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3. METHODOLOGIES FOR REFLECTIVE PRACTICE AND MUSEUM EDUCATOR RESEARCH

The Role of "Noticing" and Responding

INTRODUCTION

We argue in this chapter that research focused on learners and learning, as well as on teaching, has sharpened our insights about how museum educators, in the process of becoming increasingly reflective practitioners and teacher researchers, can learn to both 'notice' learners in new ways and respond to these learners with flexible scaffolding rather than with predetermined disciplinary content, scripts or standardized questions. We base this argument on research conducted over the past five years using a sociocultural theoretical framework to inform methodological decisions. Our work and that of others (Tran & King, 2007, for example) and Kisiel's and Tal's chapters in this book have underscored the need for theoretically grounded practices for those teaching in informal science institutions (ISIs).

Our research is set in the context of a newly emerging field of study: professional development for informal science educators. As is typical of such new fields of study, new theories and methods are just now appearing in the science education research literature. One purpose of this chapter, then, is to present a new research-based method for modeling responsive teaching in out-of-school settings. We emphasize both sides of the learning and teaching equation—family and student learning and teaching, and museum educator learning and teaching— arguing that they are intimately intertwined. The professional development design we propose focuses on museum educators' *noticing* of what families do, learning how to flexibly respond to what they notice, reflecting on their own and others' practices and, finally, becoming teacher-researchers.

Because our chapter focuses on methodological tools that evolved, we also want to be particularly clear how certain approaches came into being. We have relied on multiple phases of data collection (family visits-unmediated, family visits-mediated, reflective practice, etc.); each layer has been designed to substantively inform the others, allowing us to focus and refocus our efforts in new ways, typically transforming the ways we analyze new data. As with all good design-based research, we understood from the beginning that we have needed to regularly feed the results of earlier phases into the next levels of analysis, in order to design an effective new approach to professional development. As findings became available, they were used to design subsequent new methods. This approach is also consistent with Anderson's hermeneutic approach, proposed in the previous chapter of this book.

In order to highlight some of the themes we will address in this chapter, we begin by introducing Kevin, a museum educator who took part in the showcased professional development program grounded in reflective practice. Kevin began his own development at a point where he began to change how he viewed visitors' interactions with exhibits.

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There's a level of patience [now] associated with dealing
with people because [I understand] they're not just there
messing up the exhibits, they honestly have no idea how to do
anything.
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This quote by Kevin allows us a glimpse into his (and perhaps others') early thinking about family activity in a museum of science. Kevin's original concern was that families might be "messing up" the exhibit because they didn't seem to recognize how these science exhibits were supposed to work. Such thinking implies that there may be a right way to "do" exhibits and that museums educators and exhibit designers expect families and other learners to conform to such norms. If a family does not "do" or interact with the exhibit in the way(s) the designers expected, then the museum educators may interpret the family's actions as inappropriate or wrong, or they may even discount what the family actually does do with the exhibit.

Such assumptions could have remained implicit and unexamined had Kevin not had ample practice in collaborative reflection with his peers and mentors. He was a collaborator in our year long research-focused, museum-university collaborative partnership, which involved establishing a new community of practice intended to provide a new model for museum educator professional development. This model, aspects of which were borrowed from successful classroom-based research and which has come to be called the REFLECTS model, is predicated on the tenets of ongoing reflective practice as well as museum educator/teacher research. Classroom-based reflective teacher research has suggested that teachers trained in these methods progress rapidly toward more sophisticated teaching practice, especially in their ability to see and 'notice' nuanced interactions. The research described in this chapter will demonstrate how this same progress is true of museum educators/teachers as well.

Professional development began with Kevin and his colleagues spending a great deal of time watching both real and video taped family activities (not mediated by museum educators) at four carefully selected science exhibits (Dino-saurus, Museum Magnified, Bed of Nails, and Pendulum). Kevin and the others learned to take careful ethnographic notes of a variety of social activities. He then engaged over many weeks in reflective discussions (both written, and in small and large groups) about the activities, talk and ideas in these episodes with his 15 peers and a facilitator. Through these reflective practices, Kevin came to realize that the families were sometimes mystified by the exhibits; they did not know exactly what they should be doing with them. One child voiced this succinctly by saying, "What are we supposed to do here?" Kevin also noticed, as did his peers, that many families tended to spend a great deal of time 'figuring out' the exhibits. By 'figuring out' exhibits we mean taking time to discuss, ask each other, play with

and try out different aspects of the exhibit. These activities typically occurred before family members actually moved toward understanding the science content (see Mai & Ash, chapter 6).

Kevin and his colleagues then watched short, carefully selected 1-3 minute digital video activity segments, which showed pre-trained museum educators (from prior years) mediating family activities. The newly emerging community of practice then collectively reflected on what had worked and what had not, discussing styles, strategies and expected outcomes. They discussed and read about the notion of scaffolding among themselves and with other researchers from both museum and university settings. They then looked at more video activity segments, searching explicitly for examples of successful and unsuccessful scaffolding.

Over time Kevin and the others began to wonder whether it was even appropriate to 'deliver' science content without first watching how learners approached and 'figured out' each exhibit. Once they formulated that question, they had seen video and real life (on the floor of the museum) examples of other educators delivering science content, some in moments when it was unclear if that was an appropriate strategy. This questioning of the appropriate role of a museum educator, and the transformation in world-view that Kevin and his peers experienced through their professional development, are the primary focus of this chapter.

