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## 21. USING COGENERATIVE DIALOGUES IN AN INFORMAL SCIENCE INSTITUTION

**Abstract** In this chapter we document and advocate for the use of cogenerative dialogues as both a methodology and method to be employed for the purposes of improving teaching and learning in settings such as informal science institutions. We describe why such dialogues are useful tools, and why they are critical in revealing key ideas that are particular to informal science institutions. We present how cogenerative dialogues are used in situating Explainers, students who work as floor facilitators, as co-researchers. The authors, each having worked as an explainer, take a polysemic approach to data analysis and writing and use metalogues and voice-overs to preserve the polyvocality of the co-authors and the Explainers who are represented in this chapter. A number of key ideas emerge from the dialogues; ideas that we think may not have been possible had we not interacted about them in cogen such as: sharing strategies, understanding self and others' motivations for interactions, teaching and learning in diverse settings, reflexivity, and catalytic activity. We conclude by describing implications for the informal science field.

In this chapter we document and advocate for the use of cogenerative dialogues (cogen) as both a methodology and method to be employed for the purposes of improving teaching and learning in an Informal Science Institution (ISI) setting. We present how cogen are used in an ISI setting situating Explainers, students who work as floor facilitators, as co-researchers. We take a polysemic approach to data analysis and writing and use metalogues and voice-overs to preserve the polyvocality of the co-authors and the Explainers who are represented in this chapter. We, the authors, maintain our identity but use pseudonyms for Explainers presented in the data. The first author (Preeti) was the Senior Vice President for Education and family programs at the New York Hall of Science (NYSCI), the second author (Jennifer C.) was the Senior Manager of Explainers at NYSCI, the third author (Marcia) is the Program Administrator, and the fourth author (Jennifer S.) was an explainer at NYSCI. Preeti, Jennifer C. and Marcia worked as Explainers at NYSCI before moving into upper level positions.

### FLOOR FACILITATORS IN ISI SETTINGS

Most ISIs have floor facilitators, many of them youth and college-aged, who engage visitors in conversations about science. They can be thought of as science teachers

who work in a free-choice learning setting rather than a school. Across the United States, there are approximately 350 science centers and of those, approximately 40% have a youth employment program (ASTC 2009), each providing significant amounts of training to its floor staff.

NYSCI, a hands-on science center in Queens, New York, has a formalized youth employment program called the Science Career Ladder Program. In this program, high school and college students are employed as floor facilitators and are called Explainers. For many of them, NYSCI becomes a hands-on lab where they learn to teach science, but in a science center environment. Explainers are a diverse group of people. The average age is 15–24 and the gender breakdown is 52% female and 48% male. The ethnic breakdown in 2010 was 28% West Indian/Indian, 26% Latino/a, 21% Asian American, 12% African American, 7% Caucasian, and 6% Other. As the percentages show, there is diversity in the makeup of the staff and this is because recruitment is conducted from approximately 26 New York City public high schools and 27 colleges. Walking around NYSCI you see both the Explainers and visitors engaged and speaking in many different accents and sometimes even dressed in styles representing their ethnicity. The New York Hall of Science has used an explainer model of floor facilitation for over twenty years. In the early years of the program, many Explainers chose careers in science teaching and claimed that working as an explainer contributed to their decision in pursuing a teaching career. Working as an explainer, one teaches to different audiences throughout the day. An explainer also gets opportunities to meet different kinds of people and construct social interactions with them. Through routine, but unique social interactions, an explainer develops effective teaching techniques and begins to appreciate the act of teaching and also how different people learn.

Inspired by this activity, in 2005, a National Science Foundation research project, *Collaboration for Leadership in Urban Science Teaching Evaluation and Research* (CLUSTER), was granted to the New York Hall of Science in collaboration with the City College of New York and the Center for Advanced Study in Education at the CUNY Graduate Center. In what follows, we describe CLUSTER as the context for the study presented in this chapter. We then describe how the need for cogen arose and the outcomes of implementing them in an ISI setting. We provide evidence of how cogen served as structures for supporting our growth as teachers and learners, aligning us to have shared goals even in the presence of diversity and contradictions. We conclude with claims for why cogen can be employed as a method for training floor facilitators in any ISI setting regardless of whether the floor facilitators are studying to become formal schoolteachers.

#### CLUSTER – A TEACHER PREPARATION PROGRAM

In CLUSTER, NYSCI and City College of New York, CUNY partnered to develop, implement and research a pre-service secondary science teacher education program where undergraduate science students take state-mandated education courses and

work as Explainers at NYSCI. The Center for Advanced Studies in Education from the CUNY Graduate Center conducted the research and was charged with documenting how the Explainer's experience serves as a valuable and unique opportunity to actually teach while learning how to teach. As Explainers, the pre-service teachers interact with visitors by engaging them in dialogues about science using exhibits as conversation starters. They also conduct demonstrations, facilitate discovery labs and assist with after-school programs. These Explainers attend weekly exhibit training and receive all of the support and mentoring offered to the rest of the Explainers corps (about 150 students) employed by NYSCI. CLUSTER was conceived to support teachers in developing reform-minded principles as a central objective because the team felt that teachers need to develop an understanding of teaching and learning as socio-culturally situated, and cogenerated through dialogue and discussion rather than transmitted through chalk and talk methods of teaching.

