stimulated by the presentation of images of objects similar to core objects in the exhibitions, each image picking up on or inviting reflection on the big ideas of the exhibition. A measure of thematically extended talk that occurs at the end of the visit combined with a measure of the time spent in exploring the exhibition are incorporated into the model as a single outcome measure that we call *learning as conversational elaboration*.

Figure 1 shows the core elements of the MLM and the assumed paths of influence. The assumption is that identity and responses to the learning environment both influence the visiting group's explanatory engagement during the visit and that all three of those elements influence learning, where learning is conversational elaboration. We used this model as a guide for the data to be collected and for the analysis as well as a way of deciding what to measure. In addition to these elements, but not anticipated by the model, is the possibility that specific *prior knowledge* about the contents of the exhibition might affect learning. The MLM does not treat visitors' prior knowledge as a separate element from identity because the identity construct includes a rating of visitors' experience with and connection to the objects as well as their motivation to attend the exhibition. However, in the conduct of the study, separate information was collected specifically about the visitors' knowledge of the content.

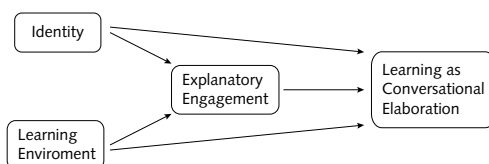


Figure 1. Model of learning through conversation in a museum (from Leinhardt & Knutson, 2004)

Method

General Procedure

After selecting the museum and the exhibition of focus and obtaining all the necessary background information and requisite permissions, we began to collect the data. As a small group of visitors (from two to five people) approached the targeted exhibition we greeted them and asked for permission to explain our study. If they were willing to hear more we explained our goals and procedure and obtained their signed consent. Once they agreed to participate, we attached small wireless microphones to two of the members of the group and then asked all members of the group to first engage in a conversation in which they discussed among themselves (without the researcher) responses to a short set of questions that were printed on cards. This self-administered interview was designed to have the group practice talking together without the presence of the researcher; it also served to test out the equipment prior to their tour through the exhibition.

The pre-tour "interview" consisted of cards with questions that asked about why they had come to the museum, what they knew about or how they were connected to the content of the exhibit, and a set of five cards focused on the contents of the museum exhibition that presented a related photograph or drawing and a phrase that reflected the content which the group discussed. The group then moved into the exhibition space and was encouraged to take as much or as little time as they wanted to explore the space. Groups could stay together or split apart; they could talk or remain silent. As they moved through the exhibition a researcher followed at a distance, listening through headphones to their conversation and tracing their stops on a map (tracing dual paths if necessary), briefly noting a piece of the conversation at each stop. These stops also determined the segments for the audio-recording. When the group decided they

were finished with their tour, they were again given a set of cards—this time portraying actual objects in the exhibition, each of which closely paralleled in theme those items depicted on the pre-tour cards—and were asked to discuss them without the researcher. They were also asked to respond as a group to eight other questions about their visit. For each stop a group made, a digital “mark” was placed on the audio recording as well, thus creating both a visual (through a marked map) and an audio record of the stops, which were then used as the segments for coding. Conversation that occurred between stops was coded separately unless it related to the previous or upcoming stop.

Visitors

We traced the visits of over 200 visiting groups at seven exhibitions. One hundred seventy eight of those at six exhibitions were included in the final analysis. We used a stratified random sample for selecting times and days for our data collection, with the goal of collecting 30 units (groups) at each site. At some exhibitions, however, we ended up staying longer than planned until we had collected data on the targeted number of groups. We excluded from our data any groups who appeared to be uncomfortable speaking English, who had a member that required obvious intensive attention (a crying child, or an elderly visitor with severe cognitive impairment), or who did not want to participate.

For the purposes of this paper I focus on four visiting groups that came to the Light! exhibition described below. All four groups consisted of friendship dyads between the ages of 20 and 30. Two of the groups—Helen and Henry, and Helga and Hillary—learned far more than average from their visit (more than one standard deviation above the mean), and two of the groups—Lara and Larry, and Lisa and Lou—seemed to learn far less than average from their visit (more than one standard deviation below the mean). These four groups serve as cases that

illustrate how visitors experience a museum exhibition in different ways and learn or do not learn from it.

