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## Forensic Science in the Elementary Classroom

### *by Todd Campbell and Brianna Worst*

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The National Research Council (NRC), American Association for the Advancement of Science (AAAS), and the National Science Teachers Association (NSTA) are all organizations which promote student inquiry as a central strategy for instruction in the science classroom at all grade levels (AAAS, 1993; NRC, 1996; NSTA, 1998). As a science educator working with pre-service elementary teachers, a central focus in our elementary science methods course is inquiry. While this definition is defined differently by many educators, the starting point for defining inquiry in our elementary science course is the definition provided in the National Science Education Standards:

Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations. Students will engage in selected aspects of inquiry as they learn the scientific way of knowing the natural world, but they also should develop the capacity to conduct complete inquiries (NRC, 1996 p. 23).

This article stems from a pre-service teacher's attempt to translate "inquiry as a theory" into "inquiry as a practice" in a science classroom. It is intended to provide a snapshot of grappling with inquiry instruction, from both a pre-service teacher and a science teacher educator's perspective, while also offering approaches for allowing students to engage in scientific inquiry by posing questions and working toward solutions. Lastly, this article offers what the teacher researcher and the teacher educator learned in the pre-service preparation program.

As part of the elementary science methods course, pre-service teachers were asked to design an inquiry-based lesson for peer instruction. This peer instruction opportunity allowed the pre-service teachers to plan a lesson, prepare and gather all materials for their lessons, teach their lesson to their peers in the methods classroom, and receive feedback from their peers and the instructor regarding their instruction. Peer instruction has been widely employed in the professional development of both pre- and in-service teachers. In pre-service teacher education programs, peer instruction has served as an induction program (Harlin, 2000) promoting collegial relationships between in-service teachers leading to "reciprocal, in-class assistance . . . as they attempt to incorporate new teaching skills, strategies, and approaches into their teaching (Neubert & Stover, 1994 p. 8)". Further benefits of peer instruction opportunities are revealed in

Emmer's (1970) study, where it was found that instructional behaviors acquired as a result of teaching to peers in a simulated environment transferred to settings with actual students in the classroom.

In the elementary methods classroom, peers and the instructor assumed the role of the science students enabling each of the elementary methods students the opportunity to assume the role of the teacher. Brianna, the teacher research and one of our elementary pre-service science teacher candidates, designed a forensic science lesson aimed at enabling students to investigate many different facets of fingerprinting including: their prevalence in environments long after subject leaves an environment, the uniqueness of individual's fingerprints, and the categorization of different types of fingerprints.

The lesson began with Brianna demonstrating a procedure for using baby powder, a paint brush, scotch tape, and glossy back paper to extract fingerprints from a clear plastic cup. The initial activity served to motivate the students to learn about the topic through providing concrete examples for examination. A brief discussion followed the demonstration, as to the reason such a method might be employed and by whom. After the discussion, Brianna gave each student their own zip-lock sandwich bag of baby powder, paintbrush, glossy black paper, and tape and asked them to scour the classroom for fingerprints. Students moved around the room, guided by their own ideas of where fingerprints might be obtained, and preceded to assemble their own collection of fingerprints. After 10-15 minutes of fingerprint collection, the class moved back to a large group setting to share their finds. In describing the rationale behind allowing students to collect their own samples, Brainna stated "I wanted to give my 'students' every opportunity I could to gather information on their own".

Following the sharing of the finds, Brianna asked the class to help create a KWL chart about fingerprints. Brianna shared the following rationale behind the decision to incorporate the KWL chart:

By constructing the KWL chart with my "students", I enabled them to come up with their own questions they wanted to learn about. This chart gave the lesson a more personal touch. Also by constructing the KWL chart, I thought it would help to elicit the schemas of my children. The activity, I believed, would get the students motivated and capture their attention for the lesson to come.

In the K column, what students know, students offered the following: 1) all fingerprints are different, 2) everybody has fingerprints, 3) fingerprints can be found almost anywhere, and 4) some surfaces are better for capturing fingerprints. These knowledge statements, while coming from Brianna's peers and myself, acting out the role of elementary students, represented our prior knowledge, including the knowledge gained in the opening exploration activity.