The guiding premise for the CLUSTER project is that in order to support students in becoming science teachers, we have to provide them with opportunities to practice teaching in low-stakes settings. April Lynn Luehmann (2007) advocates for such an approach to science teacher preparation and reminds us that pre-service teachers face great challenges in becoming reform-minded teachers. Their experiences as students and memories of their own teachers do not always mirror reform-minded teaching so they don't have experience or buy-in for such approaches. Their experiences during student teaching are often counter to what they have learned about constructivist theory. Luehmann invites us to design opportunities for pre-service teachers where they are in low-risk, low-stakes environments with a continuum of experiences and claims that traditional classrooms don't always offer such opportunities. Kenneth Tobin and Wolff-Michael Roth (2007) claim that talking about practice is very different from actually being in the act of teaching and we need to address the "rift between descriptions of teaching practice and enacted teaching practice" (p. 2). Each act of teaching is both *singular*, concretely enacted by this person in this situation, and *plural*, a possibility for acting in this culture generally" (Tobin and Roth 2007, p. 31). Explainers' experiences with visitors are individual acts of cultural enactment, and with each act comes their ability to embody the role of a teacher and develop theory about what techniques work or don't work. By developing the ability to maneuver (Roth, Lawless and Masciotra 2001), or to develop practices that are anticipatory, timely and appropriate to given situations, teachers can be prepared to the best extent possible to take advantage of teachable moments. Concurrently, they could utilize contradictory events and re/produce and transform culture in real time, working as an explainer, whether they intend to become a science teacher or not, which supports the development of such skills in a pre-service teacher.

A teaching space, the exhibit floor, can be described as a field, which could be defined as a site for cultural production with specific structures and porous boundaries (Tobin and Roth 2006). Fields have structures composed of schema (ideas, beliefs), practices, and resources. Resources in this field consist of exhibits and fellow staff. ISIs, by definition, are places where all kinds of people (both school groups and

families) visit for different reasons. Visitors' motivations for a visit become a factor into how they experience the museum and its resources (Falk 2006). By interacting with different and unique visitors over the course of one to three years, Explainers have ample opportunities to develop, test and refine their approaches to teaching. They learn what works, what doesn't work, how to employ different strategies for different types of visitors, and how to engage them in conversations that lead to successful interactions. CLUSTER aims to take their experiences and link them to formal education ideas and structures (composed of its own schemas, practices, resources) so that students can apply their understandings to a formal classroom.

#### THE NEED ARISES FOR COGEN

Preeti's role as co-principal investigator for CLUSTER situated her to work closely with the project team from City College. She also had regular interactions with CLUSTER Explainers. As time progressed, she noticed that certain markers of identity development as a teacher emerged as these Explainers work at NYSCI. Her own personal experiences as a former explainer reminded her of how being on the exhibit floor and regularly working with visitors helped shape her interests in teaching and learning as a career choice and her own identity as an educator.

The CLUSTER team struggled to document how working with visitors mediated a change and growth in the CLUSTER Explainers. One aspect of data collection in CLUSTER was to audiotape each CLUSTER explainer interacting with visitors at a given exhibit, *Light Island*, at the time of entry into the program and then every six months. *Light Island* is a hands-on exhibit designed to demonstrate a number of phenomena related to light and offer multiple entry points for a visitor. It also has the potential to allow for visitor-centered investigations on light without prescribing a formulaic protocol. This exhibit is ideal to measure the potential shift in a CLUSTER explainer towards more visitor-centered reform-minded teaching.

In Spring 2008, the CLUSTER team felt that more support and mentoring were necessary for the CLUSTER Explainers beyond the coordinated coursework to the explainer experience and the weekly training they received as Explainers. While there were documented changes in their growth as Explainers employing inquiry-based methods in their interactions with visitors, the team felt that a more explicit approach through small group coaching meetings might be useful. Preeti offered aspects of cogen as an approach to the design of these meetings feeling that the CLUSTER explainer interactions with visitors needed to be taped, shared, and reviewed more regularly than every six-months, the protocol in place at that time. She also felt that from an identity development perspective and as a critical epistemological stance, the Explainers themselves needed to review these tapes, reflect on their actions and make plans for personal change. By having a voice in selecting their audio and video vignettes, and articulating and explaining personal experiences in a shared space and without concerns for assessment, the CLUSTER Explainers would find it safe and useful to examine and improve their practices. Ontologically, Preeti advocated

for this protocol because she knew from her Explainer days that during interaction with visitors, many thoughts and ideas flowed in her mind that could not be captured on tape, but would serve as an important data source for understanding the act. If her taped interactions were the object of discussion, she would want to narrate what happened just before, and after and the thoughts in her mind that afforded or constrained her activity in real time.

Different cogen groups were organized and Preeti, Marcia and Jennifer C., were designated facilitators along with others at NYSCI. Although we, the facilitators were responsible for organizing the cogen, we positioned ourselves as equal participants and not leaders during these meetings. Epistemologically, ontologically and axiologically, we felt that we would never effectively be able to support the Explainers in becoming more aware of their teaching practices by simply modeling for them. These understandings would need to emerge from within themselves and could in fact, emerge from them because they are culturally and historically situated students with vast experiences, outside of the program and also through the program. As Tobin and Roth (2007) noted, cogen are “an alternative to interviewing teachers about their experiences. First data are generated (by listening to tapes and talking about them) and then when we make sense of what happened, we evolve our understandings, and it provides a concrete situation in which to generate theory as part of research” (p. 85). This premise supported our decision to use this method as a structure for the meetings. However, we questioned the specific ways in which cogenerative dialogues serve as a useful methodology for ISI facilitators’ growth as teachers.