With continued reflection and discussion, followed by watching even more videos, Kevin and his group recognized that relying only on the strategy of delivering content knowledge often had poor results, for example, if the family did not engage in dialogue or ask questions, especially with families who were less accustomed to museums. Kevin came to see that every family approaches exhibits in its own way, and that, if he spent time watching, listening to, and seeking to understand family strategies, he would be more successful at his job in the long run. Kevin talked, then, about his role as a museum educator researcher, or MER:

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When families interact with a museum educator researcher
(MER), it becomes a structured environment with a distinct
leader; they (the family) have a harder time exploring the
exhibits, whereas when they are at the exhibit without a
museum educator researcher they discover on their own. The
museum becomes a formal teaching session with the
introduction of the MER.
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Kevin gradually came to understand that families need specific and sensitive scaffolding, which should take into account the individual family's words, actions, culture, power structure and overall level of readiness to learn the material, the content in the exhibit, as well as an exhibit's (the museum designer's) intended goals and operating procedures. He came to trust his developed ability to flexibly respond to learners, saying:

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Trusting yourself that you know where you are and where you
need to start; whereas, before you might just rush in there
and hope for the best, now [after reflective practice] you
can see what has worked.
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Over time Kevin and the collegial group of 16 museum educators co-constructed a community of practice centred on shared goals, practices and language. Such shared practices included designing new tools for diagnosing and mediating family activity, which we describe later in this chapter. They reflected on when, how, and why to support family science learning in museums. At one point Kevin said:

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I really feel proud of my work here and the work of the
entire group. I feel like the dynamic is so strong and has
yielded some really interesting results.
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One of the things Kevin came to appreciate was the difficulty his initial stance (that there is a right way 'to do' an exhibit) presents for a mediator such as himself. This stance had led him to suspect that families who did not follow the museum exhibit designer's particular way were 'messing up' the exhibit. He began to look beyond traditional approaches to family interactions, which he now saw as often one-sided, content driven, and presenting didactic information from the top down, from the educator to the family.

Kevin could really see how that old way of thinking got in the way of what he might accomplish as a MER. Once he realized this, Kevin opened to other possibilities. He came to appreciate the depth of meaning making families could achieve with their own social strategies and existing resources.

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Your (family learners') way of understanding is not wrong, it
is different. Let me help you understand the way we
understand and together we will see the world in a way, which
is only possible to see with this exact combination of
perspectives.
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The process of reflective practice and research on practice, which Kevin's story illustrates, was the focus of our professional development program. Our goal in this chapter, in reflecting on the results of that professional development program, is to re-envision what we mean by teaching in museums, asking the question: How can we help educators in informal learning settings to decide how and when to scaffold social activity of groups and individuals during their visits?

In the sections below, we first provide, based on our theoretical grounding in sociocultural theory, an account of the main aspects of our initial methodological design features and their rationale. Following the natural evolution of key turning points, as each phase of the research organically informed subsequent phases, we describe the evolution of the professional development model we propose (PD). We use this new PD REFLECTS model as a backdrop to illustrate the museum educator transformation we discovered in our implementation and evaluation of the model. Finally, we discuss the implications of such approaches.

THEORY AND METHOD INTERTWINED

We need powerful theoretical grounding to design effective and long-lasting professional development, such as the reflective practice and research on practice framework used to guide Kevin to know when and how to scaffold family groups

as they engaged in scientific meaning making. Our work is set within a sociocultural framework, which reflects socially, culturally and historically situated views of learning and teaching. We incorporate the findings of the community of practice literature, modern theories concerning the zone of proximal development and scaffolding, current views of reflective practice in both classrooms and museums, and also activity theory, which guided our selection of the basic research unit of analysis, the 'scaffolding scene.' The emphasis in all this research, which includes our own, is on collaborative social activity, negotiating multiple pathways towards goals, and honoring multiple interpretations of meaning.

The MERs, university researchers, and museum practitioners together established an ongoing community of practice with shared language, practices and identities; these three were intertwined with peoples' roles within the community. Most importantly, we may think of the members and the community as mutually constituted (Lave & Wenger, 1991), which means that the members form the community and the community forms the members. Being part of such a community of practice, in this case, was made visible within the larger context of the informal science institution (ISI) by the MERs' clothing; they each wore a bright blue shirt carrying the logos of the museum, university, and NSF with identification as researcher on the sleeve. Membership in the community was visible from its inception. Different levels of socially organized activity characterize such communities of practice; in this case, these levels were most obvious in differences among members in having had prior teaching experience, either in museums or classrooms. Approximately half the members (8 of 16) had had such prior experience. Wenger (1998) contends that the coherence of a community of practice depends on mutual engagement, joint enterprise, and shared repertoire. Kisiel addresses these in depth in chapter 4 in this volume. We will see many examples below of shared enterprise and repertoire while members were mutually engaged in learning how to become more responsive and less didactic with learners.

We have relied on contemporary scaffolding theory as a focus for the professional development for several reasons. First, scaffolding research is common in classrooms but it is much less studied in informal learning settings. Second, we view museums as rich learning contexts where we might observe naturalistic scaffolding, rather than the more formulaic, top-down teacher-to-student practices. Furthermore, we have found that scaffolding is practiced by both family members and by museum educators (see Mai & Ash, chapter 6). Finally, scaffolding is a key component in sociocultural views of learning, especially Vygotsky's (1986) "zone of proximal development" (ZPD); and scaffolding is also related to theories of learners' participation in mediated activity. In this way we draw on both cultural historical activity theory and communities of practice research for the foundation of our methodological design.

We view scaffolding as a temporary support system, that enables members of a social group or "ensemble," to "perform at a level that is beyond the unassisted level of one or all the ensemble members" (Granott, 2005, p. 144). When discussing scaffolding we explore the same set of underlying tensions that have

emerged from our prior research: issues of cultural diversity and who owns meaning; issues of when to intervene in dialogue and gesture; issues related to how much science is enough, and issues related to power and hierarchy (see Mai and Ash, chapter 6).

To avoid a crude 'one size fits all' teaching strategy, we have chosen instead to match the educator experience to the family and exhibit, through sophisticated reflective practice (Schön, 1987). We have specifically adapted the reflective practice "noticing" models developed for classroom teachers (van Es & Sherin, 2002) for our museum educators. van Es and Sherin have argued that pre-service teachers who learn to notice become more discerning in what they "see" more rapidly, resembling mature teachers. This reflects Bakhtin's (1981) recognition of the social nature of language and learning, as it emphasizes the importance of the "dialogic," even in professional development programs, over any methods of didactic "telling." For the museum educator this means matching both the level of readiness of the family and the scientific information the material exhibits offer with appropriate scaffolds. Wells (1999) and other cultural historical activity theorists (CHAT) view scaffolding as a "way of working in the ZPD." We view museum educator interactions with families using exhibits (words and gestures, etc) as mediational means to be an ideal frame for the learning and teaching activities we most wish to understand.

Later in the chapter, we will describe methods we have developed for locating and labelling distinct forms of scaffolding activity by noting particular scaffolding scenes, within which people interact with multiple mediational means in order to reach a goal. These activities consist of families learning how to 'do' an exhibit, and museum educator researchers (MERs) learning how to scaffold family activity. In the section below we track a narrative of transformation as it occurred over time during several phases of research.

