Science Communication in a Café Scientifique for High School Teens

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Abstract: Our adaptation of the popular Café Scientifique model has proven to be effective for communicating science to a high school teen audience. Our process for achieving effective science communication between scientist-presenters and teens focuses on overcoming the "information deficit" mode of presentation that most scientists are trained for. Our coaching stresses that effective science communication requires engagement on a personal level that meets the audience where it is in terms of both prior knowledge and social context, while making connections to the teens' daily lives. Scientist-presenters report strong satisfaction with the coaching process and the resulting quality of science communication.
Keywords: *Café Scientifque, high school teens, science literacy, information deficit model, storytelling, science communication*

A novel Café Scientifque program for high school teens in four towns of diverse character in northern New Mexico—Albuquerque, Santa Fe, Los Alamos, and Espanola—was inspired by the popularity of the adult Café Scientifique programs that have proliferated in recent years (e.g. Giles, 2004; Sink, 2006; Dallas, 2006; Cohen and Macfarlane, 2007). Such programs—in which citizens interact with a scientist to learn about some hot science topic in the news—originated in the United Kingdom and France, and now have spread across North America and the world (www.cafescientifique.org). Adult Cafés typically are held in pubs or coffee shops, but may also take place in other social settings, such as museums.

Although the details of Café Scientifque programs may differ somewhat, all combine two essential ingredients. First, they take place in a collegial social setting where participants can interact with each other. Second, they satisfy participants' curiosity about a science-based topic through lively interaction with a scientist. It is this blend of the two interactive ingredients that accounts for the Café model's growing popularity.

Our teen Café program—now in its fifth season—has proven popular well beyond our initial expectations. Attendance has continued to grow and retention is high. The impacts on teens are visible in their enthusiasm for the program and commitment to keep it running.

There are many aspects of the program, but two stand out as keys to success. The first is that to the greatest extent possible the teens are given ownership of the program via Youth Leadership Teams in each town. The second involves achieving effective science communication between the scientist-presenters and the teen audience. How we have sought to achieve the latter is the subject of this article.

Importance of Engagement

With some exceptions, the teens attending the Café sessions can be characterized as being interested in science, but having a low to moderate degree of science literacy; in this, they

reflect the general population (Miller, 2004). We seek to increase teen science literacy by increasing their awareness of the fruits of science research across a wide range of subjects and its relevance to their lives. We would like them to be able to talk knowledgeably with peers, parents, and teachers about the science they have learned about in the Cafés. Our evaluations indicate distinct success in these areas (Foutz and Luke, 2010).

However, our primary goals are for the teens to get a significantly increased understanding of the nature of science and to develop a realistic perception of scientists and the lives they lead. We want to get across to the teens that a scientist is a real, complex, multidimensional human, like them, with his or her own unique set of motivations, delights, abilities, and baggage. We want for our presenters to convey that—in part because of a career in science—he or she has had, and is having, a particularly interesting life. This is in essence a way of "framing" the science message. We see it as a vehicle for achieving the enhanced science literacy goal. How our scientist-presenters communicate with the teens in the Café sessions is the make-or-break determinant of whether the goals are achieved.

Rejection of the "Information Deficit" Approach

It is well established that the "information deficit" approach to science communication—one-way transmission of facts from an expert to an information-deficient lay audience—is usually ineffective (e.g., Nisbet and Mooney, 2007a, 2007b). As is often the case with classroom lectures, the message sent is often not the message received (Johnson, 2010), and may not stick.

Often the inadequacies of the information deficit model are discussed in the context of the need to "frame" a message in order to move an information-deficient public to a more enlightened view of a controversial subject. Such framing needs to take account of current knowledge, misconceptions, biases, and cultural and other affective responses (Kahan, 2010). The message needs to be tailored so as to be relevant and accessible to the audience. "Effective communication will necessitate connecting a scientific topic to something the public already values or prioritizes, conveying personal relevance" (Nisbet and Scheufele, 2009).

While the Café program is not in the business of persuasion about controversial subjects[1], the ineffectiveness of the information deficit approach applies fully. To achieve our goals, there needs to be full engagement between the Café presenter and the teens, who need to be met where they are. The presenter needs to be able to calibrate his or her

[1] While certain Cafe topics would seem to have the potential for controversy (e.g. climate change, Internet censorship, HIV vaccines), in only two Cafés have we detected some discomfort for some teens, one that presented fossil evidence from East Africa for human evolution and another that discussed the Human Papillary Virus as a cause of cancer and its vaccine for pre-teen girls.

presentation—often on the fly—to existing knowledge. It is important to make a connection wherever possible to their daily lives[2]. Hands-on activities that actively engage the teens help to cement the science message.