#### WHY COGEN IN A SCIENCE CENTER?

Cogen consists of interactive dialogues about “shared experiences of participating in a field” (Tobin and Roth 2006, p. 91). In this case the exhibit floor is the first field. However, a second field is produced in the cogen, where stakeholders (the Explainers, and the co-authors) have a shared focus of improving teaching and learning by using “current understandings to describe what has happened. In addition, we identify, and articulate problems, note contradictions, and frame options that provide us with new and increased choices for enacting teaching and learning. That is, these sessions can be understood as new learning environments that take classroom learning environments (Field 1) as the “object of inquiry” (Roth, Tobin and Zimmerman 2002, p. 9). In this research, we bring the experiences of Field 1 (the exhibit floor) into Field 2 (the cogen) and then back into Field 1. While much of the research on using cogen has been done in the formal education sector, it seemed to us that it was an appropriate way of structuring our meetings in a science center setting.

#### *Emergence of key ideas as a result of cogenerative dialogues*

A number of key ideas emerged from the dialogues; ideas that we think may not have been possible had we not interacted about them in cogen such as: sharing strategies,

understanding self and others' motivations for interactions, teaching and learning in diverse settings, reflexivity, and catalytic activity.

### *Sharing strategies*

Cogen is a field where culture is enacted. Members who participate in this field—the collective—have a motive, a shared focus of improving teaching and learning techniques. Each individual member has her own goals for how to increase her own ability to effectively interact with a visitor. There is a dialectical relationship between the collective and the individual and as such there also is a dialectical relationship between motives of the collective and goals of individuals. Through sharing strategies, each of us works towards our personal goals, but that presupposes that we are also working towards the motives of the collective, to improve teaching and learning. In this system, the idea is not to become like the other at the risk of losing one's own style and identity, but rather to learn new perspectives. Using audio and video files of interactions as resources for learning about and discussing each other's styles of interaction, we see evidence of why Explainers choose to approach an interaction in a certain way and how they negotiate other people's perspectives into their approach.

**Marcia:** The first time I shared my recording with the group I was pretty intimidated by all the feedback I would get. It was my first time back on the exhibit floor explaining to visitors, after a few years of administrative work, and my first time having other people listen to any of my explanations. Before I started the taping I excused myself for my horrible explanation but then I realized that this was a common trend for all of us. Once the recording ended a new worry was the feedback I would get; will they be harsh or will they be polite and keep it nice? The great thing about these group meetings is that even if you do get “called out” on things you said wrong it is all done in such a way that allows you to walk away with a better understanding of what you need to work on and full of ideas to make your explanations better.

**Preeti:** Marcia, this was true for me as well. While my designation as a senior vice president for the institution is not forgotten, it has become less important and has faded into the background as my identity as fellow educator and a researcher has become prominent. This allows all of us to become more comfortable and reveal our ontological and epistemological understandings about learning and teaching. In addition to their growth as a teacher, the structures allow me to examine my own epistemological and ontological stances and growth as a teacher. We are able to share ideas and strategies and be reflexive about aspects of teaching and learning. Most interestingly, we are able to be catalytic with our understandings. I present a vignette, which demonstrates how the structures of cogen support minimization of the concept of an expert and reduce issues of power.

In the following vignette, we had just finished listening to an audiotaped interaction between Seema and some visitors at the *Biosphere* exhibit. This exhibit is a self-contained ecosystem—an enclosed glass structure filled with water, algae and dwarf shrimp. It was placed in NYSCI in the late 1990s, and continues to sustain life with ceiling light as the only input. It is a popular exhibit for facilitation because it demonstrates a unique phenomenon. Seema deconstructed her interactions with visitors and we all took turns and commented on it. Rhonda (another member of our group) stated in this conversation that she learned how to facilitate that exhibit from Seema. All of us have just described the main idea that we try to get across to our visitors with this exhibit. Some of us are interested in describing sustainability of life in a biosphere and others are interested in discussing the main idea of gas exchanges among two or more living beings in a system. Seema and Rhonda both tend to focus on gas exchanges, especially because Rhonda learned the exhibit from Seema, but Rhonda had just mentioned that she uses words like “how do plants grow” instead of “photosynthesis.”

- Seema: That works too. How do plants grow? (as a statement)
- Preeti: How do plants grow? (repeating as statement, Rhonda nodding her head in agreement)
- Seema: I don't know, first thing I think of is photosynthesis. I think too complicated I think. All these bio classes (inaudible) so how does photosynthesis occur.
- Preeti: Yeah so you think of the fancy way of saying and you forget the everyday way of thinking about it.
- Seema: But that is a good idea, I should use that.