METHODOLOGICAL DESIGN

There were five main phases to this research project. To date, four phases have been completed, and the fifth is underway. These phases have included:

– Phase 1: Observing families' scaffolding behaviors with museum educator mediation (N =42).
– Phase 2: Observing pre-training museum educator scaffolding behaviors (N=10).
– Phase 3: Analyzing Phase 1 and 2 data to reveal information to feed into Phase 4:
  a. Identifying the four tensions of *content*, *acculturation*, *power* and *roles*;
  b. Analyzing the discrepancy between pre-trained museum educator and family agendas;
  c. Designing the scaffolding scene as unit of analysis for the professional development program
  d. Highlighting the skill of "noticing" and "responding" as central components of future PD

– Phase 4: Long-term Professional Development (PD) for MERs (N=16) to notice and respond flexibly, including:
    a. Design a family noticing tool (MERs create the cues chart and MERtrix)
    b. Reflect on other museum educators activity (MERs create the 10 Super Strategies)
    c. MER reflection on their own scaffolding activity with a and b in mind
– Phase 5: the creation of MER PD program for dissemination to other ISIs

The initial two phases of the research consisted of capturing digital video of 42 families, some mediated by 10 museum educators and some not, and analyzing the activities, the scaffolding and the learning that did and did not take place. As noted in the brief outline provided above, major outcomes of the first two design phases included: development of *the four tensions*, *scaffolding scenes* and the *discrepancy between expected outcomes and goals between museum educators and families,* which led, in turn, to the *noticing* focus of the PD program. We describe each briefly below.

Four emerging tensions were identified through Phase 1 and 2 data analysis, informing subsequent research in fundamental ways. These tensions: Roles, Power, Content and Acculturation (see Table 3.1) were abstracted from a variety of data sources, including both museum educator-mediated and non-mediated family scaffolding scenes. We used these tensions as the fundamental underpinnings of MER PD, reflecting and retuning to these at every major negotiation. This theoretical frame was later explicitly included in the 'tools' designed by MERs to enable them to notice these tensions in action. For example,

Table 3.1. The Four Tensions

Roles
    How do families negotiate the exhibit and each other (who leads, who speaks, who does not)
    Gender, age considerations
Power
    Who has the power; how do we know?
    How/if people relinquish power?
    Mother, father, children, MER (Museum Educator Researcher)
Content
    What kind of content are families doing or talking about?
    Families learning how 'to do or figure out' vs. disciplinary content
    Whose disciplinary content
    When is it acceptable to not 'tell' the answer?
Acculturating to museums
    Culture matching, language, dialects, slang,
    Belief systems (creationism, evolution)
    Educational background
    Museum goers
    Attitude, engagement, motivation

We used the tensions to help select appropriate scaffolding scene videos for professional development, and as the starting categories for both reflective practice and noticing protocols.

Scaffolding Scenes

While analyzing family activity in Phase 1, we were challenged methodologically to determine a new unit of analysis for viewing and coding what we perceived as scaffolding activity units. A major turning point occurred as we developed what we have termed 'scaffolding scenes,' a theoretically based practical tool for segmenting ongoing family, physical, and dialogic activity at exhibits. Our selection of such 'scenes' was informed by activity theory, specifically by thinking of each scene as an enactment of mediated action by people toward some particular goal or outcome. These segments, which were also later used for detailed micro-coding of family scaffolding (see Mai & Ash, chapter 6), also became a fundamental cornerstone for reflective practice professional development training sessions. The theory behind scaffolding scenes is discussed in more detail in the Mai and Ash chapter. Our short definition for scaffolding scenes is:

> Any interaction or exchange between at least two people that involves guidance, leading questions or comments, and/or direct teaching, with positive or negative educational outcome. They include identifiable exchanges involving at least two people that include at least one turn. An exchange is defined as an initiation of talk or gesture that solicits a response in the form of talk or gesture. Such scaffolding is designed to fade over time, as learners have advanced in the collective ZPD.

We used Studiocode to identify and capture the scaffolding scenes (see Figure 3.1 for an example of a Studio code segment) for both, MER reflective practice and professional development. Studiocode is an innovative video analysis technology that allows for segmenting and coding digital video data in flexible ways. We initially focused on family interactions at each individual exhibit; we then segmented these larger pieces (4-20 min) using Studiocode, into digital videos of family interaction and MER/family interactions at the intermediate level (short 1-2 minute segments meeting the criteria for scaffolding). Scaffolding scenes were then further coded again with two different coding schemes (content & noticing codes) for further analysis.[i]

Discrepancies Led to Noticing

Our Phase 2 data analysis identified fundamental discrepancies between how pre-training museum educators viewed their work and how families acted in museums. Analysis of many hours of museum educator-mediated video data revealed a myriad of teaching styles, some applied to families whether they wanted the science content or not. Pre-interviews with a sub-group of those same pre-professional development museum educators or MERS also suggested that they

were less invested in, or discerning of how people learn, then they were in knowing the content and being able to deliver it. These museum educators' goals were more closely aligned with making people happy, providing content knowledge, entertaining them and allaying any fears they may have. Such interests are typical of many informal setting educators with access to few opportunities for professional development. This analysis is different from that of Tran and King (2007), who conducted a study in English museums. This difference no doubt reflects the training museum educators may have received there.
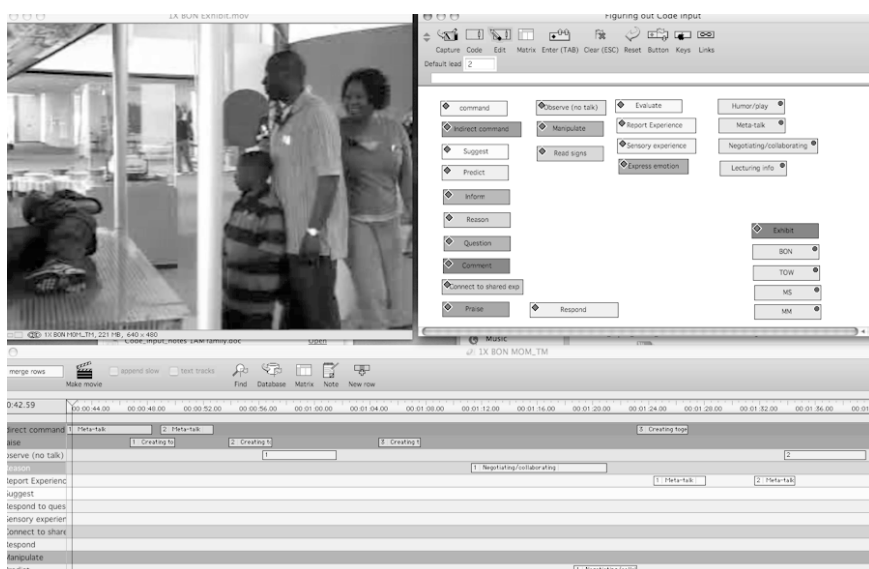