When Brianna moved to the W column of the KWL chart, what students want to know, the following questions emerged: 1) Does it matter which finger a print comes from?, 2) Are all fingerprints on a person's hand the same?, 3) What are the names of the things on the fingerprints, 4) Do your fingerprints change?, 5) Do your toes have prints, 6) If your fingers get wet, do your prints change?, and 7) Can you get rid of your fingerprints, burn them? clean them?

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As the science teacher educator and in my role as an elementary student in the peer instruction, I volunteered the question "Are all fingerprints on a person's hand the same?" This question arose a few days prior to the lesson while I watched Crime Scene Investigation (CSI) on television. It is not necessarily the question that is important, but what it represents. The question is based on my prior attempt to gain an understanding about the technological processes involving matching fingerprints found at crime scenes with their owners. While I thought I understood that each person had their own unique fingerprint, I wondered, as I watched the television show, how a fingerprint might be matched to a criminal if it was unclear which finger a print came from. When I was able to ask questions, I wanted to use the opportunity to make better sense of something that did not match the simplicity that I had originally understood about fingerprinting. Because I was given the opportunity to ask my own questions, the classroom lesson became personal and relevant. I did not ask "Why did I need to know this?" but instead I asked, "How can I find this out?"

There are two endings to this forensics lesson, the one that Brianna facilitated followed by her rationale behind the ending and one which was not facilitated, but suggested as an alternative ending, along with the rationale behind the suggestion. In the first conclusion to the lesson, Brianna shared a PowerPoint presentation with statements about fingerprints she gathered from various sources. Brianna explained her decision to facilitate the lesson in this manner, "Although I did not allow them to gather the facts on their own or work towards gathering the facts, I did allow them to gather supporting evidence to use as concrete examples". As each slide was shown, Brianna asked students how the information found in the slides might or might not lead to answers for the students' original questions in the KWL chart. An example of one of the statements was, "Fingerprints are formed in the fetal stage and remain the same throughout lifetime, barring disfiguration by scarring". This statement led students to an answer for their question from the KWL chart, "Do your fingerprints change?". Through this process, students used critical thinking skills to look at how the information related to the original questions form the KWL chart. Brianna facilitated the lesson in a manner that fostered the development of higher-order thinking. An example of Brianna fostering higher order thinking can be seen in the following interaction between her and her peers/students:

Teacher: There are two rules of fingerprinting. [Student A] Can you read these two?
Student A: They are permanent. Fingerprints are formed in the fetal stage and remain the same throughout a lifetime barring disfiguration.
Teacher: Does anyone know what barring means?
Student B: Except
Teacher: Except. What might be disfiguring?
Student C: I got a cut and it came out on my fingerprint.
Teacher: Anyone else?
Student D: If you touch the hot stove.
Teacher: Burning might alter your fingerprint?

In this interaction, Brianna is engaging her students in "higher-levels of the hierarchy of cognitive processing (Manzo)". More specifically, she is helping students move up the hierarchy of thinking associated with Bloom's Taxonomy by seeking students' "evaluation-level of thinking

(Manzo)". Brianna also accepted students' answers and generally followed these answers with clarification statements and additional information related to the original information.

In describing the rationale behind the first conclusion to the lesson, Brianna stated,

I was trying to create a lesson with as much student involvement and interaction with the environment as possible. I believe the vital pieces of science instruction are the relation to real life, student understanding of how science affects their lives, and how science can be used helpfully or even harmfully.

Throughout the lesson, students were engaged. Students could be seen scurrying around the room to locate and collect fingerprints, moving to the front of the classroom to use the board in articulating their understanding, and using ink pads to take and identify their own fingerprints before comparing them with those of their classmates. Students were given time to explore and opportunities to work with hands-on manipulatives. Students were allowed to ask their own questions, and through the information presented in PowerPoint, were using higher-order thinking skills in working toward answering their questions.

While Brianna's lesson provided instruction far removed from viewing students as "blank slates" awaiting information from the teacher, behaving in a didactic manner as a disseminator of information, and seeking correct answers in validating student learning, all characteristics that Brooks and Brooks (1999) labeled as traditional teaching, our discussion following the lesson led to the suggestion of another possible conclusion. When referring back to the questions generated by the students, it was apparent that a majority of the questions could be categorized by what Llewellyn (2003) described as questions that were "ready to be answered". An alternative route would have the teacher refraining from giving the students information from experts, which sometimes demands blind acceptance by faith and instead having students' complete inquiries for themselves. Students would plan investigations geared toward answering their own questions, carry out the investigations, analyze the data accumulated from the investigations, and share their conclusions to the questions with peers.