Seema describes her affinity for wanting to use the bigger science words and claims that it is all of the biology classes she has been taking that force her to use fancier words. Rhonda, who learned the exhibit from Seema, describes that she gets the same concept across using everyday words, and prefers to do that compared to the science word as an engagement strategy. This sharing of strategies among all of us who have a preferred way of facilitating an exhibit contributes to our growth as teachers of this concept. Cogen becomes a structure where the stakes are low and collectively, we all know that learning new approaches with support for our individual goals are the motives of the collective. In addition, by definition, these dialogues are structured such that there is an acknowledgement and invitation for each person's right to be different and bring different perspectives to the meeting. While Rhonda learned the exhibit from Seema, she does not mind sharing her strategy with the person who taught her the exhibit. There isn't a sense of expert or master and apprentice. Power struggles do not seem to be evident to hinder sharing. Rather, cogen allows for multiple voices and reveal multiple ways of thinking. While Rhonda learned the exhibit from Seema, her way of thinking about it and owning it as knowledge become apparent in the way she teaches the concept back to the visitors. A different

way of conceptualizing this knowledge becomes visible to Seema and the rest of the group. In this way, sharing strategies becomes a way to bring to the surface multiple ways of knowing, of teaching and of cogenerating a plan for improved facilitation at exhibits. It expands our repertoire, supports our *spielraum* or ability to maneuver in timely, anticipatory and appropriate ways. We increase our ability to engage in more successful interactions than before mediating our identities as successful educators.

### *Motivations*

ISIs are free-choice learning environments that are outside of school, but provide intentional learning experiences (Eshach 2007). People who enter these institutions can experience it on their own or choose to participate in a planned activity. Learning is usually not evaluated and typically is non-sequential. John Falk and Lynn Dierking (2000) offer us a framework to consider the structures that mediate learning in an ISI. This framework, the contextual model of learning, states that learning is dependent on personal, sociocultural and physical contexts and as these contexts dynamically change, so do the opportunities for learning. Embedded in this framework are the motivations for why one visits an ISI. John Falk and Martin Storksdieck (2005) theorize that there are five categories that visitors can be grouped into based upon their identity-related motivations when visiting a cultural institution. These identity-related motivation groups are explorers, facilitators, professional/hobbyists, experience seekers and spiritual pilgrims. Explorers are those visitors who are curious about what an ISI has to offer. Facilitators are those people who are supporting the learning in a group such as a teacher who brings a field trip or a parent who visits because her child is interested in visiting. Professional/hobbyists are those who feel excited by or close to the material being presented at an exhibit. Experience seekers are interested in engaging with the institution in some way. Finally, spiritual pilgrims are those whose primary motivation is to be *affected* by the experience, possibly learn something new, and have time for reflection and contemplation. Each of these groups visits with a particular outcome in mind. The motivation for visiting or the intended outcome of the visit can be mediated by face-to-face encounters with floor staff in an ISI and these encounters not only presuppose emotions but also produce them. Below we see these ideas emerge as a topic in cogen and how it supports Explainers in the development of local understandings about themselves as teachers and others as learners.

**Jennifer C.:** One topic that emerged during cogen is how both a visitor's and an explainer's motivation for being at the science center plays a major role in an interaction with a visitor. What motivates a visitor to come to the museum, go to a specific exhibit area, and interact with an exhibit? Once there, what motivates an explainer to interact with that visitor, and during that interaction, what keeps both the explainer and the visitor motivated to continue that interaction?

Visitors are motivated to come to the museum for a number of different reasons. These may include school trips, family outings, dates, school projects, interest in



learning something new or interest in checking out a new exhibit, to name a few. These motivations can play a major role in how Explainers interact with them. For example, on some school trips the students come with specific worksheets that they must complete. They are motivated by the fact that they have to find an answer to a question when they return to their classroom. Other students might see a school trip as an opportunity to run around and have fun. The Explainer has the tough job of trying to get the kids who just need to get the answer engaged in the topic, and interested in learning all the other cool things the museum has to offer. For the kids who just want to have fun, the Explainer needs to find the right way to get them interested in learning something. Sometimes an Explainer might be motivated to approach a visitor, but gets rejected because the visitor is “just here to have fun” or “doesn’t need any help.” Those moments can discourage Explainers from approaching other visitors. In cogen, Explainers have the opportunity to share these moments, come up with strategies to take back to the museum floor, and encourage each other to stay motivated and focused when negative interactions happen.

**Preeti:** During one cogen, I remember, the Explainers and I had just finished listening to a recorded interaction with one of the Explainers, which led into a conversation about visitors who are not interested in learning about the exhibit; they are visiting the museum just to have fun. Triggered by this conversation, Marina, one of the Explainers, offered a recent experience with a group of boys at an exhibit called Celestial Mechanics. This exhibit is designed as a gravity well where a visitor can push a button, which releases a ball with force onto a circular platform that has a hole in the middle. The ball begins to roll on the platform in an elliptical fashion, gaining speed as it gets closer to the central hole and eventually enters the hole. Marina had just finished describing how she had tried to help this group of boys, but the parent stopped her and told her to just let them push the button. The following transcript demonstrates how a negative interaction triggers a set of emotions and actions.

