Karen Elinich

Cycle Two Report
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For Cycle Two, my research question was:

If I provide a structured workshop experience with primary sources, how will teachers decide to use them for K-12 classroom learning?

My Action

To answer this question, I planned and conducted a pilot workshop called "The Nature of Science Through Primary Sources." I invited seven teachers to attend. All seven expressed immediate enthusiasm, but one teacher had a scheduling conflict.

I scheduled the workshop for Monday, May 16, from 4:00PM to 6:00PM. The participants have all attended professional development events at The Franklin Institute in the past, but none had ever encountered any of our primary source materials. All six teachers work in suburban, middle-class communities. All are veteran teachers with a wide range of K-8 classroom experience. Debbie and Sara both teach science for eighth graders in a rostered middle school environment. Lisa teaches grade one in a self-contained classroom. Kathy, Terry, and Dot are partners for the third grade.

In exchange for their participation in the workshop, I provided free parking, light refreshments, and a $50 stipend for each teacher. The teachers understood that this was a pilot workshop for research purposes and, therefore, they would not receive any professional development credits for their time.

I began the workshop by introducing the history of the Institute's Case Files and explaining my interest in seeing the primary sources be used to help in-service classroom teachers understand the nature of science. I deliberately provided significantly more context than I had in Cycle One. I wanted to establish a common level of understanding about the nature of primary sources. I introduced the teachers to Latour's concept of science as a network of social engagement. (None of the teachers had every heard of Latour.) I suggested that science teachers are scientists because of their important actions within the social network.

My introduction lasted fifteen minutes. I then asked the teachers to "pick a partner" and move to one of the three workstations that I had prepared in advance. At each workstation, I had placed two pairs of white gloves and one Case File. I instructed the teachers to wear the gloves while they were

exploring the historical materials in order to protect the file. I asked them to skim all of the documents and then focus on a few that most intrigued them.

I had deliberately selected the Marie Curie Case File because of its centrality to my work in Cycle One. However, I wanted to ensure that the first encounter with the primary sources was extensively hands-on. Therefore, I knew that I needed to have no more than two teachers encountering a Case File at once. I placed the Thomas Edison Case File at the second workstation and the Guglielmo Marconi Case File at the third.

I rotated from station to station, listening in on the conversation and making myself available to answer questions. I deliberately avoided lingering too long at any one station. I had decided to allow thirty minutes for this important exploration phase.

At the conclusion of the explorations, I gathered all six teachers around the Curie File and asked the teachers at that workstation to talk about what they had discovered in the file. They immediately mentioned "Le Radium" and their fascination with its scientific content. Neither of the teachers knew French well enough to attempt a translation, but their knowledge of the universal language of mathematics enabled them to interpret the charts and equations. The teachers who had worked with the Marconi file expressed a similar frustration at the language barrier; some of the Marconi documents are written in Italian. All agreed, however, that there were sufficient English language documents to allow for a meaningful interpretation of the Case File.

Next, I guided the conversation so that the whole group used the Curie File as a case study for talking about classroom applications. Their ideas, detailed below, were thoughtful and creative. As in Cycle One, the teachers seemed to see the Case Files in a cross-curricular context. None of the teachers limited their consideration of the Case File to their science instruction. This view of using a scientist's work across subject areas parallels the idea of a science teacher acting within a larger social network of science.

After a short break, we gathered again at the main table for a discussion about the overall experience. I asked them to discuss the unique characteristics of primary source materials. I asked them to reflect upon the experience they had just had. Each seemed convinced that she had worked with the most interesting Case File. Finally, I asked each teacher to spend a few minutes reflecting and writing about the workshop experience. After ten minutes, I gathered their reflection sheets, concluded the workshop, and thanked them for their participation.

My Research

Cycle Two builds directly upon my findings from Cycle One. Together, the cycles are helping me learn how primary sources are made most useful for K-

12 science education. I predict that the utility is maximized when in-service teachers participate directly in the interpretation of the materials.

For Cycle Two, I am looking particularly at the differences between unstructured, individualized inquiry with a Case File and structured, collaborative inquiry with a Case File. For Cycle One, each teacher first encountered the primary source materials alone. For Cycle Two, each teacher's first encounter was with a partner. Likewise, during Cycle One, I provided virtually no instruction or context. During Cycle Two, I spoke at length about the context.

My Evidence

Throughout the workshop, I looked closely at how the teachers responded to the primary sources. As in Cycle One, I used a simple instrument to record qualitative impressions of the individual reactions. I also subjectively evaluated the quality of each teacher's responses during the meeting using a five-point scale. I also asked my team to use the same instrument to record their impressions. We found it difficult to separate each teacher's enthusiasm and response, since they were working with a partner. I decided, therefore, to represent the observational assessment based upon each two-person team. This table presents our average impressions.

