



**Acadia Partners**  
*for Science and Learning*

## **Interim Report – Year Two**

### **Professional Partnership and Praxis: An innovative approach to supporting teachers through the professional development cycle**

*Bill Zoellick  
Acadia Partners for Science and Learning  
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The report provides MDOE with a mid-course update on our progress toward our objectives in the Mathematics/Science partnership grant over the course of this 2008-2009 school year. This is the second year of work on this project, which commenced in the summer of 2007. At the end of the report we provide a tabular summary of progress toward objectives as identified in Appendix A of the grant proposal for this second project year.

### **Brief Background**

During the first year of the project we worked with two high schools and two career and technical education schools in a program to provide professional development and other support for teachers as they acquired skills and developed programs to engage students in scientific inquiry and in exploration of the dynamics of natural systems. During the first year the professional development focused on improving scientific content knowledge in subject matter related to studies of airborne pollutants as they move through a watershed. The assumption, based on research literature emphasizing the importance of content knowledge (NRC, 1996; Supovitz & Turner, 2000), was that content knowledge was the principal professional development requirement necessary to enabling more successful use of scientific inquiry in classrooms.

Our initial year's experience confirmed the importance of content knowledge, but also revealed a variety of other professional development needs associated with successful science inquiry in the classroom. They included:

- training and practice in helping students formulate questions that they can answer and hypotheses they can test by collecting data
- training in the use of simple statistical methods to analyze and understand data and in introducing these methods to students
- models, planning tools, and other assistance in connecting the fieldwork and inquiry to the in-place science curriculum
- models and tools to use in formative assessment of student learning

The second year program was designed to address these needs.

## Review of Objectives

The objectives for the second year of work are to:

1. Provide professional development for math, science and CTE teachers, including teachers not served in the first year, in the use of field research, student inquiry, and inquiry-based instruction.
2. Increase student engagement in experiential, field-centered, hands-on research.
3. Improve student understanding of the structure and dynamics of natural systems and of the nature of science.
4. Improve understanding of innovation diffusion and barriers to such diffusion in groups of teachers.
5. Strengthen cooperation and sharing between CTE teachers and high school teachers.

As an overarching objective we also hope to introduce more teachers and students to Acadia National Park and to the scientific work that goes on there.

In pursuit of these goals we have greatly expanded the number of high schools and CTE programs engaged in the project.

	2007-08	2008-09
<b>High Schools</b>	Nokomis Mount View	Nokomis Mount View Sumner Scarborough Old Town MDI Lewiston
<b>CTE Programs</b>	Waldo County Tech Ctr Tri County Tech Ctr	Waldo County Tech Ctr Hancock County Tech Ctr Augusta Portland Region 10 Lewiston

This substantial program expansion was motivated in part, of course, by a desire to take the program out to more teachers. It was also motivated by a research goal: We needed to assess program outcomes across a wider variety of schools.

## Research Questions

In addition to the substantial professional development objectives associated with this project, we are also pursuing a few research questions that have emerged from this work. They include:

- Can concept mapping be a useful tool for teachers to use in formative assessment?
- Can concept mapping be a useful tool for teachers to use in organizing the connection between the inquiry field work and the in-place curriculum?
- Are there differences in the views that teachers have regarding the nature of science (NOS), and, if so, are these differences associated with the way that teachers approach inquiry?
- Are there differences in the views that teachers have of science education—in particular, with regard to “traditional” views of science education and “constructivist” views—and, if so, are these differences associated with the way that teachers approach inquiry?
- What do students understand about NOS and do these views change over the course of their engagement in inquiry-based field work?

## Overall Program Scope

As noted above, the program has expanded from two high schools and two CTE schools in its first year to seven high schools and six CTE schools during this second year. Thirteen high school teachers and six CTE teachers are involved in research projects with students this year. (This is up from five high school teachers and one CTE teacher who involved students in research last year. All of these teachers are participating in the second year of the program.)