Figure 3.1. Studio Code Example

Such teaching behaviors as providing content knowledge and entertaining did not, however, fit well with how families interacted with exhibits as we had identified in Phase 1. These prior results indicated that families frequently designed their own experiences at exhibits, often co-opting the official curriculum. The participating families typically were not seasoned museum visitors; they had been invited to participate through their Title I school. They represented a full spectrum of urbanity, education, ethnicity, language, and experience.

We noticed that family members scaffolded each other's participation, often inventively creating alternative curricula for the exhibits. Such non-adherence to the official curriculum, as Kevin said at the beginning of this chapter, could be perceived as 'messing up.' Families often did speak about the particular science content and ideas intended for each exhibit, but not always in the ways intended by the museum (see Mai & Ash, chapter 6). We were struck by the disconnect between the museum educators' goal of wanting to teach specific content and the

families' goal of wanting to create their own learning experience. Prior to professional development, museum educators often struggled, unsuccessfully, to impose and re-impose the museum's agenda, failing to recognize the family's ability to use an exhibit for its own learning experience.

Once we recognized the nuanced and subtle ways that families re-designed the exhibit designer's content goals, we felt it imperative to design ways for museum educators to recognize when and how this occurred. Phase 1 and 2 results required us to design a practical way to translate our new-found knowledge of how families morph exhibit experiences into a trustworthy set of PD protocols supportive of close scrutiny of learning by the MER's. We did this by carefully selecting *digital video scaffolding scenes*, which we then presented as the raw material for guided reflective practice in tandem with discussions of the four tensions. In short, we needed to guide the museum educator to "notice" what we had just spent two years discovering through data analysis.

Insights we learned from Phase 3 implementation were fed into Phase 4, the professional development for future museum educator researchers (MERs). We invited a new group of sixteen museum educators to take part in reflective practice, using the four tensions as underpinning, and offering carefully selected scaffolding scenes. The new MERS then participated in reflective "noticing" for themselves of how families actually "figured out" how to "do" exhibits. Kevin was one of this first group of 16 MERs.

Evolution of the Components of the Professional Development Program

To develop our professional development program, we turned to recent teacher development programs centered on reflective practice. The collected research of Sherin and van Es (2002) was particularly useful given its focus on pre-service teacher professional development through analysis of digital video and reflective prompts. Such research suggests that when teachers pay close attention to what learners do and say, they become more discerning and aware of the nuances of teaching. We view "noticing" as partial diagnosis and partial 'tuning' of the involved educator to the families' roles, hierarchy, content, and issues of acculturation (language, for example). The elements of the PD model (which we have termed the REFLECTS Model) are illustrated in Figure 3.2.

Over the 40 weeks of professional development, the work of "noticing" generally focused on three data sources: actual activity on the museum floor, digital video scaffolding scenes, and real-world activity outside the museum. MERS first learned how to take ethnographic notes on the museum floor and at home, simply recording events without interpreting them. They began to understand early on, after comparing notes on their observations, that they did not see the same things and that each missed certain details and nuances that others had noticed. They worked in four groups of four to tackle the detailed pieces of close observation, taking notes, and then negotiating meaning during both small and large group discussions [see Appendix A for the schedule of 40 training sessions (TS) weeks].
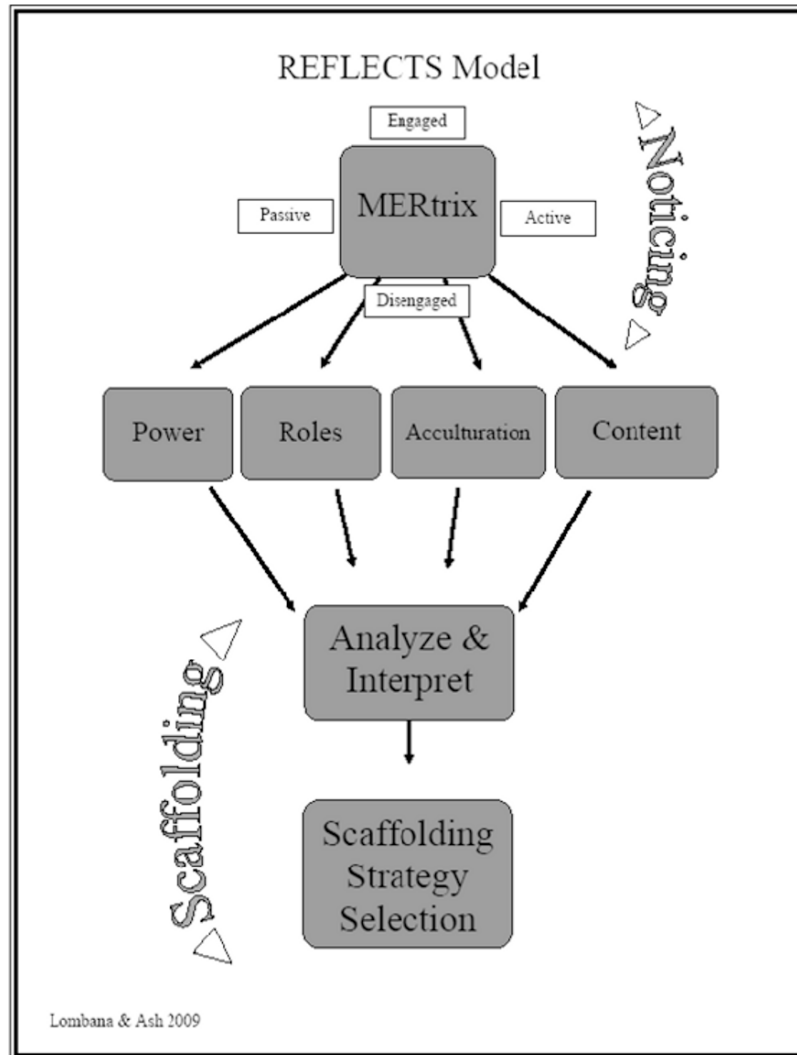
Figure 3.2. The REFLECTS Model