Examples of planning investigations that might have emerged to answer the student generated question "Does it matter which finger a print comes from?" might have students using ink pads to collect their own and their peers' fingerprints, deciding how to determine if a print is identical or not, and relying on the conclusions made by the group as a whole to answer their questions. Another example of an investigation that might have emerged from the student generated question "Do your fingerprints change?" might have students seeking resources outside the classroom, their own fingerprints at a younger age which they could compare to fingerprints they recorded during this lesson, or the fingerprints of someone else at two different time periods.

The alternative conclusion offers students a chance to take ownership and to participate in knowledge construction. It also offers students the opportunity to experience the creativity inherent in science, as a step toward curtailing bright students' rejection of science as a career because they were shielded from seeing the creativity involved (McComas, 2004). This alternative approach also implicitly teaches students about the "nature of science". They recognize science as processes leading to conclusions based on empirical data that may not nicely conform to the sterile steps of the scientific method, but which are no less scientific than processes that do. This alternative approach also lends itself to the explicit teaching of the "nature of science" with emphasis on the biases underlying methods and conclusions in science, as well as the social influences that direct science, such as the technological advances of the forensic field that have been driven by an ever increasing societal need for advance methods of controlling crime.

## What the Teacher Researcher Learned from this Experience

In an effort to investigate what long term effects this peer instruction opportunity had on the teacher researcher, the teacher researcher end of the semester essay summarizing her educational philosophy as it pertains to science teaching is shared.

. . . I myself define science as the study of anything that affects your life. There are many different forms of science including, but not limited to, social sciences, behavioral sciences, physical sciences, and life sciences. All of these different sciences all effect us in one way or another, whether it is the study of our body, our environment, our brain, or our society, they all have a profound importance in our survival and happiness. In order to study these different "phenomena", as the dictionary identifies them, we must engage in observations and experiments. We must have an interest in what we are learning and we must realize that it will have an influence on our life in one way or another . . .

My teaching of science will rely heavily on the impact that each topic will have on the student. They will understand that everything in this world interconnects and everything has influence over everything else. I will urge my students to question things they find problematic, and search to find a solution to the things they see as problems. They will be working with their hands as much as possible but also will have a tremendous part in the forming and facilitation of information for the classroom. There will be ample opportunities for students to study anything they find interesting or are curious about. While there will not be enough time to engage in every activity in class, I will provide support and the opportunity for students to come in early or stay late to work on things and promote the students to inquire about things while they are at home. These inquires will not only be prompted in the science field but in every other content area as well.

Brianna's essay offers a glimpse into her thoughts about science teaching as she exited this elementary science methods classroom. While the understanding that is articulated about science teaching in this essay is not a direct discussion of the forensic science peer teaching experience, it does depict what Brianna has come to believe and share as her educational philosophy at the conclusion of elementary methods course.

## What the Teacher Educator Learned from this Experience

First and foremost, my involvement role playing an elementary science student, allowed me to consider my own learning. What facets of the lesson excited and motivated me as a student? What reactions did my students, other role playing elementary science students, and I have to the differing opportunities given to us in the lesson. My experience gathering fingerprints and sharing questions for the "W" column of the KWL chart were those that excited and motivated me the most in the lesson. While I participated in helping to create the "K" section of our KWL chart and listened attentively as Brianna shared information with us about fingerprints, I did not feel the same motivation and excitement about the lesson as I did collecting fingerprints and asking questions in the "W" column of the KWL chart. As a teacher educator this experience allowed me, although in a somewhat artificial environment, to put myself in the position of students to analyze the lesson from a different perspective. It allowed me to consider those things that students might value most about instruction and to consider what the teacher was doing to allow me to value the experience.

This experience along with the other peer teaching experiences throughout the semester allowed me to understand the extent to which the pre-service teachers valued the opportunities afforded them as they engaged in peer teaching. In a survey given at the end of the semester, each student was asked to identify the assignments and activities that were most helpful to them throughout the semester. There were six students in the class and four of them listed the peer teaching experiences as the most helpful. The following are a few of the reasons cited:

- Peer teaching [was most useful] because it gave me a way to express myself and show the class. Also allowed me to evaluate my teaching effectiveness.
- The teaching allowed us to get better feel for creating and implementing lesson . . . It let us see how out lesson went compared to how we wanted it to go.
- Peer teaching helped improve my ability to communicate.