The program will involve between 300 and 350 students in field research over the course of the current school year. Most of these students are freshman and sophomores.

## Outputs

One significant change in the program during this second year is that the classroom research is now focused in one general area of study. During the initial year we allowed teachers to develop research topics of their own. This year all of the projects are related to the research into mercury deposition and bioaccumulation that has been underway at Acadia for more than two decades (Kahl, et al., 2007). There were several reasons for this change:

- Teachers expressed strong interest in having students participate in citizen science work in which students would be collecting valuable information that is useful to Acadia National Park.
- Concentrating on one area made better use of scientist resources.
- During the first year we found that teachers needed significant support with regard to the content area of the study, including support regarding sampling protocols and more. Focusing on one general area made it possible to provide this support.

- Having all classes work in one general area facilitates sharing between teachers.
- Focusing on one area enabled us to develop curriculum materials for teacher use.

This last point relates to another significant difference between the first and second year programs, which is that ***our team developed detailed teacher guides for the current year's program***. These guides are an output of this funded work and are available for use by other teachers in other programs. We will make them generally available on our website after this first year of development and refinement. Samples are included with this report.

## What We Have Learned To Date

All work with teachers and students and all data collection is still in progress. Consequently, all results at this point are partial and tentative.

### *Teacher Views on NOS*

Our survey results to date (not all teachers have responded yet) indicate that teachers have a reassuringly solid grasp of the key concepts, ideas, and beliefs underlying the nature of science. The only place where the responses to date show a little fuzziness in teacher understanding is with regard to the difference between a scientific “law” and a “theory.” We feel that this is a minor matter and more an issue of terminology than one that would cause concern about a teacher’s understanding of what science does and how it does it.

### *Traditional and Constructivist Views*

Survey results collected to date indicate that we have a mix of teachers tending toward more traditional views of science (Science = Truth) and others tending toward more constructivist views (Science is constructed by scientists and reflects societal values). That is an interesting finding and one that might help us better understand differences in teacher application of the professional development that we are providing.

### *Student Understanding of NOS*

Maine’s Learning Results identify the importance of helping students understand what scientific knowledge is and how we create it.

To date we have responses from approximately 230 students to the “Student Understanding of Science and Scientific Inquiry” (SUSSI) questionnaire (Liang, et al., 2006). These are pre-test scores collected prior to engagement in the inquiry phases of the student investigations.

*The survey results collected to date indicate that students have a general lack of understanding of what scientific knowledge is, of what is involved in creating such knowledge, and of what scientists do.*

Student responses to the survey indicated the following misunderstandings:

- Confusion between observations and facts leading to a belief that different scientists will agree on what was observed.
- Lack of understanding of what scientific laws and theories are and of how they differ. (As noted above, teachers have this same problem to some degree.)
- Some confusion about the potential for social and cultural beliefs to influence scientific work: Many students believe that science is unbiased and independent of society and culture.
- A belief that there is some single “Scientific Method” and that, when this method is followed, results are true and accurate.
- The belief that scientists do not make use of imagination and creativity in their work.

These last two beliefs were particularly strong and consistent across classes. The general pattern, across all the classes, suggests a view that science consists primarily of unearthing facts that exist in the external world, rather than an active and ongoing construction of knowledge. The strength and consistency of this finding suggests that this could be an important and general problem.

### *Concept Maps*

We have encountered unanticipated difficulty in working with teachers to use concept maps (Novak, 1984) as both a formative assessment tool and as a way to organize and express the connection between the field-based inquiry work and the in-place curriculum. We have found that most teachers are familiar with the term “concept map” but do not have experience with using them. This is serving as the impetus for new professional development work.

### *Use of the Online Resources*

A few teachers make frequent, consistent, and deep use of the online discussion site and the supporting materials that we have collected on the website. Others visit it fairly often but are not active participants in discussions. Sustained interactions between teachers are rare.

### *Engaging Students in Developing and Testing Hypotheses*

This is still a difficult area for many teachers in the program – perhaps THE most difficult thing we are doing with them. It is also an area where there has been some active website discussion.