The Museum Exhibitions

The research on the role of conversation in learning in museums was conducted over a period of 18 months in five museums (Exploratorium, Henry Ford, Connor Prairie, Carnegie Museum of Art, and the Carnegie Museum of Natural History) and involved seven different exhibitions (Behind the Screen: Making Motion Pictures and Television; The Automobile in American Life; Prairietown (1836); Light! The Industrial Age (1750-1900); Aluminum by Design; Alcoa Foundation Hall of the American Indian; and, Africa: One Continent, Many Worlds). All of the data collected at any one exhibition were collected in an intensive effort that lasted between 2 weeks and 1 month. The overall results of the research are based on data from all of the exhibitions; the detailed examples that appear in here are drawn from just one.

That one exhibition is—Light!—a temporary exhibition installed at the Carnegie Museum of Art. Co-curated by Louise Lippincott of the Carnegie Museum of Art in Pittsburgh and Andreas Blühm of the Van Gogh Museum in Amsterdam, Light! was designed over an extended period of time and was intended to highlight the influence of the technological and scientific understandings of light on artistic efforts from the time of Newton up to the beginning of the 20th Century. The exhibition was unique for two reasons: First, it was co-curated by these two international colleagues, with the first show opening in Amsterdam; and second, it attempted to bring a sense of both art and science into a venue that was traditionally focused only on art. The show was dramatic in both the Amsterdam and Pittsburgh installations. The exhibition in Pittsburgh started with an exquisite projection of light through a prism displayed on a black ground in the first “room” and it continued with alternating

displays of art, aesthetic instrumentation, and scientific activity, some of which was interactive. The rooms moved from dark brown wall paint to startling, bright, light blue. The general path through the exhibition was straightforward but the detailed paths available were quite variable. There were many famous painters represented and the paintings were combined with exotic and somewhat obscure instrumentation as well as several rare historical film clips.

Determining the Themes and Building Maps

Since much of the analysis rested on carefully identifying the core themes of the exhibition we spent a considerable amount of effort in developing the themes for each exhibition prior to data collection. First, all label copy and, if available, catalogue material was examined for the stated groupings of material. In most exhibitions there is a series of defining groupings intentionally designed to differentiate parts of the exhibition from other parts (e.g., in the case of the *Light!* exhibition, the groupings were *A Ray of Light*, *The Light of Nature*, *Makers of Light*, *Personal Light*, and *Public Light*). Our goal for the identification of themes was to find broad thematic ideas that cut across sections of the exhibition such that almost any given exhibit item or display could belong to at least one. After examining the catalogue and label copy for an exhibition, we asked the curator to walk through the exhibition while being video- and audio-taped as he or she discussed the ideas and items being portrayed. The curators were encouraged to spend as much time as they could going through the exhibition and to discuss what they thought were the critical ideas of the displays. From the combination of both print and taped material we then developed five themes that were defined in ways that were intended to allow any element in the exhibition to be related to it. Finally, we conferred again with the curators to establish the validity of our themes. For the exhibition of *Light!*, the themes were Science and Technology,

Art and Artistic Techniques, Spirituality, Work, and Societal Change.

Data Analysis

Each complete visitor record (i.e., small-group tour conversation) was transcribed, segmented by stop (long stops lasting more than 2.5 min were sub-segmented at 90 s breaks), and then coded. Each segment that could be coded for a thematic reference was so coded; in addition, each segment was coded with respect to its more structural feature—that is, whether the talk was List-Like, made a Personal Connection, Analyzed the Material, Synthesized the Material, or Explained the Material. These structural conversation codes were assigned as unique and non-overlapping classifications that were considered to be hierarchical, from list through explanation. We assigned only the highest observed behavior to a given segment. For example, if a group did a quick identification (List), remembered they had seen a poster like that when they were students (Personal Connection), noticed the color shifts (Analysis), compared that shift to other ones in the exhibit (Synthesis), and then described how the paint was applied to make the light appear in a particular way in that painting, the segment was coded as Explanation even though other “lower” level kinds of talk had been included in that segment. Together these conversational codes formed the explanatory engagement element in the model. Finally, visitors do not always talk. Sometimes they stand in front of an exhibit and just study it. In those cases in which visitors examined an object for 90 s or more we coded it as No Talk or Silence.

Pre-tour and post-tour conversations were examined for elements of identity. Specifically, these codes included ratings of visitors’ background familiarity with and prior participation in the activities shown in the exhibition as well as the intensity of the motivation that prompted the visit in the first place (two 5-point scales that were combined). Behavior and talk during the tour that

dealt with the exhibition environment was coded for learning environment (attention to section labels, for example). Sometimes there was a stop with no talk or there was talk that occurred during a movement from one object to another—these too were accounted for in the coding. Overall reliability for coding was 85%, with discrepancies being resolved through discussion.