Professional Development Session (TS) Details

Each week, MERs worked for 6-7 hours, meeting with a trainer/mentor and sometimes with university researchers. They viewed videos, wrote written reflections, conducted interviews with families and with each other, and worked in small and large groups to discuss outcomes. The MERs selected for the professional development program had a wide range of experience levels, ages (17 to retired), demographics, and cultural representation. Criteria for selection included previous experience in informal or formal education and/or educational studies, ability to write well, experience in public speaking and/or theatre experience and a commitment to continue with the project for its full two-year duration. Candidates were also judged on being adaptable and motivated to participate as a team in a fast-paced research environment. As noted already, two types of candidates were selected for participation in the project: some who had already been working as educators at the museum and others who were new to this setting. All MER positions in this study were paid part time.

Professional development began with a semi-structured interview with each MER as a baseline measure. Then each MER was videotaped mediating one Title I family at two of the four selected exhibits, again as a baseline data point for later analysis of the MER's own practice. MER-mediated family activities were also followed by a post interview with the MERS and a survey for the parents. The early interviews queried MERs' assumptions about their role as educators in a museum setting. Early professional development sessions, as well as the semi-structured interviews, focused on the following ideas: qualities and perspectives that MERs bring when interacting with visitors; the exhibits and how families' prior knowledge is useful; reflections on each MER's personal own style of interaction and past experiences in education (see Appendix A for a complete taxonomy of the training sessions [TSs]).

Every MER-mediated family interaction (before, during and after professional development) and every MER training session (TS) was video-recorded with two cameras onto a MiniDV, transferred to backup hard drives, and translated to quick time and mpeg formats as needed for transcription and analysis. Such TS data capture allowed both MERs and university researchers to revisit discussions, reflect on practice and to change direction where necessary. This data review specifically enabled the university researchers to change the design of the professional development model and its direction, giving more or less time, as well as providing data for more in-depth analysis of MER transformation. The MER-family mediated interaction tapes were used to:

– Allow MERs to become more comfortable with viewing and analyzing themselves on video.
– Record the level of expertise of the MER at the time.
– Allow for ongoing reflection upon practice, especially comparing before and after training video exemplars

– Provide data for the university researchers to better understand the MER trajectory of change

The professional development model incorporated the community of learners model and dialogic inquiry (Wells, 1999), which together involve overlapping participant structure (small group, large group, web-based communication, etc.), MER research into their own practice, abundant dialogic interchanges between participants, and strong design principles. Beyond the professional development sessions, MERs communicated via Webex or regular email; they wrote weekly prompted reflections on their work; they coded their own data; and they worked collectively to understand the data they were seeing. Table 3.2 includes a sample reflective activity based on scaffolding scenes and the context of the day.

Table 3.2. Outline of a Professional Development Session

Session Topics:
    Noticing Scaffolding in Family Dynamics
    Responding and Stepping into the Space: Developing Strategies
9:30am-10:30am – Group Discussion
    Last Week's Session review of scaffolding theory
      Research Paper "Understanding Scaffolding and the ZPD in Educational Research" by Irina Verenikina
    Jrene Rahm Scaffolding Example / Shawn Rowe Scaffolding Examples
10:30-11:00am - Complete Activity [20.1]
    "Writing a Response to a Video Segment" (see below)
10:30-12:30pm – Break into four groups and work on Activity 20.2
    Exercise on Noticing: Scaffolding Practices
12:30pm – 1:30pm –Lunch
1:30-2:30 – Break into groups A & B and Complete Activity 20.3
    "Using Science Process Objectives to Enrich Your Interactions"
2:30-3:30 – Group Discussion / Experimentation
    Responding / Stepping into Space
    Role Play
    Creating and Testing Strategies
3:30-4:00 – Wrap Up

Writing a Response to a Video Segment
Complete the following activity after you have viewed the video segment:
– When the scene has stopped, write your individual impression on [name of scaffolding scene or segment].
– Next, get into a small group (4) and review each person's impressions (approximately 15 min).
– After discussing, write if and how your impression has changed as a result of the discussion. Include why did it change and did your group reach consensus? Do you know why your views may have changed, if they did? Discuss as large group.

Findings from Phase 4

We found that the mixture of short *digital video scaffolding scenes* created a rich platform for deep discussion and reflection for university researchers, MERs and other museum professionals. MERs also relied upon written transcripts of scaffolding scenes to test their ideas and to see more detail. Over time we saw the following changes:

– MERs developed an ever more nuanced ability to observe salient features of learners' activities along with more nuanced reflection skills.
– MERs increasingly saw themselves as researchers, continually negotiating their roles with each other and the families. They reframed their own roles as educators, becoming more collaborative and deliberately less 'powerful' with learners.
– MERs gained increasing reflective-practice sophistication while developing an "improvable object" (Wells, 1999), a new tool—the MERtrix—for analyzing and describing family dynamics, as reflected on continua representing the four tensions.