Here are some excerpts from that discussion. The first comment speaks to the important (and complex) connection between the citizen science and educational dimensions of this kind of work.

I see an inevitable (so let's call it a healthy) tension in this project between offshoot questions and conducting research with an aim. It may be a truer representation of how science gets done to have students work together in a structured inquiry. I think about graduate student master's theses. Usually, the master's candidate falls in line with a lead researcher's ongoing projects.

My students think that they are providing a service -- that they are doing this for other people. So the goal has not been communicated as gratifying an individual's personal question about how nature works.

Because we had the whole course to devote to the project (I'd like to acknowledge that we may fall flat on our faces) we took on a multi-faceted inquiry and have been collecting data in a quite predetermined way to accomplish some objectives: to describe the watershed physically as a system, to get specimens so we could ask questions about Hg biomagnification in parts of food webs in each stream and to collect similar trophic status organisms from the 4 streams so we can look for differences across the streams. We can relate the Hg stuff to the physical stuff.

The students are going to be heavily responsible for formulating the questions. In fact, fights could break out and it could get ugly. The teams are going to have very different jobs, but it is not really about autonomy, it is about coordinating efforts to bring the parts together into the whole and getting the work done. Things will be discovered, and a host of second generation questions will be suggested and this is exciting, but they are not doing it for themselves.

Later, from that same teacher ...

In attempting to form these hypotheses with my crew, we are headed into uncharted territory and I am filled with fear, especially about structuring classroom activity so they have the feeling of authorship. But that's why I did this, for the thrill.

Generating hypotheses is different from many other activities in school. The focus is on successfully engaging in a process that results in knowledge, rather than just on the knowledge itself. The fact that this work is so unlike other school work can make it difficult for students and teachers. Here is a comment from another teacher, speaking to these difficulties.

It has been a little painful, but we are ALMOST to a set of focused research questions. I found I had to give students examples of some hypotheses from other mercury studies and discuss why they worked. Then we looked at a few of the student hypotheses and put them out there to the whole class to decide if they were ready to go or if there were some crucial flaws. Their final question guidelines were:

- 1) They have to be testable with the equipment we have at our disposal e.g. no mercury in water questions, no fish questions
- 2) They have to relate to mercury (surprising, but many questions had to do with insect abundance or size of insects)
- 3) They had to be specific
- 4) They had to be a relationship question and not a yes/no question. Many of the first round questions were "Will soil have mercury in it?"

I think it would have been helpful to spend some time discussing variables beforehand. Lessons for next year!

Despite the challenging nature of this kind of teaching, most teachers find it rewarding and worth working at. Here is a comment from yet another teacher.

I am moving to develop hypotheses over the next week or two and I am going to try utilizing a group concept mapping exercise prior to formulating hypotheses - but I have an additional twist besides our leaf litter collection in my Biology classes; My groups will be looking at leaf litter, [another teacher's] groups will look at invertebrates from the same locations, and [a third teacher's] Chemistry classes will be looking at hair samples from students. While I intend having my students hypothesize on leaf litter we intend to be taking an overview of three trophic levels in our "systems" here at [school name] - I believe this is going to be even more fertile ground for further hypotheses development once we have data available to look over from all three of our groups.

## Next Steps

We are still very much in the middle of this process. Over the coming months we will:

- Initiate new studies with teachers who will be looking at mercury in fish tissue.
- Initiate work with a new set of teachers – probably focused on mercury in macroinvertebrates.
- Initiate work with CTE health occupations programs focused on mercury in humans.

- Data from the initial studies are just now coming back from the lab. That means we will begin work with all teachers on helping students graph and analyze the data using simple statistical methods.
- We will do SUSSI (nature of science) post-test work with as many teachers as we can. (Not all want to take the time.)
- We will work with teachers and students to create poster presentations summarizing their thinking and findings
- We will host a series of symposia around the state in which students will present their findings.

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