The teens do not want to sit through a science lecture—after all, they have been listening to lectures in school all day—and they will take little away from it. As in a school setting, passively sitting through a lecture will not foster the mental engagement required for learning. As Ainsworth et al. (2011) note in promoting drawing as a means of fostering mental engagement to achieve science learning, "Many students disengage from school learning because rote learning and traditional topics reduce them to passive roles....Reformers advocate more interactive, inquiry-based learning...." Lyons (2006) documents the failure of the information deficit model in interesting students in science internationally.

This degree of engagement needed to spark interest in science topics is unfamiliar and daunting to many Café scientist-presenters, even those with experience in public speaking; most have been trained to approach science communication in the information deficit mode. But our experience has been that with coaching from the program staff, described below, after some initial trepidation the scientists rise to the occasion.

Recruiting and Training Café Presenters

Café Scientifique New Mexico is now in its fifth season. Over this period, we have offered Cafés spanning a broad spectrum of interesting topics in science and technology, from a search for cures to HIV to forensic seismology to diseases of the brain to climate change and the future of CO_2 sequestration. A list of Café topics, presenters, and their institutions is available at http://www.cafenm.org.

We are fortunate to have had Los Alamos National Laboratory as a partner; its staff of excellent scientists working at the cutting edge across a vast array of research areas has provided us with most of the Café presenters. A significant number of our presenters came from the University of New Mexico: the College of Medicine, the Department of Anthropology, and the Department of Computer Sciences. The remaining presenters came from a variety of organizations: the U.S. Geological Survey, the U.S. Air Force, the forensic team of the Santa Fe Police Department, the New Mexico Office of the Medical Examiner, a biological research institute, and a small business specializing in holographic technology.

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[2] In some cases, it may be necessary to take account of existing biases. A local newspaper asked ten students from Los Alamos and ten from Santa Fe about their attitudes toward work being done at Los Alamos National Laboratory. All ten students from Los Alamos were favorably inclined. All ten from Santa Fe had negative attitudes, presumably due to local cultural attitudes toward the lab's work on nuclear weapons and materials and little knowledge of the breadth of research on issues of national importance carried out there.

We run the program in seven months of the school year. There are meetings in September through November, followed by a break for the holidays. We resume in January and go through April. We found that a May Café was not feasible because students are too busy with end-of-year school work.

In the months of September, October, January, February, and March, we have run two Cafés in each town, with the two Cafés providing different perspectives on the same theme. This was an important element in our original design. We felt the teens needed more than one exposure to really learn about a topic and get a broader understanding of its importance or application. For example, in one Café session, the teens "spied" on nuclear facilities in Iran using Google Earth; a companion session in the same month was devoted to "spying" on nuclear and other detonations in other countries using forensic seismology.

Filling a large number of slots in a season's schedule with good presenters able to cover a breadth of subjects—and able to grasp the challenge of successfully interacting with our particular public audience—has made for some interesting recruiting and training challenges.

Recruiting Presenters

The process for entraining a scientist-presenter into the program begins with the Youth Leadership Teams. The youth leaders are eager to tell us what topics they think would be interesting in a Café, and we poll their interest as we begin the recruiting process for an upcoming season. Now, the teens do not know the universe of interesting science, and we may not be able to find a scientist who is available to present on a particular topic. And a great presenter can make an obscure topic come alive, while a poor presenter can make the most interesting topic seem boring. Nevertheless, we make every attempt to satisfy the teens' wishes. So, for example, Cafés on cyber-warfare, brain pathologies, crime scene science, and nanotechnology resulted from teen recommendations.

The next step in finding good presenters is to simply ask around. We approach contacts in all our local organizations with a science mission—starting with those who have presented in the Café program before—and ask for recommendations on colleagues who are doing some particularly interesting research and have given good talks on the subject. We make further inquiries about likely presenters that have been recommended to us. We learned from hard experience that it is important to thoroughly vet potential presenters. They need to have a good science story to tell and already have some facility with speaking to a public audience.

We approach likely presenters and explore their interest in participating in a Café; with few exceptions, we have found the scientists we have approached to be eager to participate. We have found that our presenters are uniformly interested in sharing their science with a broader audience. Some, of course, get encouragement from their

institutions to do this kind of outreach. Quite a few of our presenters have initially said something to the effect of, “sounds like fun.”

After setting tentative Café dates for a scientist’s Café series, we provide him or her with a written “Guidelines for Café Presenters” document intended to frame their preparation for and conduct of the Café sessions.