Observational Impressions of Engagement

	Debbie & Sara	Kathy & Lisa	Terry & Dot
Length of interaction with file	30 mins	30 mins	30 mins
Perceived enthusiasm during meeting	5	5	5
Quality of responses during meeting	5	4	4

These impressions, combined with the data directly below, suggest that the use of primary sources for science education may be most impactful at the middle school level. While Kathy, Lisa, Terry, and Dot were personally enthusiastic about the experience of working with primary sources, their connections to classroom learning were more metaphorical. Their strongest ideas connected the Case File to language arts, while Debbie and Sara offered more direct connections to science, math, and social studies. I interpret this difference as a practical function of middle school versus early elementary school.

Classroom Applications of the Curie File

	Debbie & Sara	Kathy & Lisa	Terry & Dot
Science			

	Col 1	Col 2	Col 3
Look at the applications of x-ray technologies		X	
Test the Case File for radioactivity using a Geiger Counter	X		
How does this science build on the work of other scientists?			X
Implications of Curie's work on medical science and life expectancy.	X		
Investigate the science of paper—the primary source material composition.	X		
Trace today's technology back to origins in primary sources.	X		
Social Studies			
Look at scientific timelines and chart the historical development curves.	X		
Consider the role of women in science.		X	
Contextualize the file with the geopolitics of the time.	X		
International nature of science. Not all inventions are American.			X
Role-play panel discussions with scientific competitors.	X		
Math			
Need to understand the metric system for science.	X		
Use half-life data and other numbers from the file for statistics exercises.	X		
Language Arts			
Use Curie's letters as models for student letter writing.		X	
Create an oral history of scientific events by interviewing grandparents about remembered science.			X
Create a resume for the scientist in today's format.	X		
Write a science fiction story inspired by the primary sources.	X		
Write a skit based on an exchange documented in the file.			X
Write a poem inspired by the primary sources.		X	

I looked across the written reflections and extracted key words. The following table presents the commonality of those words or phrases.

Commonality of Reflective Descriptors

	Debbie	Sara	Kathy	Lisa	Terry	Dot
authentic	X					
important		X		X		
exciting / excitement	X	X	X			X
passion		X		X	X	
wonder	X					
awe / awesome	X	X				X
real			X			
connections / connect to life	X	X		X	X	
conversation			X			
treasure						X
humbled / humbling	X	X	X			
profound experience	X					
imagine / imagining / imagined	X	X		X	X	X
expectations / unexpected			X	X	X	

My Analysis

As in Cycle One, I measured success in Cycle Two based upon whether or not I effectively engaged the teachers with the creative process of interpretation of primary source materials. Based upon both the quantity and quality of ideas that the workshop participants generated, I am confident that this was a successful learning experience that deepened my expertise. In particular, I reinforced my belief that primary source documents can generate enthusiasm for learning about the nature of science.

By comparing the data from Cycles One and Two, I do not believe that there is a significant difference between unstructured and structured encounters with the primary source materials. In Cycle One, three teachers generated thirteen distinct descriptors; in Cycle Two, six teachers generated fourteen distinct descriptors. In Cycle One, three teachers generated ten distinct classroom applications; in Cycle Two, six teachers generated nineteen distinct classroom applications.

In Cycle Two, I did begin to detect a significant difference, however, between teachers of elementary grades and teachers of middle grades. The four elementary grade teachers conceived only eight of the nineteen classroom applications. The two middle school teachers suggested the other eleven. And, the eight applications suggested by the elementary teachers were only metaphorically connected to the science presented in the Case File. The middle school teachers were more ready and able to see a specific use for the primary source materials in science education.

During Cycle Two, I began to consider a phenomenon I am calling "white glove syndrome." I wanted teachers to reinforce my belief that encounters with primary source materials can help them develop their understanding of the nature of science. Now, however, the unanimity of that reinforcement has begun to raise doubt. I wonder if the white glove experience was—in and of itself—so novel that objectivity became clouded. In both cycles, every teacher expressed enthusiasm that they could and would use primary source materials in classroom practice. Why were there no skeptics? Certainly, I believed that they all valued the experience, but their universal readiness to use the materials in classrooms seemed unrealistic. I decided to investigate "white glove syndrome" during Cycle Three.

My Reflection

I began Cycle Two with a suspicion that there would be a significant difference between unstructured, individual encounters with the Case Files and structured, group encounters. That difference turns out to be insignificant. However, I did change my thinking about the value of primary source materials for elementary grades. While the teachers expressed enthusiasm and I do believe that they would make creative use of the resources, I'm not convinced that the experience would sufficiently impact student understanding of the nature of science. However, I now believe that the impact may be dramatic for middle grade students.

During Cycle One, I came to a realization that action research is a manifestation of social constructivism because of the way that my interaction with my peers and with the teacher participants helped all of us advance our understanding in various ways. During Cycle Two, I began to reflect upon the importance of conversation and dialogue in the process. In Cycle One, each teacher's first encounter with the Case File was virtually silent. The dialogue happened later, during the final meeting. In Cycle Two, each teacher first encountered the Case File with a partner, so there was immediate conversation and dialogue. The quality of dialogue in both models was high. The teachers in Cycle One actually had more time for reflection and self-narrative during the interlude between their first encounter and the final meeting. I am not yet prepared to conclude that one model is better than the other. I am convinced, however, that some form of dialogue is essential for the participants to make meaning from their experience.