Proceedings

Of the

Second Annual

Convergence on Inquiry

24 May, 2004

American Museum of Natural History

Proceedings
Abstract

These proceedings tell many stories:

I. First, there are stories of science and social studies teachers from New York City and New Jersey who challenge their students to inquire, investigate and reflect on their learnings. These stories tell of teachers' *sharing control* with students who pose significant questions leading to investigations of key concepts within the curriculum.

II. Second is the brief narrative of our field trip to the Exploratorium and the need for all of us to *experience the inquiry process* first hand, *reflect on the process* and *model it* for our students.

III. Third, we include the story of research on inquiry-based teachings, from Project Inquiry and from the National Research Council report. We are learning of significant, positive effects on *achievement, attitudes and process skills.*

IV. And, fourth, we conclude with stories of four scientists who have asked key questions of nature, conducted their own long term investigations and shared their reflections on the process of inquiry with us–"*We live inquiry all the time."*

We hope these stories of teachers inviting their students to participate in what comes naturally to all of us early in life–asking good questions–might encourage others to embark upon one of education's most exciting journeys–that of becoming an ever more inquisitive person.

John Barell
AMNH / NCSLET
September, 2004

*Initial Notes taken by Bunny Jaskot

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Welcome and Introduction

This was the second annual Convergence focused on inquiry-based teaching. We added several elements to our major focus last year, that is "Stories of teachers." Those additional elements include: 1) An inquiry experience at the Exploratorium Exhibit at AMNH; 2) A brief look at research on inquiry-based teaching and 3) A Buffet with Scientists designed to identify what they have learned about the inquiry/investigative process.

Greg Borman, NYC Board of Education Instructional Specialist, indicated his interest in using Inquiry despite the emphasis on standardized testing. "We want to do more sharing of inquiry based learning in the classroom" in the New York City Schools.

John Barell (AMNH) modeled his own inquiry processes with a story of a box turtle. Observing the turtle in front of a basement door. "How did it get there? Where had it spent the winter?" and "Why does it always appear once a year?". If we want our students and colleagues to engage in inquiry, we must be ready *to model* our own inquisitiveness, share our own curiosities about the world.

I. Stories of teachers challenging students to pose good questions:

A "One vote doesn't really matter…or does it?" Maura Lincoln and Paul Kotlewski, Caldwell-West Caldwell, NJ Grade 7

Key concepts: **Group action project to effect change within community; students confronting major discrepancy between ideas in books and realities at home that lead to good questions and investigations; trusting our students to make good decisions; teacher-guided questions; role of media specialist; and informal, reflective assessments.**

Maura Lincoln and Paul Kotlewski, seventh grade social studies teachers shared their month long inquiry project, inspired by simultaneous involvement in a graduate course on innovations at Montclair State University and a teacher study group on inquiry.. Students learned that only a few people voted for the school budget. "They'd been studying about democracy and when they learned that only 6.8% of eligible voters did actually vote, they were really mad!" After an involved discussion, the teachers realized that this was a great opportunity for inquiry that could lead to developing an active citizenry.

Maura and Paul helped students set up a structure for inquiry including these questions about the newspaper article they had read:

1. How does the article relate to the American voting process?
2. How does this article reflect on American citizenship and the importance of democracy?
3. Why do people vote and/or note vote?

Their guiding question was, "What can we do to double the vote turnout in the next Caldwell-West Caldwell Board of Education election?"

Using previously developed research skills, students conducted their investigations.

Action Plan

The students worked collaboratively establishing a wide variety of committees: Advertising, Survey, Community Liaison, School Liaison, Vote Advocacy, Media, Letter Writing and Speech Writing Committees. Students' action plan included visits to nursing homes, articles for newspapers, interviews, info-mercials for local television.

Students made decisions, made mistakes and learned from the process.

Their efforts were rewarded with an increase from 6.8% to 11.3% of eligible voters turning out and the passage of the school budget.

Resources

Newspaper articles identifying the need/problem; election board officials/League of Women Voters representative; Prentice Hall Civics text; Video "Rock the Vote," and these websites:

League of Women Voters–http://www.lwv.org
"Project Vote Smart" http://www.vote-smart.org
"Rock the Vote" http://www.rockthevote.org

Reflection on the Process

What did they learn about inquiry? "You've got to step back and it [inquiry] will happen," said Maura. Paul noted that "Success is in the eye of the person doing the work." Both agreed that you have to learn to trust the students.