Speaker	Dialogue	Gesture and Tone
01 Marina	<p>I was standing there trying to talk to them. I am trying to explain to them, “Oh so what happens when, what kind of energy do you need,” whatever and then the ↑mom just completely cut me off and one point she goes, “oh let them just push the button.” And I was like, ↑are you serious? The mom cut me off just to tell the kids that they could push the button for the ball. And I am like, “ok, so have fun pushing the ball. ↓I am gonna go now.”</p>	<p>Excited with a frustrated tone. The words “are you serious” were not actually said to the visitor but are used by Marina to express an emotion of disbelief. Tone of defeat</p>

- 02 Jay      You could kind of like do it like have some fun and then learn and then have some fun, for example, *Anti Gravity Mirror*, I just go up and start doing crazy tricks and then I sort of explain it a little bit and then more crazy tricks, and they have fun with it, because at the end of the day, you wanna have some fun while learning. What's the main goal, you want them to learn something and have fun at the same time      Hand gesture of interweaving. Collective comments of "right" or positive head nods
- 03 All      But a lot of the exhibits don't have that.      Overlapping talk with the louder Explainer being caught on audio.
- 04 Seema      That exhibit is a very entertaining exhibit. Think about *Celestial Mechanics*.
- 05 Preeti      Yeah, do you have a strategy for that one?
- 06 Jay      Take it easy. You know, let them press the button and let it go around a little bit and then say, "what did you notice?" because all you do at that exhibit is push the button and watch the spheres go around. Could be like, "Could you guys relate this to something?"
- 07 Marina      Yeah, I was saying that. I had used that exhibit just before and it went fine. It was just that group which I found, I don't know. I shouldn't get offended by it because I shouldn't take these things personally, but I took it personally. I was so m:a::d. I was like, I can't believe it.      Rest of group smiling or chuckling  
Group discusses the degree to which certain exhibits are fun or are not fun.
- 08 Preeti      Marina when you got so mad, what were your next five to ten minutes like?
- 09 Marina      Well after I got mad, I was fuming right, so I was walking back and forth, I was trying to figure out why they wouldn't listen to me. I was like, you know what, screw it, I'll find another visitor, but first I ↓told another Explainer about the incident      Collective laughter

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| 10 Preeti | Oh so you had to vent it out  | Overlapping talk of rest of group |
| 11 Marina | I had to tell them and they were like, oh, its gonna be fine. And then I found another visitor and then I explained <i>Light Island</i> , so then I felt a little better, I was comforted by, kind of, explaining to another visitor. | Smiling collectively              |

We presented Marina with the transcript of the vignette and invited her to interpret it. We each interpreted the transcript independently of each other. Marina describes her interpretation of the transcript in the white box. Preeti presents her interpretation in the grey box.

Looking back at the interaction, I believe that I acted more on my emotions than my senses. I should have not taken the interaction with the visitor so personally. I cannot force people to learn or listen in this case. I think that I find the situation unusual because it is usually kids that do not listen to Explainers, not adults. As mentioned in our last meeting, adults tend to stay long after they are bored because they do not want to be rude. And I believe that I pre-judged that the adult would “force” the children to stay and listen to me. Through similar interactions it becomes more evident that the Hall of Science is much different from a classroom. In a classroom, students have to listen to the teacher but at the Hall it is different, the visitor chooses if he/she wants to listen to the explainer.

Marina described her anger with this interaction knowing that she had just had a positive interaction at the same exhibit earlier that day. Jay offered her strategies, but in this case, she did not find it useful because she was using similar strategies in this interaction to what she had used in the past, which had proven successful with a different group of visitors. Marina, especially after venting to another Explainer, accepted that while she is angry, she was unable to control whether visitors will want to learn or not. She decided that she would find another group of visitors at a different exhibit and aim for a successful interaction in order to re-motivate her.

In interpreting both Marina and my own understandings of what happened in that transcript, I believe that Marina has developed an expanded agency that encourages her to deal with her emotions and immerse into another interaction. She may be rejected again, but she has had enough experiences to know that it could also be successful. She knows that for her own sake (individual) and for the sake of the job (the collective) she has to try again and risk another defeat that she may

take personally. Emotions are a key aspect of the schema produced in this field and are carried from one field into another. Bringing an emotion-laden experience from Field 1, the exhibit floor, as a thought object into Field 2, the cogen, allows us to develop awareness about visitors, their motivations, our roles as Explainers and as teachers. By examining the vignette of our discussion, and interpreting it through our own lenses, Marina and the rest of the group continue to make this topic a thought object as we each give meaning to what happened. This polysemic approach mediates the emergence of key ideas. Marina reveals that having many other similar interactions reinforces her understandings of the differences in structures between a formal and nonformal learning institution. Production of positive and negative emotions becomes part of the schema for an Explainer's developing identity as an educator. Due to the dialectical relationship of schema to practices, emotions mediate the development of practices that potentially lead to an increased frequency of successful interactions.

**Jennifer C.:** Explainers also have their own motivations for coming to the museum. Some of them may be motivated to get paid, earn credit for school or gain experience. Whatever their motivations are for starting the job can impact how they interact with visitors on a daily basis. Working as an Explainer, one experiences many different emotions and learns to navigate through them to produce successful interactions.