The pre-, during-, and post-tour data described above was used to determine values for each of the four variables in the model—Identity, Learning Environment, Explanatory Engagement and Conversational Elaboration. The first three variables were predictors in a structural equation analysis for the fourth.

Examples of codes. A detailed description and examples of the coding system appears in Leinhardt and Knutson (2004), but in order for the reader to understand the discussion here, it is useful to describe several of the conversational codes. When visitors approached an object or an activity and simply identified it or evaluated its pleasantness and then moved on, we coded those kinds of comments as list. Because it was a simple identification move, the talk that occurred in a segment coded as list did not have a corresponding thematic code.

Sometimes visitors saw in an object or an activity the opportunity to share a memory with their family or friends. We coded these conversations as personal connections. This code had no possibility of a thematic referent in terms of the museum content. Museum designers are often very pleased with this kind of behavior because they feel that it makes the museum experience more personal for visitors and because it shows that people identify with and incorporate the objects on display into their own world. Below is a segment of tour conversation from Lisa and Lou that serves as an example. These two friends were having a very good time at Light! They were on a visit to Pittsburgh from Akron, Ohio. They were responding first to a

brief (59 s) video from the 1901 Pan-American Exposition in Buffalo, New York, which showcased both Edison's lighting and movie-making capabilities; then they viewed a display of electric company stock certificates, looked at a painting, skimmed by a large display of candles and lanterns, and then skipped most of one room, ending this excerpt in front of Toulouse-Lautrec's painting, *At the Moulin Rouge*, the quotation below comes from their response to Edison's lighting, with no mention of the other items they saw at subsequent stops. Double slash marks (//) in the transcript excerpt indicate the move to a different stop in the tour.

Lisa: I interviewed for a position in Schenectady // Edison had some- I mean he moved some things from New York City up to Schenectady 'cause he didn't care too much for the labor unions. Edison was involved in which electric company?

Lou: Wasn't it General Electric?

Lisa: Yeah. G. E. [pause]. As I said, I went up there to interview for a Human Resources position. So that's how I found out the history. But the equipment that // was made at that facility up there—it was just phenomenal! I'd like to find out more about Edison himself. He can't be the only person who discovered the light bulb. But he's given the credit. He made 40,000 before he got it right. But I'm sure other people were involved in it too. They did a thing in- Have you been up to Dearborn Michigan?// Have you been up to Greenfield Village?

Lou: I don't think I've been there.

Lisa: Greenfield Village. Coach'll take you, he loves it. Can't get to go again. Anyways // I went to Edison's home somewhere. I know I did. I know, I know, Mom and Dad took me there. Because- He also made the first talking doll and I loved it.

Lou: Did he do Chatty Cathy?

Lisa: No that's Mattel. But he did the first talking doll and that was the last part of the tour and I really wanted to see it so bad that we stayed 'til after it closed and they took the doll out of the case and let me hold her.

Lou: Wow.

Lisa: Really. I was a very good child. That's one thing I did really well.

Despite the brief reference to Edison and the General Electric Company, the personal recollections in this episode are what caused it to be coded as personal connection.

In a contrasting example, other visitors, Helen and Henry, paused by a Gazing Ball, designed to show both an object of the times and also the nature of light and reflection, from both a scientific and an aesthetic point of view.

Henry: This is cool. You get to the point where, like, right around here, or something, where your body flips, or something?

Helen: Yeah.

Henry: Upside down, right side up. [pause] That looks like an Escher painting, almost.

Helen: Mm-hm.

Henry: Like those three spheres.

Helen: Mm-hm. Have you ever seen, there's a famous painting called The Arlofini² [sic] Wedding, where they have, um- it's a northern Renaissance painting...um, like the woman with a- or something.

Henry: Hm.

Helen: But they have a man- it's a really famous painting of a man and a wife... And then it's really a detailed, like in a door knob [sic],³ where you can see a reflection, back of the painter. It's really interesting.

Henry: Mm-hm.

Helen: Like, it reminds me of Escher. Gazing Ball...

Here, the two visitors synthesized the knowledge they had of other works outside of the exhibition with the details of one of the objects in the exhibition. The statements started with the specifics of the Gazing Ball (a short analysis of what happens in the exhibit), then moved beyond and outside of the exhibit's intentions and objects. This move, however, is made in the service of deeper understanding and connections with the object, not as a free association that bounces off of the exhibit.