Know Your Audience

The Guidelines document stresses the importance of knowing the audience. Teens will readily engage with a presenter on some hot science topic if it is accessible to them. It is best to assume the audience knows nothing at all about the topic. The presentation needs to be free of jargon and delivered in an engaging manner at an entry level so that teens will be pulled in and have a chance to develop some new mental images.

It is important that presenters not try to cover the whole breadth of a science topic, thus creating too many new mental pictures for the teens to try to process at once. A better approach is to organize the presentation around one essential provocative idea or concept, and let everything flow to it. This we refer to as the *Most Important Thing*, an idea deliberately designed to be accessible enough to the teens that they can engage in discussion of it.

It is most effective if a presenter leads up to the *Most Important Thing* by *telling a story.* In our first year of the program we actually engaged a professional story-teller in a workshop for presenters, which was quite effective; we have used lessons learned from the story-telling workshop in all subsequent years.

It is a challenge to get the scientists to give presentations appropriate for the teens and the informal setting, as opposed to what they are used to: presentations to peers at a professional society meeting or a public lecture. A typical science talk is not really about communication. Typically the presenter is delivering information one way about what he or she did in the investigation and what results came out. Presenters show PowerPoint slides that will closely follow their words. They hope that those in the audience that are conversant with the science will to some degree understand what is being communicated, but it is part of the game that it is not necessary to find out. Other than perhaps a few questions at the end, there is no interaction with the audience.

In contrast, *interactivity* is one of the most important ingredients of a teen Café. In a Café presentation, communication—meaning two-way verbal interaction, supported by a few key graphics—is of the essence. Presenters must be able to paint a picture in the mind of each audience member of the concept they wish to convey. To succeed, it is important for presenters to put themselves into the mind of the teen in the audience who knows little or nothing about the topic and imagine how he or she is processing words into mental images. Feedback along the way by members of the audience provides clues to how to

adjust the delivery. This can be accomplished by pausing occasionally with a provocative statement or a question that will promote discussion.

In a rich discussion of the essential ingredients of effective science communication, Benka (2008) sums up the fundamental requirement: "... I want to turn upside down the assumption that in communicating science, information is paramount. Instead, let's examine the reverse premise, that determining the actual information to convey is secondary to ensuring that it be understood. Let me say it again: It is far better to be understood by your audience—even if you convey less information that you hoped—than to convey everything you intended and be incomprehensible. I am not suggesting that the information is unimportant or to be treated sloppily: The candid delivery of accurate information is a necessary *but not sufficient* condition for an effective presentation...."

Teens engage best if they are able to *do* something. So we strongly encourage presenters to increase interactivity and engagement with the teens by bringing some "hands-on" kind of activity, if that is at all feasible. This can take a lot of different forms, such as handing around some objects and challenging the teens to organize and interpret them, giving them a trivia quiz, or getting them on their feet and choreographing some simple concept. We work with presenters to brainstorm ideas that might work with their specific presentation.

For example, a paleoarcheologist from the state medical examiner's office presented on human skeleton characteristics that allow determination of the gender, age, race, and cause of death. She then presented the teens with three complete human skeletons and a list of potential crime victims. They were challenged to match the victim descriptions to the skeletons. In another Café, teens learned about hydrogen fuel cell cars of the future, then constructed model hydrogen fuel cell cars and were able to race them. And in another Café, teens learned about the challenges of cybersecurity, then engaged in deciphering puzzles in a manner that computer security experts use to search for weaknesses in their networks, programs, or other systems that can be easily exploited.

Taking care with graphics is important. The teens are not happy with many PowerPoint slides, if they are too busy, if they contain jargon, or if the presenter reads from them. In fact, we request that few words or no words at all are on the slides. Rather, there needs to be a judiciously selection of very simple slides that are specifically designed to help create mental images of the most essential concepts. The teens expect that presenters will explain diagrams, figures, and images, as they may have never seen anything like them. Really, this is just a matter of best practice in presentations.

The Essential Dry Run

We have found that it is highly valuable—and indeed essential—for presenters to do a dry run with a small group of teens before presenting to a full house. Initially, we did dry runs with an audience of science peers. It was the youth leaders that suggested that they be done before a group of teens after school, and we adopted this advice. This has proven

exceedingly valuable in getting the presentations pitched at the right level and the graphics comprehensible. It also serves to overcome a certain intimidation factor for many presenters concerning the prospect of presenting before an unfamiliar audience. We agree with Benka (2008) that "A rehearsal is essential.... [It] will reveal some significant flaws [and] is a golden opportunity to identify problems and solve them." While many of our presenters have initially told us they are experienced at presenting to the public and never do a rehearsal, every presenter has told us afterward that the experience was well worth their time.