**Preeti:** As a high school Explainer, I remember wanting to go to work every Sunday because it made me feel good. In reflecting why it felt good, I realize that it was the feeling of interacting with visitors and seeing them excited about an idea, or seeing them learning something new or simply showing them something cool. In contrast, I also experienced times when I would approach a visitor and ask, "Would you like to see how this exhibit works?" and the response would be, "No, thank you." It was difficult to hear these words and similar phrases that might be characterized as negative responses. Since I did not have control over when those times would occur, I could only develop my ability to create an environment that had a higher chance of getting positive responses. Without realizing it, I was adapting my opening line to be more inviting. Instead of saying, "Can I help you?" I would say, "Wanna see something cool?" I was looking for body language and gestures that signaled that a visitor might be amenable to a social interaction. When I had negative experiences, I didn't have the choice of halting my interactions with visitors because then I would not be doing my job. As an Explainer, I was required to interact with visitors and for me, this meant developing a thick skin with those visitors who were not interested in chatting with me about the exhibits. I had to learn to develop strategies that led to more positive interactions as opposed to negative ones. Over time, successful interactions with visitors led me to build confidence in teaching science. I believed I was good at it, enjoyed this work and identified as being an educator.

*Working with diverse learners*

Ana Maria Villegas and Tamara Lucas (2000) advocate for providing those who are learning to teach with opportunities to rethink their own selves in the context of their students. When applying this to an ISI setting, we are offered a unique opportunity because physical context of the ISI is designed to foster social interactions (Falk and Dierking 2000) between people and between people and exhibits. It is often the role of Explainers to facilitate interactions between the visitors and the exhibit. Places like NYSCI attract ethnically and economically diverse visitors and Explainers have the opportunity to learn how to interact with and teach a diverse population (where the diversity can even change from moment to moment!). Explainers can observe how culture plays a role in level of engagement. They can think about and practice various ways to work with students who may have various disabilities. They can also develop pedagogical approaches that allow them to successfully interact with students *who may speak a different language than that of the host country. In the ISI setting, the explainer can become more aware of herself as a culturally situated being.*

**Jennifer S:** The diverse nature of both the explainer corps and the visitors at NYSCI led to the emergence of a topic of conversation of teaching to diverse students. Sometimes there are issues of accents, pronunciation, or even that the visitors don't speak any English in which case we have to find alternative ways of communicating such as using hand gestures, or drawings. The cogen meetings have become an important place for us to bring up issues we have with communicating with such visitors and developing and sharing strategies to be successful. We also learn about ourselves when we listen to the audiotapes realizing when we are speaking too fast or our own accents are getting in the way of effective communication with the visitor. Once, while explaining in *The Search for Life Beyond Earth* exhibit, I met a young girl who was struggling to understand an exhibit. I was able to tell that English was not a comfortable language for her. She had difficulty pronouncing some words and she very much reminded me of myself when I was her age. It seemed like she grew up in a multi-lingual house like me with Spanish as one of the languages. As we explored the exhibit together, new words like "microbe" were tough for her. She noticed the "m" word repeated several times, and tried each time to pronounce it. Afterwards, her classmates approached one of the exhibits, and before I could say anything, she gave them the whole explanation about microbes I had shown her not long before. I was so proud of her because that meant that she really understood what I taught her, and hopefully the experience gave her greater confidence and a new outlook on science. Another time, I was interacting with a young girl, about twelve years old who only spoke Spanish. We were at the exhibit about germs and importance of washing our hands. We spoke about what atoms are and what they look like- oxygen, hydrogen, carbon and how they will give a certain characteristic or specific

object when put together in a certain way. She understood when I was trying to pronounce oxygen in Spanish, that she said it correctly for me to pronounce it better. Then I showed her on the computer how atoms and molecules work together. When she understood, she explained the whole concept back to me in Spanish. Also, you could see it in her face that she understood. While I was in this situation, I tried and developed strategies that were working and then in the cogen groups, I shared those strategies.

#### REFLEXIVITY

In all of the ideas discussed above, the underlying premise is that of becoming aware of the unaware, or experiencing reflexivity. Our work as teachers can often become a routine and while we realize that each activity is a historical act and no two moments repeat, often what becomes habit for us blinds us from reflexivity. The following monologue from Rhonda exemplifies how it is easy to develop practices that are routine once you are comfortable with them, but become aware of these practices through structures of cogen.

During one meeting, an Explainer, Neel had just finished presenting his interaction with a group of eleventh graders at an exhibit called *Cheshire Cat*. This exhibit is structured so that our two eyes are focused on two different images. The exhibit demonstrates that even if our two eyes are seeing different things, our brain focuses our attention on the object that is moving and more interesting, causing us to overlap the images in our brain and produce an illusion. In discussing this interaction, a very small comment was made regarding making assumptions. At this point, Rhonda launched into a monologue about her interaction earlier that day at the cow's eye dissection demonstration with the same group of eleventh graders. This is a 20-minute demonstration where Explainers dissect a real cow's eye for the audience and review the function of each part of the eye and discuss related disorders. Rhonda is certified to conduct this demonstration and has performed it many times. Certification is a rigorous process of demonstrating content knowledge, presentation of material and active engagement with visitors.

Rhonda: When I was asking them questions about uh.. in the beginning it was just things like uh..normal things like uh..inversion, involuntary and stuff that I kind of thought you should know because you are gonna take your SATs, you are gonna go to college and I assumed because I knew it, that they would know too, and normal things like rods and cones and you've sort of heard about them. You might not know exactly what they do ... so at one point I asked them "do you guys know what rods and cones are?"