Many of the visitors to the Light! exhibition stopped in front of a Signac painting, Places des Lices St. Tropez, to examine just how the series of dots of different colors conveyed so powerfully the sense of shade and dappled light. Helga and Hillary were particularly articulate as they analyzed the painting.

Helga: It just takes on a whole new look when you stand away from it.

Hillary: Mm-hm.

Helga: Up close I really didn't get the effect of the light coming down onto the leaves, but when I stand away I can see that more clearly now. [pause] Must be amazing to have that kind of

2 Helen is referring to Jan Van Eyck's The Arnolfini Wedding.

3 She is referring to a small convex mirror on the wall at the back of the room depicted in the painting. This painting has been used often to illustrate the role and technique of reflection in paintings (e.g., Mirror Image: Jonathan Miller on Reflection, an exhibition at the National Gallery in London in 1998 [Miller, 1998]).

image in your head, to know... I can't- I just don't know how they do it.

Hillary: I don't either.

Helga: It's amazing.

Finally, visitors sometimes offer explanations of how things work, what the intention of the curators was in presenting or sharing the object, or why an object was appealing. These explanations usually had a sense of query about them and some attempt at a description of mechanism. Near the Gazing Ball and across from the Chardin described earlier there was a Lace Makers Globe. Henry and Helen stopped there. This sphere of water was used in combination with a candle to focus and amplify light. A painting of a lace-maker's globe in use, placed nearby, helped to clarify the use of the object that caught the eye of several visitors.

Henry: What's up with this? Flickering electric light?

Helen: Lace maker's globe. [mutters/reads something] It's a lens. [reads more] So is this a lens to this?

Henry: No, there is a point over there... I guess that's where...

Helen: Hmm [pause].

Henry: Oh, wait a sec, [pause] Could serve as a lens. Oh, unless they are saying that, if you look at the reflection on-

Helen: On the back, yeah.

Henry: -on the far side, yeah, it's reversed.

Helen: Yeah, upside down, in the back.

Henry: Or it's right side up on the front, yeah.

Helen: So that's 'cause of the curve?

Henry: Mh-hm.

Helen: So, what would people use this, like-

Henry: For?

Helen: Yeah. Like, did someone actually- Is that what that guy is using in that picture?

Henry: That's an interesting question.

Helen: So they used that to concentrate on a single thing? Like a really small point?

Here Helen and Henry use both the wall text and other related objects (a nearby painting) to make sense of a piece of scientific apparatus. Their query is in essence, what is the object supposed to do? Their answer is that it is supposed to concentrate light and act like a lens. They are distracted by the inverted images that appear on and through the globe. They remain somewhat puzzled and do not quite reach the intended curatorial conclusion; but their deep engagement with the object likely increased the chance that they remembered it and would remember that the light available indoors before electricity was weak and pale, making crafts such as lace-making more difficult, especially in the northern climates where the activity was conducted.

The MLM suggests that the greater the identity-based connection between the contents of the exhibit and the visitor (e.g., for this exhibition, a scientific historian or an art historian with an interest in light as it became a subject of art, or a collector of scientific equipment from a certain period, or an optometrist, etc.), and the greater the visitors' sense of themselves as museum goers and engagers, the more likely they are to engage in conversation about the exhibit and to learn from both the exhibit and the conversations. The MLM further suggests that

the more the learning environment is designed to support engagement with the objects in the exhibit in a way that can be discerned by the visitors and the more they do discern it, then the greater their level of learning. Finally, the model suggests that the more the visitors spend time discussing the exhibition contents and themes by analyzing, synthesizing, and explaining them, then the more they will learn. We tested this model by running a regression and structural equation model using LISREL on the data from the Museum Learning Collaborative (MLC) study.

Results

The transcribed, segmented, and coded data were analyzed by regression analysis and by using a system of structural equations. The results are presented in Figure 2.

Figure 2 shows the results of the structural equation analysis conducted using LISREL (Jöreskog & Sörbom 2003). The standardized regression is given below the figure. All paths on the figure are significant. The tested model is consistent with our hypothesized model, but it is also more complex. The strongest direct influence on learning is the explanatory engagement of the group with the material in the museum.