Major Outcomes

Using scaffolding scenes and the noticing curriculum involved a fundamental shift from prescribed science content toward 'noticing' what families actually do. MERs have come to value explicit professional development opportunities in "noticing," often saying how much it has changed the way they do their work. Alex said:

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Sometimes it's hard to think on the spot what to do and later
when you ruminate over the interaction you see it differently
every time; with a video you're not adding in any weird
details or thinking you missed something, it's all right
there. You are free to reflect and go back and watch specific
segments over and over again and you notice more and more
every time.
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Mandy said:

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I've never had a chance to look at interactions in such a
way. I'm able to observe behaviors that will alter my way of
interacting with families and with exhibits.
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These comments reflect the increasing importance MERs now place on discerning observation, keeping inferences out of their initial observations, as well as the value of the process. They have become more nuanced. As Sandy said:

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Family noticing involves a lot more than the traditional
methods. It allows us to identify specific traits and cues,
which lead to individualized strategies. This takes into
account our own styles and how they match up with the
families.
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They identified as researchers:

42

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I feel more bound to the body of research and more personally
responsible for failures and successes.
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I see my role much more as a researcher. Professional
development on reflection has made a huge difference.
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I see myself as a research tool.
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They developed and used new teaching tools:

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The MERtrix tool provides a fairly objective way to measure
where someone is as they interact. It should allow us to see
how someone moves on the graph over time to see if
scaffolding techniques have an effect.
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I think that the MERtrix tool could be used to identify
people that both would benefit from scaffolding and would be
receptive to it. Furthermore it can help us fine-tune the
actual scaffolding experience and adjust it to individuals
and families, all so they can get the most from their museum
visit.
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In addition, MERs dialogically negotiated their role as researchers. The section below from TS 7 exemplifies MERs' beginning interrogation of the research process as well as their self-reflections in terms of their role as researchers. The MERs had just watched a pre-MER trained, museum educator-mediated scaffolding scene at the "Bed of Nails" exhibit. Many MERs had voiced their view that the museum educator controlled and led the family's activity (e.g., by directing family's attention) and critiqued her tone as condescending and problematic (e.g., by "talking down" to the mother and daughter). "Caroline" started a discussion about doing research:

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[start 32:55]
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```
Caroline: I have a general question about how when this is
all happening [activity at the exhibit] in the moment and
they're (untrained museum educators) not really thinking
about all this the way that we (MERs) are, so I wonder if
sometimes we over-analyze their actions and put too much
weight on their (museum educator) intent.
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[1 turn]
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--because especially when we talk about…the MER taking over
power (Power is one of the four tensions) as a one-man show…
this might not be what is going through her head because
here, we're sitting here with our purpose of interpreting the
video, ...I don't know when we over-interpret because we
almost give it a malicious intent when we talk about it…
because it's all happening so quickly that I don't think
they're analyzing the situation the way we are.
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Facilitator: There are museum educators who never go through these noticing (professional development) where these dialogues (like the one the group is having now) never, never happen. … It's what I said earlier, it's not about intent, but about issues of power.

Caroline: No, I understand that it's about issues of power, but sometimes I think we give them intent (pre MER training museum educators) that may not have been—because …we're talking about her taking all the power and controlling everything and asserting her power, but in her head, maybe she was just teaching, but it wasn't her intent to have the one-man show and in her mind, "the camera's on me and I have to" –

Ken: But her idea of teaching might be that "I'm the one in power and I'm going to teach you" and there's no other way around it.

...this is how we're trained (in the past) as museum educators, that's how we give the show, that's what we're trained to look for. …She [MER on video] didn't get this (reflective) training.

[4 turns]

Terriann: I think at the very beginning I was taken aback by how much detail we go into and I always thought that maybe we are doing analysis too deep but then I keep going back to the—that's kind of our role and that's why it's so important that we keep it locked up in secret because what we eventually want to do is take that training that the other museum educators have, which is what it is right now, and change it. Ok that's what we did before but now be conscious of your own power.

Such dialogue, sometimes quite heated, indexes moments in which MERs grappled with their power position as producers of knowledge and indicates a shift in their identity from teacher with power to negotiator who listens.

Finally, MERs have gained increasing sophistication in analysis and were able to identify workable principles and strategies for noticing over time, even designing several new tools to help them diagnose where each learner (and an entire group) is positioned at a given moment in the zone of proximal development. One of the most useful tools was the MERtrix. The MERtrix (see Figure 3.3) grew out of the need to understand where learners' collective and individual activities placed them in relation to possible scaffolding. The MERtrix was developed from a need to quickly 'see' where individuals and families appeared in relation to the four tension attributes, such as role in activity, interest in content, or use of power and acculturation. Through a rigorous iterative process using over 250 observations, the MERtrix grew out of the measurement of specific Social Activity

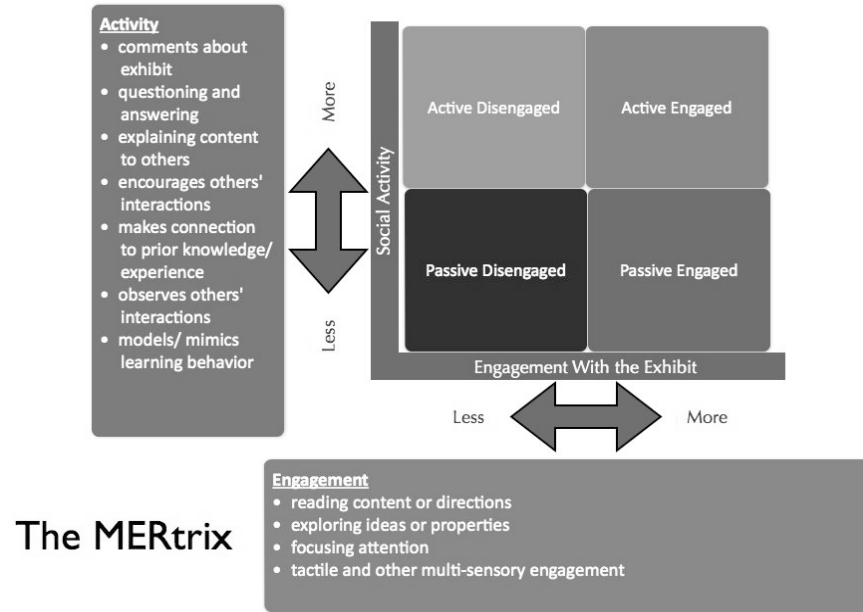and Engagement behavioral cues that family members illustrate (see Table 3.3, MERtrix Cues).

Figure 3.3. The MERtrix

The MERtrix condenses social behaviors along the vertical Active and Passive axis and the horizontal Engaged and Disengaged axis The MERtrix cues of Engagement with the Exhibits, which are assessed horizontally and the Social Activity cues that are assessed vertically together allow MERs to quickly diagnose the readiness of any family or individual for potential further scaffolding along a number of planes. Like all action in the ZPD, once the initial target has been reached new goals need to be formulated. This moving target approach characterizes 'working in the ZPD' using a variety of mediational means.