And this one kid kind of shouted out from the back, “Ms, you think we are so smart, but we don’t know what you are talking a:bou::t (laughter from all in the cogenerative dialogue). And that’s when I realized I shouldn’t assume that just because I knew when I was their age ... I mean a couple of them knew what I was talking about but I kind of assumed that just because a couple knew that I didn’t have to say it over because it was a big crowd. I didn’t ask what inversion is or when the image gets inverted. This one girl kept answering but I figured if she knew it others would kind of know. But I was wrong and I felt really bad. “Ms, you think we are so smart, but we don’t know what you are talking about” I said oh and I said, “I’m sorry.” It is my fault. I should have realized that I shouldn’t have assumed, so after that, I was sort of careful about explaining everything.

Rhonda reveals how she made assumptions and based it on her own experiences as a student. However, one statement from one of the students in her audience triggered her to realize that she was making assumptions and this was unacceptable to her. Cogen is a place for making visible different ontologies (Tobin and Roth 2007). For Rhonda, the cow’s eye dissection coupled with a discussion about her emotion and sudden awareness of her act of making assumptions allowed her and us to understand her ontologies about schooling and students. She believed that eleventh graders are preparing for college entrance exams and are only a few years away from college and should have a working knowledge of science words such as inversion and involuntary. Her reflexivity about making assumptions triggered the rest of group to recall and discuss their own experiences with making assumptions. Each of us took turns during that meeting and revealed moments when we made assumptions, which affected our ability to successfully complete our interactions. The conversation about assumptions became a blog post on the social networking site and other CLUSTER Explainers posted their opinions and stories about making assumptions. The posting below demonstrates how another CLUSTER Explainer added to the conversation by writing on the blog, offered his own examples and then revealed his struggle with another issue, that of, differentiated instruction.

Assumptions are ubiquitous everywhere we go. People are always assuming different things about different people. However, here at the NY Hall of Science this could lead us to a bad explaining experience when we assume certain things about our visitors’ prior knowledge. SIMPLEST examples of these are that we often speculate on whether to interact with certain visitors, because we may fear that they may already know about the exhibitions or get irritated for disturbing them. These are some of the chances we take and there are very few alternatives. But, most important, assumptions that we make as an Explainer are about our visitors’ prior knowledge. Believe it or not, this is where we

start losing our visitors. Let me give you a scenario: say you are explaining an exhibition to a group of people. Say its the optical lens .. and there is this visitor who seems to be ahead of others and talks about focal points before you get the time to fill in others with the basic principles about the lens and refraction .... what do we do? Just engage the person who is smart and lose others or ask the gentleman to hold on 'til others catch up with the discussion???......this often happens to me and I lose one or the other....(Harry, October 10, 2008, 2:24pm)

While Harry was talking about visitors and not students in a classroom, he is met with a challenge that new teachers often struggle with, differentiated instruction. Harry used the opportunity of talking about assumptions to bring up a whole new issue, which then led to a new set of conversations. Cogen, by design and structure, allow for such conversations to emerge and then trigger reflexivities in unexpected ways, all the while related to the motives of the collective. Elizabeth Davis, Debra Petish and Julie Smithey (2006) found that new teachers are often surprised about what students do or don't know as they begin to teach them, often under or over-estimating content knowledge. Rhonda was able to experience such contradictions because she could teach in low stakes settings and through participation in cogen share those experiences and plan for the next time. Teaching in a science center with diverse visitors affords an Explainer the chance to produce an experience that is modified and based on understandings of Self and Other. Over time, an Explainer can describe a change in her ontologies and can articulate her shifts as an educator.

#### *Let's develop worksheets*

Cogen affords opportunities for catalytic work, which emerges from the group and becomes a symbol of solidarity and group identity. Often, our cogen conversations were about helping students who had worksheets to complete at the exhibits. We would discuss our praxis, the length of the worksheet, the quality of questions, the purpose of worksheets or even if the worksheet was effective at meeting learning goals assuming that was the intention of the designer. Discussing worksheets became a regular activity in our weekly meetings even when we were not listening to a clip related to worksheets. In one meeting, Preeti asked them, "If you were a teacher now, and you had to design a worksheet, how well do you think...." Before she had a chance to finish the statement, there was a collective high-pitched response with a variety of words such "Awesome" and "we would be so good"! Her response was, "so why don't you"? After a few minutes of deliberation, we collectively decided that we were going to design a worksheet and we would actually test it on some students on a Friday field trip.

Cogen becomes a way for stakeholders to deal with contradiction and conflict and design changes themselves rather than waiting for policies and recommendations from teachers. They serve as sites for potential catalytic activities especially if they



reduce oppression and lead to more equitable classrooms (Tobin and Roth 2007). This story exemplifies how an idea emerged from the meetings to design a worksheet that the group felt would be better and more effective than ones they may have encountered. The group felt we had enough experience at not just seeing different worksheets, but helping students work through them to know how to recognize a quality question. Coupled with this was our comfort with the museum exhibits and the science content behind the exhibits. We negotiated various aspects of the worksheet, but we didn't necessarily have agreement on the style of the questions and the goal of the worksheet. Were we testing for knowledge? Should the question be such that the answer can only be found at one particular exhibit? Should it be a group oriented activity or an individual activity? Should it consume the entire field visit time or allow time for free exploration?