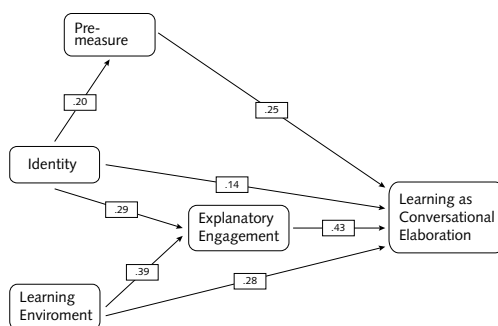


Figure 2. Learning through conversation in a museum

$$LCE = .25P + .14I + .28LE + .43EE \quad R^2 = .58$$

This suggests that for every unit of explanatory engagement the level of learning went almost one-half of a unit of learning. The group's conversational response to the learning environment is the next strongest direct influence; and, finally, the prior knowledge and identity of the group is least but still significant. In addition, as we had thought, the identity of the group and their response to the learning environment influenced their explanatory engagement. Finally, the identity of the group is influenced by the prior knowledge of the group. Prior knowledge was measured by the group's spontaneous response during their pre-tour discussion, in terms of thematic mention, to pictures of objects that were similar to, but not identical to, those in the exhibition, while identity was measured as a more general construct combining motivation for the visit itself and the kinds of background connections that one might have with the material in the exhibition, such as doer-maker, or a collector-appreciator. These are powerful results for groups spending an hour or so talking about objects in a museum. They are also results that need to be interpreted with some caution.

One caution relates to the goals and intentions of researchers concerned with visitor behavior. As learning scientists, we are interested in understanding what it means to learn and what it might mean to learn while engaged in a variety of activities. Museum designers are interested in what makes people happy about coming to a museum such that they are likely to return. Learning and happiness might not always be supported by the same set of activities. So, for example, people might learn more if they attend a docent-led tour - where learning refers to remembering elements in a museum. But if one goes to the museum as a shared social activity, then moving through a museum accompanied only by one's friends and relatives might be the thing that is most appreciated - even if less is remembered about the exhibition itself.

With respect to the finding that conversation that focuses on explanatory engagement influences learning, it might be assumed that it is the general quantity of talk that relates to the museum content that is the influencing feature. After all, the construct of explanatory engagement is the combination of analyzing, synthesizing, and explaining, all of which involve thematic references as well. While each of the structural codes also contained one or more thematic codes these were not included in the structural equation reported here to allow us to examine the relationship between structure of talk and content of learning. Thematic codes from the post test were included as a part of the learning measure and the pre measure.

But visitors are talking and also silently observing in ways not included in explanatory engagement. A second kind of synthesis involved making personal connections between what was seen while visiting the museum and the personal backgrounds of the individuals. This suggests that it might be appropriate to examine the overall inter-correlations among different types of talk and learning to see whether and to what extent each of the sub-units of talk correlate with learning. Table 1 displays those results.

From the results in Table 1, we see that analyzing, synthesizing, and explaining all have strong positive correlations with learning and

also among themselves. (Thus, justifying combining them into a single measure.) No talk or silence has little or no correlation with the talking measure but a modest and noticeable connection to learning. These findings suggest that groups that engage in one type of discussion also engage in other types and that this cluster of conversational activity supports learning. However, personal connections are negatively correlated with learning and with other kinds of conversation. This suggests that there is a competition for attention between the personal and the exhibition. Silence is especially interesting. It is both obvious and clear that when a group or individuals stop and carefully contemplate an object without talking they are likely to remember it and to be at least noticing some of its features. From the point of view of research, however, this “measure” is contaminated because it cannot be reasonably disentangled from simply waiting, or day dreaming, or worrying about what to make for dinner.

All is not Always So

In addition to the structural equations analysis there are two other investigations that help to fill out the picture of what happens with respect to learning when groups visit and talk in a museum. The first is to indicate that groups who seem to learn less do engage in intense

Table 1
Correlations among types of talk and learning

	Personal	No Talk	Analyzes	Synthesized	Explain	Learn
Personal	1.00	-	-	-	-	-
No Talk	-.27	1.00	-	-	-	-
Analyzed	-.30	.19	1.00	-	-	-
Synthesized	-.22	.07	.56	1.00	-	-
Explain	-.46	.04	.33	.30	1.00	-
Learn	-.30	.32	.58	.52	.43	1.00

Note: Adapted from Leinhardt & Knutson (2004).

explanatory conversations and that groups who seem to learn quite a lot do engage in lengthy personal reminiscences. That is to say, most visitors to museums display an array of behaviors and some of these seem to produce a certain kind of learning while others seem to distract from it; it is the accumulation of behaviors that matter not a single episode. There is no pure learning trajectory. (It is important to point this out because otherwise it could be argued that it is some inherent competency within the groups that allows some to learn more and that the conversational behavior is just a symptom of that underlying competency or lack of it.)