Both Maura and Paul lauded the efforts of their media specialist, Wayne Rush, who threw open his doors, saying, "Come on in! What do you need?" Such support was vital to the success of this project.

"Thinking and putting it all together was the main point of students' activity
This voting experience actually got the students and their parents involved."

Follow-up Question: "How did you assess this?" Several members of the audience spoke about creating rubrics; having students create their own rubrics for key concepts. Maura and Paul used a Group Collaborative Skills Category to help students assess Helping, Listening, Questioning and Respecting. Other categories might include: Presentation; Knowledge of Content; Critical Inquiry and Thinking Skills and Use of Media.

Their major assessment instrument was a self-reflective essay with these guiding questions: "How did you personally make this project a success?" "Is there more to success than just reaching your goal?" "Was there an area or action that could have been improved?" and "Explain what you have learned through your inquiry project."

Key Idea: Students' inquiry was stimulated by confronting the conflict between the reality of voter apathy and textbook principles of life in a democracy.

B. "Eco invaders (nutria, kudzu) and Biology," Dorian DiBlasi (Burnet Hill School, Grade 5) and Maria Cannizzaaro (Science Supervisor K-8), Livingston, NJ.

Key Concepts—**Learning to be less prescriptive and allowing students more control of their own questioning; using stories of young scientists to stimulate curiosity; managing learning stations during the unit; fostering inquiry within the district curriculum.**

Dorian shared her unit on ecological invaders, like nutria and kudzu. She described how she got students involved and interested by using stories of Young Naturalist Award winners from AMNH (available in book and on at http://www.amnh.org/nationalcenter/youngnaturalistsaward/). These stories sparked students to ask, "Where do these organisms come from?" and "How did they get here?" Dorian worked with native plants and exotic invasives.

Students managed the work in stages using four classroom stations for fifteen minutes each day of the unit. Students generated questions, conducted research and shared their findings through posters with their classmates.

Dorian aimed to **be less controlling**. In the unit she shared at the first Convergence (May, 2003) she gave them more information. "Last year I told them to go to Ology (http://www.ology.amnh.org) ," for example. "I was more prescriptive then. This year they showed such an interest in eco invaders that they chose to do the projects. They generated their *own* questions and answers:"

"What is the name of the organism?
What does it look like?
Where is the organism from?
How did it get here?
How has it affected the environment?
How does it interact with other organisms in the ecosystem?
If it is invasive, how can we get rid of it?
What are some interesting facts about this organism?"

Students searched textbook and on-line resources like those of AMNH (especially Ology).

As a culmination students presented their findings to each other in the form of posters.

Dorian and Maria, science supervisor K-8 for Livingston, stressed that *all the work on the eco invaders dealt with major concepts and ideas within the district curriculum*. This is a most important point because inquiry-based instruction can and must help students gain deeper understanding of important concepts and ideas within the district curriculum.

Dorian's prior project can be viewed at the AMNH Inquiry Network website: www.amnh.org/learn/musings/network/index.php.

Key idea: Students assuming more control and responsibility for their own inquiry processes.

C. "Can monkeys play baseball?" Dr. Bob Marraccino, Biomedical Technology Program, Tottenville High School, New York City.

Key Concepts: **Long-term inquiry and project-based learning; confronting key questions; thinking critically about evidence and conclusions; working with AMNH web resources; teacher and students generating unit questions.**

Posing the Question: "We commenced the unit with the question, 'Can monkeys play baseball?' Students initially respond, 'Yes!' We examined the typical evolution illustration of direct lineage from monkeys to human. We then asked, 'How can we prove or disprove whether monkeys can play baseball? How are monkeys related to humans?'"

"Examining the typical evolution illustrations of direct lineage from monkeys to humans we asked 'Is the anatomy right? Is this an accurate picture of monkeys' relationship to humans? What is implied by this illustration? Could monkeys play ball?'" Students were also curious about the nature of evolution, its processes and artifacts.

Gathering resources/information: We visited the web site for **Resources for Learning** (www.amnh.org/resources) to gather information to answer these guiding questions. The class visited AMNH to learn about hominids and made cladograms in the Hall of Human Biology with side trips to the Hall of Dinosaurs. Back in school we took a virtual tour of the permanent collections with the teacher's guide: http://www.amnh.org/exhibitions/permanent/other/evolution.html, and downloaded the guide. The students wrote a virtual tour guide for the Hall of Biology and Human Evolution, and organized the information in a PowerPoint presentation from pictures taken on the class trips.