Through collective negotiations, groups of educators were able to see the cues and MERtrix both as a tool and as a method for honing noticing skills, for research and for setting the stage for responding by scaffolding. Designing a new tool requires measurable criteria (Table 3.3, Cues) as a way to represent these so others can understand (translation). As the MERtrix evolved, it became well understood after multiple observations and MERtrix form and function revisions and iterations, that the presence or absence of cues was the strongest indicator of MERtrix placement. As they worked to identify the relevant cues, they had to examine many different activity segments. There also needed to be a process for revising

when data did not match predictions (research). The MERtrix encapsulates the major gains made by these museum educators.

Table 3.3. MERtrix Cues

Name:
Date:

CUES	
Conversation / Facilitation (Social Activity)	
1) Makes Comments about Exhibit	
2) Questions & Answering	
3) Explaining of Content for Others	
4) Encouraging Others' Interaction	
5) Makes Connections to Prior Knowledge / Experience	
6) Observes Others' Interaction	
7) Models / Mimics Learning Behavior	
Exploration / Investigation of Content (Engagement)	
1) Reading Content or Directions	
2) Exploring Ideas & Properties	
3) Focusing Attention	
4) Tactile and other Multi-Sensory Engagement	

Once proficient in its use, museum educators *internalized* the cues and the quadrants, quickly characterizing individual family members (or group) interactions before making informed choices about how they might wish to interact, which person to select, and the overall goal of the interaction. The cues and quadrants help define family engagement sufficiently to initiate a response. During the development of the MERtrix the use of video and the process of revisiting the session allowed the researchers to discover that early discrepancies in MERtrix results were being caused by fatigue and by lack of expertise in its use, which over time could be managed. This iterative process of data analysis and revision as well as development of expertise typified the research overall.

The cues and MERtrix representations, designed to help explain and negotiate their ideas, gave the MERs something tangible to get their hands on, using real data. Wells (1999) would call the MERtrix an "improvable object" a real or symbolic object, like a conversation or a graph, a text or a boat, so a thing that is collectively improved upon during collective and progressive negotiation. In this particular community of practice the design of the MERtrix was such an object. The museums educators have used it to test, examine, and prove their ideas, thoughts, and observations, testing it often to see if it holds up. It has been revised many times.

The MERs are also a perfect example of a community of practice whose members mutually engage in activity (tackling the daunting task of how to put the four tensions into a codified activity), as a joint enterprise (designing, improving,

revising and using the cues and MERtrix), leading to a shared repertoire (learning how to notice in order to respond by using the new tools).

The MERtrix is interesting for both practical and theoretical reasons. First, it was a methodological tool created by MERs to help explain, represent, and codify observations. Second, it is also a practical exportable device, which can be used by other museum educators and institutions. We have proved its usefulness. The second level of importance is that the practices and products of the unique method we have used, such as reflective practice based on scaffolding, have formed a community of practice made up of museum educators that are deeply engaged in designing, refining, testing and creating an improvable object. We know that learners can make great progress when they take their learning into their own hands, are highly motivated to change the status quo, and are fired with a feeling of belonging to a research community. By creating the cues and MERtrix representations, these MERs have co-designed their own curriculum. This latter inquiry activity is very important in and of itself, even if the MERtrix would have never proven successful.

Becoming adept at "noticing" sets the stage for a MER's decision on how and when to actually engage with a family. After noticing and diagnosing what families do using the MERtrix, museum educators have now begun the next piece of their work, incorporating the family agenda(s)/agency into that of the museum. This aspect of the research and the professional development, called "responding" will be discussed in subsequent papers.

DISCUSSION

We have focused in this chapter on theoretically informed methods for informal learning settings. The goal is to create a new model for museum educator professional development, specifically using teacher reflective research (video-based models developed over the past decade to explore ways in which flexible scaffolding might become the norm for teaching in informal settings). We wish to re-envision what we mean by teaching in museums by asking the question: How can we help educators in informal learning settings such as museums, zoos, aquariums, gardens, and field trips know how and when to scaffold the social activity of groups and individuals during their activities in these informal settings? Our analyses suggest that the outcomes of museum educator reflective research on their own practice include:

- an increased ability to pay attention to learners' activities;
- an increased sense of self efficacy as researchers;
- an increased sense of empowerment and agency;
- an increased sensitivity to the resources learners bring with them to the museum;
- an increased desire to enter into dialogue with family members at museums.

Such transformations, we believe, allow museum educators to become change agents in their own museums (see Ash et al., in review). The noted transformations

in the trained MERs were based, in part, on a set of methodological advances made during the first four phases of this research project. The first advance was the construct of the scaffolding scene, collective activity segments meant to convey collaborative negotiation by families (both with and without MERs). We used these scaffolding scenes as a major piece of our detailed analysis of how families negotiate meaning (Mai & Ash, chapter 6) and how MERs scaffold families, but also, as highlighted here, these scenes became the major teaching tools for MERs. This flexible multi-purpose construct lends great promise to the field as a potential ready-made teaching tool for those who want to understand what typical family activity looks like, but who also want a firm theoretical backing for selecting such segments. These scaffolding scenes are grounded in scaffolding and activity theory, as well as in Vygotsky's notion of "working in the ZPD." Such an all-purpose method could prove quite valuable. The idea that university researchers and museum educator researchers can use one and the same unit of analysis in their work is quite powerful, reflecting the basic premise of communities of practice, which are made of members who share and transform practices as well as themselves. This interplay between research and practice is part of each of the major methodological advances.

A second methodological tool was the "noticing" curriculum itself, which, in turn, was partially based on watching and reflecting upon scaffolding scenes. The noticing curriculum also applied the four tensions (as well as findings from Phases 1 and 2), as the basis for observing specific behavioral cues. These tensions are theoretical constructs, which emerged directly from the practices we had observed in action. Noticing protocols are now being refined in order to identify crucial aspects of family dynamics, including existing roles, issues of power, types of dialogue, who initiates it, verbal and non-verbal cues, and issues of culture. It is clear that the kind and amount of scaffolding must emanate from the 'noticing.'

A third key component of the method that emerged was the community of practice created and maintained by the museum educators, university researchers, museum researchers, as well as their shared practices, language and products. Such a community of practice is similar to that described by Kisiel (chapter 4) within which experts from different arenas can share ideas, language and practices in safety and dialogue. Such contexts place more of the responsibility for change on the educators involved and less on the leaders. Such a system of shared responsibility puts into practice a community of practice ideals.