The second investigation is to show an instance of common engagement with a single object. By examining this common point of reference, we can discern, to some extent, the differences that will matter when all stops are cumulated for each group, but we also can see that the “high” and “low” groups are often not so very far apart in their engagement with a specific object. This is important because it helps to illustrate that there is utility in examining the entire tour not just one single encounter if one wants to understand learning from a museum visit. We start with a brief exchange between Helen and Henry made as they are looking at the prism and the wonderful spectrum of light that it casts on the wall.

Helen: Have you ever seen someone blow glass?

Henry: Yeah, At the Ren Fest⁴. In New York. You've been to the Ren Fest in New York, haven't you?

Helen: Uhh...

Henry: The one near New York City?

Helen: I haven't been to that one. I went to one near where I live. I'm not sure... [pause]

Henry: Yeah. It's cool. [reading/muttering]

Helen: Yeah. I live near Corning, New York, where they- It's, like, the glass-making center-

Henry: Mm-hm.//

Helen: One of the glass-making centers of the world—Corning Glass, or Revereware.

In that exchange Henry and Helen almost ignore the striking prism on the wall and the wall text accompanying it and instead discuss personal experiences of blowing glass and the city where one of them used to live. In the next short segment we overhear Lisa and Lou as they examine the Fresnel lens and explain how it works as well as its limitation.

Lou: [pause] That's pretty cool. He takes a pin-point source of light and enlarges it. It's used in, for example, lighthouses. That's like (new--) A small beam-

Lisa: A small beam-

Lou: -casts a very large-

Lisa: Mm-hm.

Lou: -surface.

Lisa: So they expand it.

Lou: But then I guess the intensity goes down by, what? The square of the diameter or something.

So Lisa and Lou do engage in explanatory conversations about the objects and art that they see, but they do so less frequently and less consistently than the two groups who learned much more. If one reads their entire transcript, the impression it creates is that the two of them ambled through an interesting space, occasionally taking notice of things around them, but

4 Renaissance Festival.

that mainly they had a conversation about their mutual desire to return to photography and Lisa's wish to introduce her children to it as well. These two examples show that higher learning groups also chat about non-exhibition features and lower learning groups also discuss the content more directly.

We turn now to a moment of commonality. We searched through the conversations of these four visitor groups to find one exhibit at which all four groups stopped and commented. This proved surprisingly difficult. All of the groups stopped at two of the Van Gogh's and three stopped at the huge Lautrec, Moulin Rouge; all four stopped at the Monet Cathedrals, and at the Fresnel lens, as well. However, sometimes a group was talking about something other than the picture or apparatus in front of them, or they simply stood and stared quietly. It was a surprise to discover that the object that captured the attention of all four groups was a painting by Albert Bierstadt entitled, *Sunlight and Shadow*. This 1862 oil painting measures roughly three by three and a half feet (one meter by one and a half meters) and is framed in an ornate dark wooden frame.

Bierstadt was a German-born member of the American Hudson River School, a group that shared a romantic and naturalist vision of the wilderness. Their focus on light was very different than that of the Impressionists in that it emphasized the luminosity of sky, water, and reflected sunlight while developing an extremely representational and detailed approach to painting, almost photographic in nature. *Sunlight and shadow* shows a large gnarled tree on the left, whose roots are pulling up the cobblestones around it, and a limestone church (Löwenburg Chapel) entrance behind and to the right of the tree. Sunlight is pouring through from the left and slightly to the front of the tree so that shadows fall to the right and back of the objects in the painting. Most of the painting is in various shades of yellow and green, with two exceptions: the door to the church is open and the

interior includes a section of a stained glass window that glows red; in addition a woman can be discerned sitting on the church steps hidden in the shadows except for a deep red object on her lap, perhaps a child or a doll. The painting contrasts light and shadow, the natural with the man made, curved chaos with geometric regularity. It is indeed masterly in its precision and technical accomplishment as well as in its evocative mood. In spite of its beauty and the skill of its rendering it is not what one might have assumed would attract our visitors' eyes because it was not done by one of the Masters represented in the show (Degas, Lautrec, Monet, Signac, Van Gogh), it is not a famous picture as is the Chardin, *Glass of Water and Coffee Pot*, and it does not suggest a compelling 'story' as does Degas' *Interiors*. The Degas painting caused considerable discussion among visitors and docents alike. The painting suggests that the man (husband?) may have just struck the woman (his wife?) or berated her or simply come upon her when she was distressed or sad. It is a disturbing and haunting painting.