The following vignette demonstrates how one Explainer uses her awareness of a free-choice learning environment such as NYSCI and its benefit as a field trip site.

- 01 Preeti: So are we testing knowledge? (inaudible murmur and chatter from everyone)
- 02 Seema: I don't think...the Hall of Science is a more.. well we place ourselves as an interactive, fun museum. I mean if we are testing knowledge, we are not (inaudible). The classroom teacher teaches facts, like that is what we learn in college, learn random facts, you don't keep them in your head, you read and write it. I guess we should figure out a way to test retention(?) if possible, I don't know yet. (negative murmurs from the group) I don't mean retaining information like studying like when you see something interesting, you try to automatically to [retain it].
- 03 Rhonda: [But] how do you [test it?]
- 04 Seema: [I don't] know. That is why I put it out. (nervous laughter)
- 05 Preeti: Well retention, another word might be testing, um, looking for evidence for thinking. How 'bout that? Because retention is hard because we only see the kids once, but we could ...what you said is right, like, when they interact with an exhibit, it is not like they are blank slates, they have ideas in them already. (head nods) And the exhibit hopefully triggers some of the [same ideas].
- 06 Seema: [some type] of thought [process].
- 07 Preeti: [Exactly] some type of thought process. So does our question . is our question well designed so the answer demonstrates some type of ...
- 08 Seema: Understanding. (completing sentence)
- 09 Preeti: Understanding, thinking, critical thinking, some type of problem solving (tone of listing items) so does our question. Is our question well designed so the answer demonstrates some type of ...

- 10 Seema: An example of a question is for *Colored Shadows*. What would happen if only the red and green light was pointed towards the wall and the blue light was faced away? The only way you would figure that out is if you understand the exhibit and what would happen. I don't think it is something you can look at or someone could tell you. You have to stand there. Ok, you know what. You block the red light and you get a black space and that's a shadow from the red light and then the green light fills in the black space.
- 11 Naina: Yeah, we should have questions like that where to test it out, you have to work it out and not just have straight answers.

Seema is describing that the worksheet question should not test knowledge, but thought process. She struggles with the description of her ideas and is met with negativity from the group. Preeti helps her by rewording her interest and giving some new words for people to consider such as critical thinking and problem solving. The time Preeti speaks for as well as what she says becomes a resource for Seema to pose an example of the *Colored Shadows* exhibit, one that she has experienced in her work as an Explainer and has successfully used to elicit student thinking. This allows Naina to see the point and extend the idea by stating that we should create questions where students "have to work it out."

One of the key tenets of the authenticity criteria is to do catalytic work. Cogen becomes a field where such catalytic work can emerge from within the group. The decision to design and test worksheets for the purposes of providing field trip students a stronger tool for museum exploration demonstrates an interest for action and for improving circumstances. Tired of seeing students suffer through poorly designed worksheets, they question how to develop a worksheet that doesn't just test facts and figures, but encourages students to think. They discuss whether the questions should encourage collaborative inquiry or individual investigation. They are concerned with allowing time for free-exploration. These are ideas that reform-minded teachers consider and these pre-service teachers are not just thinking about the worksheets they would design once they are teachers; rather, making a difference now for students who visit NYSCI. They are ascribing themselves the role of a teacher, one who is concerned about student learning. In being in this role, they are forced to address many issues that practicing teachers face related to curriculum design, student learning and assessment. In essence, their identity as an educator is shaped by the activity of doing what educators do; design a worksheet.

#### IMPLICATIONS FOR INFORMAL SCIENCE INSTITUTIONS

In this chapter we provide evidence for how and why cogen can be used as a method for how ISIs conduct meetings for the purpose of planning, learning and transforming practices for floor facilitators. In this study the structures of a meeting focused on supporting the development of all involved as learners and teachers, and produced

activities that were educative and catalytic. The study was educative as we studied our own practices and shared our changing epistemologies and ontologies about social life through interactive dialogues with each other and then with others beyond our group, by means of a social networking site. The study was catalytic because we examined existing practices, made plans to address and improve practices in the form of worksheets, and invited participants beyond our group to interact and cogenerate with us. The data presented demonstrates that by dealing with issues of power, authority and claims to expertise we can collectively advance teaching and learning in ways that support our individual goals but also the motives of the collective.

ISIs are proud of themselves for giving their education staff opportunities to work collaboratively, to plan and learn strategies and techniques oriented towards reform minded teaching. Often, the meetings aim to support staff in developing awareness of self as teachers and learners, but curriculum planning and sharing of new activities become the focus. Employing cogen allows education staff to take a step back and develop reflexivity on their own practices as well as those of others. In those ISIs where there is a vibrant floor staff (youth or adults), much time and money is invested in developing training programs where people can learn how to interact with a visitor – engage them in conversation and use reform-minded approaches to support visitors in their own discoveries about science. Bringing the method of cogen into the training plan can support these efforts in profound ways. Both for education and floor staff, taking the role of researcher and developing local theories about teaching and learning have great implications for improvement of practice and advancing science education as a whole.

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