After our virtual tour, we answered the question "What are the characteristics that distinguish the Hominid group that includes humans from the other primate species?" We visited the site: www.becominghuman.org: In addition, we read ***Natural History*** magazine to gain other perspectives about human evolution from12/02-6/04 (http://www.naturalhistorymag.com). .

Laboratory Investigation in Class: Thinking critically and application of knowledge: Applying their knowledge, students looked at scale-model replicas of skulls of humans, monkeys, other primates and hominid ancestors making careful measurements of distinguishing characteristics. Students further investigated a comparison of genomes, brain size, and culture of monkeys and humans to confirm their predictions that we are more like the Genus–Homo than like ancestors relatives of monkeys.

We then returned to one of our original questions, 'Can monkeys do complex motions? Could they throw a ball or catch it?'

Student Conclusions:

Students discovered that there is not a direct line of ascent from monkeys to humans. Upon evaluation of the evidence, humans may be separated by more than seven million years of divergent evolution from a common ancestor with monkeys. Within those millions of years, there were many species more directly related to humans that are now extinct, and that came to an evolutionary dead-end on the path to our species.

Relevance

Students wanted to know 'Why is there a need to understand evolution.' They explored applications in the practice of modern medicine. They also explored the social science aspect of this Adam / Eve. English classes could read ***Inherit the Wind*** and engage in debates on Intelligent Design.

The Ultimate Question:

Students also wanted to know 'Where did all the biodiversity start on Earth?' And 'What were the origins of life on earth?' We studied the most primitive microorganisms that are alive today: the Archaebacteria can provide speculative clues as to the progenitor species of all life on Earth. We plunge down to the depths of the thermal vents at the mid-Atlantic ridge and also apply Miller's experiment at these thermal vent communities and study the impact of microbes on earth via the IMAX films as in "Volcanoes of the Deep."

Key idea: Students engaged in critical thinking by gathering evidence, determining its reliability and representativeness and drawing reasonable conclusions about the important question of monkeys playing baseball.

For a different version of this unit visit Bob's story on the AMNH Inquiry Network at www.amnh.org/learn/musings/network/index.php.

D. "What's social justice got to do with us?" Gennifer Otinsky Grade 6 Caldwell-West Caldwell, NJ and Dr. Monica Taylor (Department of Curriculum and Teaching, Montclair State University, NJ)

> ***Key Concepts*: Students' simulated experiences led to strong feelings about social justice and meaningful inquiry projects; teachers' modeling the inquiry process for students; generating key questions regarding social justice,--uses of power, access to resources and first class citizenship.**

Introduction: Gennifer and Monica presented the key concept of teacher *modeling* by describing how they were involved in an inquiry project focusing on social justice. Their project was funded by a grant from the New Jersey Network for Educational Renewal at Montclair State University. They asked themselves these pedagogical questions: "How could sixth graders experience concepts of social justice in a meaningful way?" and "What would they learn about exploring their own questions about social justice?"

Working with pre-service teachers: What made this story unique was the presence during the project of pre-service teachers from Montclair State University. To the surprise of the presenters these college students were initially baffled by the thought of working on social justice with 6th graders. "What do they know about stereotypes and social justice?"

Initiating Experiences: Gennifer and Monica began their three week unit with an activity designed to foster community building while at the same time developing within students a sense of their own origins–through poetry writing ("I am from America") Next, they used clips from Disney films (*Peter Pan, Little Mermaid* and *Aladdin*) to discuss stereotypes. They developed a definition of "social justice" before playing a simulation designed to give participants a sense of what it felt like to be a member of an elite, a small group with superior resources and in the majority feeling hungry, left out, with access to fewer resources. In this case students were vying for food and most students had to do without.

In their reflections on the simulations students connected their simulated experience to those of Native and African Americans. One student concluded, "The world is not fair. Too few people have too much control over the world's resources." One pre-service teacher said, "I learned that the poor are regarded as lazy complainers."

These experiences led to a series of crucial social justice class-generated questions:

Who makes decision and who is left out ?
Who benefits and who suffers?
Why is a given practice fair or unfair ?
What are its origins ?
What alternatives can be imagined?

Accessing Knowledge: Students rotated amongst 6 learning stations each with access to the Internet and various websites. This process occurred during a period of about three weeks. While working through the stations, students embraced collaborations and focused on concepts that had not been predetermined.