In the exchange below Lisa and Lou seem at first glance to not be talking about the Bierstadt painting at all, only doing an extended personal connection. But they are inspired by the painting to consider the light and what the light is doing in the painting, "watching the light". As they talk through and past one another they are in fact dealing with much of the content of the painting. The discussion of the times of day at which one can take a photograph resonates strongly with the long afternoon shadows of the painting. The fact that they begin a lengthy discussion of photography (again, for they did this continuously during the visit) echoes with the curatorial recognition that this style of painting was so precise as to be photographic in feel. At the end of this stop they continue on with an anecdote about a T. A. and cutting class, but for the beginning portion of their conversation they are clearly responding to what they are seeing. They seem to be most impressed by the technical

qualities of the painting and are drawn less to the underlying symbolism of light and darkness, time and its passage, that the curators had pointed to in the catalogue (Blühm & Lippincott, 2000, p. 144).

Lisa: Ooh I like this one, yeah.

Lou: Look at this! Look at this! Yeah, yeah, yeah, yeah! This is what makes photography so great—because you can capture an image something like that if you're really watching the light.

Lisa: Watching the light.

Lou: That's what I hate—

Lisa: It really bothers me—

Lou: about the snapshot, that sort of snapshot mentality: You just don't think about composition or light or anything, you just snap the lens.

Lisa: That's why I want to get—

Lou: But that—

Lisa: that's why I want to teach Tommy, Tommy's 8 now.

Lou: The problem though is if you want good light you've got to inconvenience yourself, you've got to get up at daybreak, or you gotta be out at this time—

Lisa: Yeah. Y'know, there's only 3 to 4 hours of good light a day.

Lou: You can't do it at mid-day.

Lisa: Two in the morning, I mean, 2 good hours in the morning and 2 good hours at the end of the day, that's all you have.

Lou: Um-hm.

Larry and Lara also stopped to admire the Bierstadt. They analyzed the painting by looking closely at the light and the directionality of the light. But Larry raises an interesting question: Did the painters paint what they saw or did they make it up in their heads? Like Lisa and Lou, they are considering the technical aspects of the painting and questioning the relationship between the artist's imagination and the effort required to capture something that could be seen. They also relate the directionality of the light to Lara's experience in some class in which the emphasis on the way light molds figures and casts shadows had been pointed out. Their comments stay a little more closely tied to the painting they are looking at than the ones by Lisa and Lou.

Larry: Albert Bierstadt, yeah. You know what?

Lara: What?

Larry: I wonder, if like, when they paint these things, I wonder if they actually think how the light would really be reflected or if they just kind of used their imagination.

Lara: You mean if they looked at something and painted it or if they-

Larry: Yeah, or if they just used their imagination and figured out in their head it would be reflected.

Lara: It's really awesome. Doing something, [—] have the light in one section.

Larry: Oh yeah? Like in one section of the picture?

Lara: Like, say, coming from that way, so that all the shadows are on that side. Larry: That's cool.

Lara: I like that.

Helga and Hillary also stop and analyze the content of the painting while connecting it to other series of pastoral scenes that are quite calm

and “peaceful”. They make use of the wall text to notice the way the leaves obscure the edges of the chapel and the paving stones, and then disagree with some aspect of the text — “decaying” (our notes and the catalogue do not use the word decaying but the way they mention it, it appears to be something they are reading). They make almost the same number of conversational turns as Larry and Lara and far fewer than Lisa and Lou but they do a little more with their conversation and notice just a few more details. It is the repeated nature of this slight increase in the level of observation and thematic mentioning throughout the tour that distinguishes the groups.

Hillary: Looks very peaceful doesn't it?

Helga: Um-hm.

Hillary: And I noticed those landscapes over there look very peaceful-looking too.

Helga: I like the way the light comes through the leaves on the building, it's very realistic.

Hillary: Yeah. And down there on the ground too.

Helga: Um-hm. But the two figures are like, completely in shadow.

Hillary: You almost don't see them there, do you?

Helga: “irregular leaves and shadows disguise the underlying geometry”. Hmm.

Hillary: I don't know if I'd say that's a decaying church.

Helga: No. I like the frame. [chuckle]

Hillary: Um-hm.