With shared ownership and responsibility, MERs also were able to design improvable objects (teaching tools) for themselves, as well as for others in their field. Participation in this community accounted, in part, for the changing identity of the MERs, as the community itself changed. In such communities, we speak of the members and the community as mutually constituted. In other words, "noticing" and scaffolding activities and changing relationships have the potential to not only change one's way of teaching but also one's way of being in a community. The TSs provided the context for putting these methodological advances into practice, while listening, speaking, and testing ideas with one another.

A fourth theoretically informed advance in methods was the creation of the teaching tools themselves, in this case the MERtrix and cues table, improvable objects that were defined and revised by continuous negotiation. Museum educators in a variety of settings can use such teaching tools. We are currently planning ways to disseminate this reflective practice professional development model, incorporating these tools.

We see museum educators as researchers, helping us to define and use "noticing" for decision-making as they enhance their own practice. Such a model for professional development puts the emphasis on what people are actually doing in museums rather than strictly following a museum's pre-scripted agenda. The implications for equity are obvious—such an intervention gives voice not only to staff in museums but also to its visitors.

APPENDIX: AN OVERVIEW OF THE PROFESSIONAL DEVELOPMENT SESSIONS

Professional Development Activities

Sessions: T2-T4, Introductions
Practice in ethnographic note taking, museum floor and home
Discussion of same

Introduction to Noticing: How to Best Observe Family Dynamics
Sessions: T5-T10
After viewing and reflecting on their own experiences (video), MER's tackled the concept of "noticing" (van Es & Sherin 2002). "Noticing" is essential to what a MER does, and it is one of the foundations of what good interactive practices should be. "Noticing" provides a starting point for a scaffolding moment. How do you engage a group? Why? Should there be a goal? How can the MER use the noticing along with his or her style to create a teachable scaffolding moment? Or not?

MER Style of Interaction
Session: T11
As a continuation of exploring the reflective process, MERs took a close look at their own individual styles. As a basis for this exploration, we invited guest presenter to lead the MER team on self-reflection by using the DiSC model to aid in identifying personal styles. We then took this information and used it as a tool for discussion on how MERs might 'intuitively' respond to a family at an exhibit compared to how one might respond based on the principle of noticing family behaviors before engagement.

MER Building of a Noticing Tool (MERtrix)
Sessions: T12-T19
As MERs reviewed data through video segments on mediated and unmediated families, MERs identified a set of cues that occur in every interaction. These cues

were consistent and the possibility of measuring them became apparent. The identification of cues allowed for structured conversations and exercises. This led to the idea of creating a "noticing" tool to gauge the frequency and intensity of those cues that were being observed. Moreover, it allowed the MERs to have a common language for discussion/interpretation and create strategies of how to best engage the visitor.

MERs had to create, develop, refine and implement the MERtrix with the goal of making the tool reliable and teachable to other museum educators. During T19, Dr. Doris Ash visited the Science Museum and the MER team and presented a Powerpoint on scaffolding. This presentation led to in-depth discussions about the definition of scaffolding and what constitutes a scaffolding moment within the family.

Exploring Scaffolding
Sessions: T19-T24
MERs explored scaffolding strategies and techniques that have come out of discussion and data evaluation. MERs became much more cautious as to how to enter the visitor's space and how to engage in order to maximize the learning experience of the visitor. These sessions required a lot of evaluation and self-reflection.

Responding and Stepping into the Space (Building Strategies)
Sessions: T20-T24
During sessions T20-24 MERs began to compare and contrast their research against other educational theories and research by noted professionals. One such example of this is the paper "Understanding Scaffolding and the ZPD in Educational Research" (Verenikina, 2003). They also reviewed the Jrene Rahm/ Shawn Rowe examples, members of the Advisory Board who had previously offered examples of scaffolding. These papers served as a springboard for using the devised MERtrix tool in noticing scaffolding in family dynamics and developing entering strategies to respond to these behaviors.

They focused on using science process objectives to enrich their interactions. Some examples are: Categorizing, collaborating, communicating, comparing, counting, describing, generalizing, recording, and relating to prior/and or current experience and using tools. This led to the creation of a list of top strategies that could be used to enter family interactions based on the observable cues that were present using the MERtrix tool. These strategies were then tested on the museum floor with families and were eventually streamlined to the ten "super" strategies.

Guest Acculturation and Customization of the Experience
Sessions: T25-T26
The concepts of guest acculturation and customization of the experience evolved

through group discussions with the goal of offering a MER the opportunity to view the visitor experience through the point of view of the visitor.

Combining Strategies and Tensions with the Reflective Process
Sessions: T27-T29

The combining of strategies and tensions with the reflective process showed that the style, content and "noticing" of the MER needed to be customized to the needs, behaviors, and agenda of the family to maximize the experience of the visitor and, thus, reach optimum scaffolding.

From these discussions, a new thought on power began to emerge. The MER team began the conceptualization of "construction zones" or "zones of power" inspired by Vygotskian notions of the ZPD.

Field Research and Noticing (MERtrix) Testing and Refinement
Sessions: T30-T36

Our MER team had the unique opportunity to apply developed observational and scaffolding strategies to families in the travelling exhibit: "Bodyworlds III:" The Story of the Heart during its final weekend at the museum. This opportunity gave MERs the chance to evaluate their tools in an environment that was less hands-on than the traditional environment created for families at the museum, which is primary hands-on and exercises the constructionist model of learning.

Addressing the Four Tensions and Designing Entering Strategies: The REFLECTS Model
Sessions: T36-T40

MERs re-evaluated the four tensions of interactions that were identified early on in the research project during T3. When looking at the tensions and their definitions it became apparent that the MERtrix tool gave us clear indications on a family member's power, role, level of acculturation and grasp of content. By including this discovery into our process of family observations and entering strategies, the MERs created the REFLECTS (Reflective Educational Formulas for Lasting Encounters in Collaborative Teaching by Scaffolding) model.

NOTES

[i] Our criteria allowed analysts to disagree *within 2 to 4 lines* of the transcript. We had three pairs of analysts who practiced on one family visit, discussed disagreements, and then established reliability with two different family visits. Inter-rater reliability of scaffolding scenes selection was 80%. See Mai & Ash, chapter 6, for the extended description, coding protocol and examples.

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