Students' inquiries: Students' researched their own important questions related to social justice:

1. "Why haven't we had a woman President?
2. Why are there more African-Americans in our jails?
3. How do African-Americans express their past and present views of slavery through their art?
4. Why do all politicians have money? If a person can't run for office because they don't have money, then how can this be a democracy?
5. How does Title IX affect sports?
6. Why, during WWII was the Jewish community so discriminate against and what are the ramifications of it today?
7. Are athletes more important than teachers?
8. Why is there world hunger?"

Culminating Projects: Students engaged in a wide variety of culminating projects: teaching fellow students what they'd learned; writing letters to the editor of the local paper; bake sales to raise money for favorite charities that donate to the cause in question and letter writing campaigns to politicians.

Reflection: What have we learned about inquiry? "Often it takes a while for a good question to form. You should ask questions about topics with which you are concerned, put all your answers together and draw your own conclusions. Inquiry is never ending. Your question branches off to lots of other questions. It takes a while for your complete question to form…you have to look at your question from different angles. *Students feel satisfied after doing inquiry based learning."*

Sixth graders said that they learned: "It is hard for someone without money to have a position in the government. . .That not all things in life are fair. . .that you should go out of your way to find out about your rights as an American, because if you jdon't find out about them, you will never have the correct rights."

Pre-Service teachers noted that: "The students were able to make more serious connections than I had expected. I learned that there are many productive projects that these students can do to really make a difference."

Gennifer and Monica further concluded: "We learned that exploring issues of social justice with young adolescents is appropriate because at this time in their lives they are developing their identities and are less jaded and cynical than their adult co-learners.. .[they] are more willing to problematize their life situations and examine issues honestly. They pose questions that many of the pre-service teachers were uncomfortable posing because of relatively little societal influence."[1]

Key idea: Students' experiencing hunger and deprivation (simulated) within a unit on social justice fostered a broad range of questions that then became personally meaningful.

E. "The Cell Project," Vicky Valle, PS/IS 123, NYC–Grade 8

Key Concepts: **Students using inquiry and problem solving skills, researching and analyzing data; organizing information; creating metaphors for cells and critically analyzing relationships; designing and building models; students generated own questions following significant comparison and analysis of cells and schools.**

Initial questions: "How and why is the structure of a plant cell different from that of an animal cell?" This question provided the unit's rationale, since it focused upon essential concepts within the science curriculum and within the state requirements.

Introduction

First, Vicky started with the question, "What is a cell?" Students studied the nature and function of human and animal cells.

Then they made comparisons between their school building and a cell. "First, we asked the students to make a list of all the parts or components of a school that make the school work properly everyday. They listed all the components, such as the principal, students, teachers, classrooms, computers, books, notebooks, cafeteria, bathrooms, water fountains, posters, bells, custodians, security officers, and handouts. I asked my students to describe the job or function of each school component.

We prepared a chart listing all the school's components and their function. As we reviewed the list, I told them there is a part or component in cells that has a very similar function. These components are called organelles. Then, I showed them a list (on a transparency) of organelles in a cell with their functions. At this point, I asked them to find the part of the school and the cell's organelle that have similar function. Here we had to engage in some critical thinking–comparing, analyzing and drawing conclusions. With
this information, we prepared a T-chart.

[1] Monica Taylor and Gennifer Otinsky, in press (2005), "What Does Social Justice Have to Do With Us?" Sixth Graders and Pre-Service Teachers Inquire Collaboratively.

School is like (=) a Cell
Principal = Nucleus
Bathroom = Vacuoles

After this activity, we analyzed the different kinds of cells. They discussed how plant cells and animal cells were different. For example, plant cells contain organelles that animal cells do not have. These organelles are cell wall and chloroplasts. "

Students' Questions

While comparing schools and cells, students generated a number of questions that we researched as we developed our models and continued with other projects:

1. *How does a nucleus know how to control a cell?*
2. *Why do we need so many different types of cells to survive?*
3. *How do cells in our eyes/ears work?*
4. *How long does it take a cell to `reproduce'?*
5. *How do cells react/behave when someone gets sick?*
6. *Can you tell if a cell will eventually turn into a `cancer' cell?*
7. *How does the first cell in an organism form?*

We returned to our essential question: "How and why are plant and animal cells different?"

Making a model of a cell

During our inquiry project we searched for a definition to the word model. A model is a small object, usually built to scale, that represents in detail another, often larger object. [Models also help us understand and make predictions.] Then we drew a picture/diagram of a cell including all the different parts (organelles) we previously discussed.

Students searched textbooks and websites for information on different kinds of cells.