Helen and Henry almost pass the Bierstadt by, mentioning it only briefly. But once again, although they render a judgment of “liking” and

notice one part appearing flat, they pause long enough to analyze, if only quickly, the overall technical qualities. They do not relate it to their personal experiences of painting or travel or other hobbies. They stay close to the text so to speak. Helen, the artist, also notices the window inside the church but neither of them points out the technical complexity of showing something inside a dark open space that is itself somewhat illuminated and glowing — and of course a window is “flat”.

Henry: This one I really like. The only part of it which looks a little bit flat, I guess, is that inner window, or like, the stained glass window.

Helen: Yeah, inside the door?

Henry: Yeah. But I really like the outside. [pause]

Helen: Um-hm. Hmm.

It is interesting that all four groups focused whatever attention they gave to the painting on its technical, painterly qualities. None focused on the complex mood that is evoked by contrasting both light and shade, living and non-living, and growing and static. Nor did they question how this particular picture related to the overall theme of the exhibition in terms of light and technology.

Discussion

What have we learned about learning and conversation by examining the visits of people to museums? First, groups visiting a museum learn more if they come to the museum with some forethought and intentionality. The evidence that supports this is (a) that groups who had higher indexes of connection and motivation engaged in more extended and more connected conversation than those who had less, and (b) that they spent more time in the museum and subsequently discussed the museum objects more in terms of overall themes and ideas that

were woven throughout the exhibition than did those who spent less time. Stated differently, to the extent that the visitors' sense of identity includes a learning stance and a sense of membership or affiliation with those who go to museums, the group is likely to learn more. Second, groups that noticed and engaged with the overall environment by reading large wall panels or discussing them learned more than those who engaged less with the overall environment. That is groups that participated in the designed encounter rather than mostly in their own encounter learned more. The evidence that supports this is that groups who had more overt encounters with the environmental cues spent more time in the museum and talked more about the content of the exhibition and discussed the museum objects in terms of overall themes and ideas that were woven throughout the exhibition. Third, groups whose conversation included analyses, syntheses, and explanations learned more than groups whose conversation did not include these features or whose conversation was minimal with respect to them. The evidence that supports this claim is that groups who had higher levels of explanatory engagement spent more time in the museum and subsequently discussed the museum objects more in terms of overall themes and ideas that were woven throughout the exhibition. Fourth, groups whose conversations focused on their personal experiences as connections to or springboards from museum objects learned less. The explanation for this is that such conversation competes with engagement with the objects and ideas of the exhibition.

At its heart the Museum Learning Model is a model of engagement with the stuff of an exhibition. Engagement involves thoughtful connection and is evidenced and mediated by dialogue within visiting groups. While the quantitative analysis is quite convincing in terms of the significance level of the model components in accounting for variation in learning, it is also the case that the detailed discussions and reflections

of groups support these claims. I close with a set of answers from our two low and two high learning groups at the end of their tours to the question: "What do you think you learned at the Light! show today?"

...I'm not sure I did. Just brought things up to the surface. Brought things I knew back. Enlightened me about some of the concepts I knew again. (Lisa and Lou)

-Nothing really. I guess we didn't ...I guess if we had probably stayed there longer we would have learned something. (Lara and Larry)

-I always thought of artists painting from perspective of light and color but not really realizing how industrial age influenced their work. Light for these artists was not incidental to their work. They had to manipulate and took a great deal of care in how they used light. Not just in what they painted, but setting the stage for them. I'm not sure we as modern day people realize how much that influenced them. (Helga and Hillary)

-None of the science was all that new. Except the one thing which was really enlightening was the Van Gogh and the lights. You?

-I guess mostly also, for the Van Gogh piece, that it would make that big a difference that kind of lighting. Troubling to an artist, the quality of light like, "Okay, light is light" But I guess the quality of light where it is shown somewhere can be so different. How much the impressionists, to what degree they were effected by it. Differences in light is something we pretty much take for granted. Artists today don't pay as much attention to it.

-Yeah, that is interesting. (Helen and Henry)

This paper and was focused in large part on talk and its relationship to learning. We have known for some time that the form and content of talk matters with respect to what is learned. Just as exploration does not lead to discovery in science education, talk in and of itself does

not lead to learning. Talk can be used, however, to formulate and rehearse ideas about specific concepts, objects, or procedures. This sort of activity does lead to learning in both formal and informal settings. But silence also leads to learning when the silence is one of attentive engagement rather than distracted absence. These understandings presses us as researchers and designers to develop conditions and situations in which this type of orientation and activity is fostered; but it also challenges us to examine closely how we can teach “listening” not just talking.

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