When asked to identify the assignments and activities that were least helpful to them throughout the semester, only one of the students listed the peer teaching experiences as least helpful, stating "I didn't value these experiences as much as the others". The identification of those experiences students found most and least helpful throughout the semester helped me to recognize the value most students placed on the peer teaching experiences, while also understanding that not all perceived these experiences in the same way. When I further questioned the student who identified the peer teaching experience as least useful, he explained,

When I said I didn't value it as much as the other experiences, I didn't mean that I didn't value it altogether. I thought it was a great experience, but I think in the future I would rather teach a class on my own. I like having complete control, but that's not to say I wouldn't be open to another co-teaching experience."

It appears that this student's assessment that the peer teaching experience was not as useful as he would have liked because he was not able to complete both peer teaching opportunities throughout the semester by himself. During the semester, students taught one lesson by themselves and another with a partner. The information provided by this student will warrant closer attention in future semesters to the differences in the students' experiences when peer teaching alone compared to peer teaching with a partner in an effort to continually assess those strategies employed in the methods course.

Another resource used to collect information about peer teaching was employed after Brianna taught her lesson. Upon the completion of the lesson, students were asked to complete an

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electronic rubric assessing the lesson. One initial concern that I had as a teacher educator was the extent to which peers would feel comfortable providing critical feedback to each other, critical here meaning "exercising or involving careful judgment or judicious evaluation (Merriam-Webster Online, 2005)". While only four of Brianna's five peers participating in the lesson provided feedback, evidence of critical and judicious evaluation could be found. Examples of the critical feedback received from peers can be seen in her peers' responses to the following indicators from the rubric:

I believe that Brianna's lesson emphasized ....

- 50% responded: Treating all students alike and responding to the group as a whole. ( A less desirable rating identified by the NRC, 1996 p. 52)
- 50% responded: Understanding and responding to individual students' interests, strengths, and needs. ( A more desirable rating identified by the NRC, 1996 p. 52)

I believe that Brianna's lesson focused on ....

- 25% responded: Student acquisition of information. ( A less desirable rating identified by the NRC, 1996 p. 52)
- 75% responded: Student understanding and use of scientific knowledge, ideas, and inquiry processes. ( A more desirable rating identified by the NRC, 1996 p. 52)

These are just two examples of the critical feedback Brianna received from her peers. They are presented as instances during the peer instruction where students did engage in critical evaluation of her lesson. Neubert and Stover (1994) state that "learning to teach involves cognitive engagement" (p. 12); this feedback provided by Brianna's peers offered fuel for such cognitive engagement.

Being able to explore my own thoughts as I took the role of a student in the peer teaching experiences, recognizing the value that the pre-service elementary science methods students placed on the peer teaching experiences, and witnessing peers' abilities and willingness to offer critical feedback to peers to incite cognitive engagement are all valuable insight that I, the teacher educator, gained as a result of facilitating peer teaching with pre-service teachers.

## Conclusion

Regardless of the conclusion that is chosen as a culmination to the lesson, this peer teaching experience in the elementary science methods classroom allowed both Brianna, the teacher researcher, and me, the teacher educator, to grapple with and progress toward the reforms advocated by the NRC, AAAS, and the NSTA. As Brianna, a representative of the future of elementary science education in our country, transitions into in-service teaching, and as I look to better understand the intricacies of facilitating in-service teachers' understanding of inquiry instruction, we will have benefited from our attempt to translate the theoretical tenets of inquiry into practice. As a result of the feedback and discussion following her facilitation of the lesson, I believe that Brianna and I have come closer to realizing the challenges that Parker Palmer describes as awaiting all those who wish to excel in the teaching profession:

Good teaching is a mystery, a primal and powerful human experience that can neither be ignored nor reduced to a formula. To learn from mystery, we must enter with all our faculties alert, ready to laugh as well as groan, able to 'live the question' rather than demand a final answer. When we enter into mystery this way, we will find the mystery entering us, and our lives challenged and changed.

Our hope is that our openness with our thoughts and methods will not serve as the "answer", but rather a catalyst for others as they continue to explore the intricacies of inquiry instruction in the science classroom.

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