They explored different ways to represent a cell and settle on an Entemann's cake box. These boxes have a plastic window that makes the interior part of the box visible without having to open up the box.

The students then made models of each organelle. They used different types of materials- plastic, clay, construction paper, candy or any other they can think of.

Culminating Projects—A Cell Book and Contest

After they were done preparing their models, students wrote a book of cells. Describing the functions of the different cells, the organelles, and other information they might find useful and interesting. They made comparisons between a plant cell and an animal cell. Students included a

picture/diagram,/drawing of the cell types.

As a culminating project students worked individually and/or in pairs to create a poem about cells. These poems were then submitted to be part of the Cell Contest, where cells will compete in the following categories: best model, best book, and best poem."

Key Idea: Building models to represent nature's building blocks—cells.

F "Dinosaur Tracks' Web Site" Kimberly Vaillancourt, Curtis High School, Staten Island.

Key Concepts: **Students' control of decision-making, planning, research and project creation; students creating own web-based project found at www.classroom2classroom.net.**

This was a more open ended project that used technology very extensively. Kimberly engaged several high school students in an after school program. The students were keenly interested in using technology to learn about dinosaurs. *Students set their own goals*: to create an interactive website; planned out a strategy that included researching the Hall of Dinosaurs at AMNH; mastered the technology involved, including use of video cams and DreamWeaver software.

Students were intrigued by theories of how the dinosaurs became extinct; they had questions about the anatomical differences between herbivores (like Barosaurus and carnivores like T-Rex and others.) After compiling information, they put it into an html format using DreamWeaver.

Their project can be viewed at www.classroom2classroom.net. Students created a Chat room for visitors to make comments. On visiting the website you will see the extensiveness of students' research on such topics as: Theories of Extinction; Relationship between Dinosaurs and Birds; Anatomy; News Articles (where students share the new findings of dinosaurs' relationship to today's birds); Glossary and images of various dinosaurs.

This project, therefore, represents one end of a spectrum of teacher-student decision making. The students controlled most all of the decisions about: topics, questions, resources (like AMNH) and how to create what kind of final product—the website. At the other extreme, where most of us find ourselves much of the time, we, the teachers, make most of the decisions. Kimberly worked with an after-school non-graded program and with students who wanted to participate.

Her project represents a significant marriage between students' curiosities well managed and structured and developing expertise in the use of technology as a resource.

Key Idea: Students' control of decision making to create web-based interactive project.

G. Slide Show from Grover Cleveland Middle School in Caldwell. Wayne Rush, Media Specialist, Grover Cleveland Middle School, Caldwell, NJ.

Wayne showed us a PowerPoint presentation detailing the work of the Caldwell-West Caldwell Study Group of teachers interested in inquiry-based instruction. The Study Group formed as part of a collaboration among the Professional Development School (Grover Cleveland), the Montclair State

University teacher education program and the New Jersey Network for Educational Renewal (based at MSU).

The Study Group read John Barell's ***Developing More Curious Minds*** (2003, ASCD) among other resources and explored various ways within classrooms to foster students' inquiry. One product developed within the Group is an Inquisitiveness Inventory, a check list for students and teachers. See Appendix B.

H. **"Will dogs ever be as smart as people?"** Jane Kinkle and Isabella D'Agostino, CaldwellWestCaldwell, NJ Grade 7

> *Key Concepts*: **Helping students frame researchable questions; teacher as facilitator of inquiry; accessing prior knowledge; journal writing; classroom as museum.**
>
> (A variation of this story can be viewed on the AMNH Inquiry website: **www.amnh.org/learn/musings/network/index.php.)**

Setting the Stage for Kids to Ask Questions

"The seventh grade life science program at Grover Cleveland Middle School in Caldwell, New Jersey provides students with daily opportunities to engage in activities that lead to inquiry projects. Students are encouraged to wonder about the nature of life as they engage in real-world hands-on investigations. The goal is to get students to ask questions and to guide them toward discoveries that will satisfy their curious minds.

Lessons follow a well-defined pattern: an Introduction presents clear goals and offers background information. Students then describe what they already Know about the topic. This sets the stage for being reflective and inquisitive. The lesson continues with students working independently or in small groups to observe specimens, complete an experiment, or participate in a simulation activity.

We then ask students to reflect on what they have learned and determine what else they Want to know about the topic. Students begin to question previous assumptions and become aware of new information they have learned. The process is modeled over and over again as classmates ask each other to critique their queries, help them find information, discuss their findings, and quite often generate more questions.