In one Café, the presenter claimed that she was far too busy to take time to do a dry run and, besides, had abundant experience with presenting to "young people." Her first Café was pretty much a disaster. She presented far above the audience's level, used abundant scientific jargon, showed incomprehensible slides, and did not engage. The teens had no idea what she was talking about. To her credit, she drastically changed her approach with feedback from the audience and leaders, and the following three Cafés were quite good. In this case, her dry run was, unfortunately, her first Café. We learned the lesson from this experience that all presenters *must* do the dry run.

The value presenters give to the dry run is captured in the following responses to a questionnaire:

"[The dry run] was crucial to prepare my presentation at the right level. I believe that dry-runs and feedback are very important for all presenters. It is necessary to know better who is the audience and what are the expectations."

"[The dry run had a] tremendous impact. The staff and students who provided feedback on the dry run have clearly had a lot of experience doing so, and could probably be called experts in public communication of scientific research. I learned quite a lot from them on how elements of my presentation would come across to a non-scientific audience, things I had not thought of before that I will be able to use in the future as I communicate my research."

"The dry run was immensely valuable. It helped me select appropriate verbiage and content for the presentation. It also helped me gauge the level of delivery. Furthermore, I found the student input extremely important in identifying what their peers would find interesting. After the dry run, I made significant changes to the presentation, including the elimination of confusing content, identification of real-world connections, and simpler examples."

"I think it fundamentally changed my presentation and approach, which was a great learning experience. I still regularly use slides I made for the Café just because they are so clear and concise."

"The dry run was invaluable. Without the input from folks who know high school students well I would have bombed on the first night. I would have talked about network protocols or something, and probably bored the students to tears."

The Essay and Bio

We ask the presenters to write two 1-page essays, one a summary of the science topic as they will present it, the other a 1-page biographic sketch. We work with them on the essays by providing constructive feedback and editing. The essays are posted on the Café website in advance of the Café session in order to stimulate good questions and substantive interaction during the session. The essays are most effective if both take the form of a *story*, as with the presentation itself.

In the bio, the presenter tells his or her own personal story. We stay away from the usual formal—and typically rather sterile—bio sketch. It is much more engaging to the teens if a picture of the real person emerges—where did they come from, how did they get to where they are, what has grabbed their interest along the way, what has pulled them in and what leaves them cold, what their lives are like in their present research position.

We encourage presenters to get across that—in part because of a career in science—he or she is having a particularly interesting life. Scientists are not used to thinking in terms of their personal stories, but each has an interesting and unique story to tell. Telling that story is an important hook for pulling the teens into the science story. We encourage presenters to bring their personal stories into their Café presentations. Some questions that we ask speakers to consider when composing a bio:

- What was your life like growing up in the years before college? Were there particular aspects that shaped your inclination toward science?
- How did your education—formal and otherwise—prepare you for your science career?
- What has been your career path? Has it been fairly linear, or have there been twists and turns? Triumphs and setbacks?
- What drives you in doing your science? What are the rewards that make it worth the effort?
- How did you arrive in your present position? What brought you to your present research?
- Do you have interests and talents outside science that you could share? How do you mesh your life in science with the rest of your life?
- What is the *Most Important Thing* about you that explains why you are a scientist?

The essays and bios have developed into an interesting collection on the Café website at http://cafenm.org.

What Do They Get Out of It?

Focus groups associated with our program evaluations, as well as feedback from questionnaires, indicate that the teen Café format is a useful vehicle for science communication between scientist-presenters and high school teens; both benefit from the interaction.

Benefits to the Presenters

Presenters have uniformly considered their participation in the Café program to be of personal benefit; none has reported a bad experience. We have captured the varied nature of the benefit in responses to a questionnaire (19 of 40 previous participants responded, a 48% response rate). One of the most significant benefits expressed by some was a recognition that effectively communicating their science has fed back into their thinking about their own research, which resonates with the findings of Feldon, et al. (2011). A sampling of responses:

"Both the preparation period (with the dry run and the "telling stories" workshop) and the presentations themselves were challenges that taught me a lot about giving a technical presentation to a non-technical audience. I also emphasize that participating in the whole process and interacting with the youth was very enjoyable."

"I found the Café experience very helpful, as it forced me to focus on the really basic elements of my research and how to communicate them. This is a skill that is important not only for engaging with the community, but also for engaging with decision-makers and funding agencies. In addition, since I am a social scientist and my presentation included an exercise asking students to evaluate the resilience of their own communities to disasters, I gained useful information from the students on the resilience of New Mexico communities. This helped me think more clearly about some of the main issues in disaster resilience."

"The Café experience was beneficial to me as a scientist in that preparing an interactive talk for an audience of young people helped me identify the critical issues in my work: why I was doing it, why it is challenging, what we are trying to accomplish (vs. being bogged down in technical details). This really focused my thoughts about my work."

"It helped me to understand how the next generation of adults will think about issues in which science intersects with public policy. In my area, nuclear waste disposal, there is a significant component of societal input into the controversial issue of what to do with radioactive that will pose a hazard far into the future. I learned that issues of long-term stewardship as well as inter-generational equity resonate strongly with teens. Inasmuch as radioactive waste disposal is an inter-generational topic, it was highly instructive to me to learn that teens feel a long-term responsibility for ensuring that their generation takes responsibility for future generations, given that people today are the ones benefiting from the electricity generated with nuclear power."

"Professionally, I feel it improves my ability to teach to a broad range of people. Sometimes trying to explain science in more simplistic terms helps me see the questions and potential new means of investigating them in a fresh and helpful light."

"It helped me to think about the basics of my research and discipline, and to rephrase the essence of it in simple terms. It was helpful for subsequent presentations for a lay audience."

"I think that the most beneficial part of presenting to the students was to see the true curiosity and love of learning new things that the students expressed. Their enthusiasm for learning was contagious. I was concerned that some of the students might be a bit hesitant to view and handle a human brain, which was a part of my presentation. Instead, they were quite curious and that portion of the session lasted longer than I anticipated."

"It takes a lot of energy and effort…but it was really, really rewarding…I got a lot out of it."

Benefits to the High School Teens

We have sought to enhance teen science literacy through the Café Scientifique vehicle. Our strategy for achieving this has been to portray the nature of science and of what scientists do, while emphasizing the importance of science to the teens' daily lives, by fostering effective communication at a highly personal level between scientists and teens.

Our evaluations indicate that we are having success with this strategy. According to survey results from our summative evaluation (Foutz and Luke, 2010), "[a]nalyses indicate that the Café program succeeded at positively influencing attitudes about science. All the items designed to measure attitudes towards science, scientists, and science-based careers showed statistically significant differences between the participant and non-participant groups...."

The evaluation results show that teens find interaction with scientists interesting, fun, and eye-opening. 71% of respondents agree that the Café has changed their view of the importance of science to their lives. We have often received feedback like, "I think it is important to be a well-informed citizen." The top reasons given by the teens for why they value the program include an intrinsic interest in the learning of new things and associated hands-on activities.

The teens value being able to discuss and argue about issues related to the science topic with the presenter and each other, and they value learning about a wide variety of STEM topics. Respondents to a survey rated the frequency of learning something new about science at 4.5 and 4.7 respectively, where 5 means "happens almost all the time in Cafés". A teen from Los Alamos said, "I enjoyed learning new things and then learning

how they are applicable in the world." Another teen told us, "Since the Café, I see science everywhere, at the store, on the street, and in the park."

The responses also confirm that during events they *learn how science is done* and *think about science in a new way*. The teens report that the science communication at the Cafés has opened their eyes to the interconnectedness of science, that science is not like it is presented in school, with each subject a separate stovepipe. As noted in describing feedback from scientists in focus groups as part of the project's summative evaluation, "[o]ne scientist thought that high school does not give youth a good idea of what science is, saying, 'I don't think they get the sense of excitement that basic science has for the basic scientist.' She felt high school science emphasized facts and not the process of science or how science is helping to solve society's problems" (Foutz and Luke, 2010).

On the other hand, the program has helped teens to make the connections between school and the real world of science. Below are comments by teens concerning their experience:

"Wow, we did an experiment like that in physics last week. I just thought it was another physics lab. I did not realize that you use the same approach to build things that matter, like the MagViz machine."

"I thought chemists just mixed chemicals together all day. I had no idea a chemist would do something like this."

While our program takes place out of school—this the teens regard as a distinct plus—our science communication strategy aligns with the results of research underlying the recent National Academies report, *A Framework for K-12 Science Education* (National Research Council, 2011). In describing support for recommendations of the report by science educators, Mervis (2011) reports that "Research over the past 2 decades has shown that children are more likely to learn and enjoy science if the material appeals to their innate curiosity and if they can see how the subjects affect their lives." It is important to "show how science applies to the real world and how scientists and engineers do their jobs." These are basic tenants of our teen Café program.

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