But inquiry is ongoing all the time. Questions shouldn't have to wait for a class project of the teacher's design. Kids should have questions during and after every lesson. Teachers need to facilitate the acquisition of knowledge by helping students find ways to answer their own questions.

Creating Models and Practicing Inquiry Skills

During a unit on "Human Origins," students searched for clues to our beginnings in a simulated dig. They compared human, chimp and mystery bones from *Australopithecus afarensis*. Which ones looked like human bones? Was *Lucy* more human than chimp or more chimp than human?

Next, students moved from station to station to watch video clips of paleoanthropologists discovering hominid fossils, to examine artifacts and pictures of hominid skulls, to take part in a real dig via the magic of the internet (http://www.ology.amnh.org . Click on *Paleontology – Dig for Buried Bones.*) and to use reference books, periodicals, and online sources of information to investigate current theories of human evolution and find out about the latest fossil finds. They took note of what interested them and what they had questions about:

* *How many possible human ancestor fossils have been found?*
* *Is there any research going on to try to find a new species of hominid?*
* *How do scientists know where to look for fossils?*
* *How often are these [kinds of] fossils found?*
* *What are the changes that took place in hominid skulls as Homo sapiens evolved?*
* *Who created the first art?*

In order to find answers we visit some of these websites:

* http://www.archaeologyinfo.com/species.htm
* http://www.wsu.edu:8001/vwsu/gened/learn-modules/top_longfor/timeline/timeline.html
* http://www.anth.ucsb.edu/projects/human/
* http://www.talkorigins.org/faqs/homs/species.html
* http://www.pbs.org/wgbh/aso/tryit/evolution/
* http://www.evolutionnyc.com/IBS/SimpleCat/Product/asp/product-id/670273.html
  (This is a catalog site with a skeleton picture.)
* http://staff.pausd.palo-alto.ca.us/~middlelibrary/earlyhumans.html
* http://www.amnh.org
  (Click on Ology – Paleontology – Dig for Buried Bones. This is an interactive site!)"

Success of the Inquiry Depends on the wording of the Question

Jane and Isabella's story highlights the need to help students formulate their own questions. Nick asked, "Will dogs ever be as smart as people?" The class helped him think of other words for **smart** such as **intelligence** and to think of additional questions so that he might be able to find enough information to formulate an answer. The group came up with alternatives such as *"How smart are dogs? How does dog intelligence compare to the intelligence of other mammals including humans? Are dogs as smart as their wolf ancestors – if not – why? How does intelligence evolve? Can intelligence level increase in species?"*

Key Idea: Helping students move from an initial question to one that included such researchable concepts as "evolution," "intelligence" "species" and could be investigated using Jeeves, Google and other print resources.

II Introduction to the Exploratorium, Jeff Robbins, Westfield, NJ and Noreen Cornoni, NYC.

> *Key Concepts*: **Need to experience and model our own curiosities if we wish students to share their own; must create a relatively risk free environment that invites inquisitiveness.**

John Barell (AMNH) introduced this segment with the story of Isidore I. Rabi. How did he become a Nobel-Prize winning nuclear physicist? "My mother made me become a scientist without ever intending it. Every other Jewish mother in Brooklyn would ask their child [upon returning home

from school], `So, did you learn anything?' But not my mother. She asked a different question. **`Izzy,' she said, `did you ask a good question, today?**' That difference—asking good questions—made me become a scientist."

That difference—asking good questions—can lead each us to becoming more aware as citizens, as potential and active professionals and as human beings seeking to live our lives to their fullest.

We designed our visit to the Exploratorium Exhibit (from San Francisco's museum of the same name) to give participants an opportunity to play with stuff, explore mysteries within the various exhibits and enjoy learning and asking their own good questions. These kinds of experiences are the foundation of our own modeling of inquisitiveness, *a sine qua* non of students' sharing their own curiosities.

Following our field trip Jeff and Noreen led a discussion of what people observed and what they were curious about. Each shared with participants how they led their own students through the exhibit and how it related to the curriculum and led to their own curiosities.

Jeff and Noreen provided participants with three inquiry models for the Exploratorium exhibits:

A. Title of Exhibit

Draw a diagram of your exhibit below.
What does it ask you to explore?
What do you think will happen (hypothesis)?
What happened?
What is experiment trying to teach you?
What question do you have about the exhibit?

B. Title of Exhibit

Some questions about the exhibit
Things that interested you about the exhibit

C. Journal Entries:

I wonder what would happen if?
I noticed that. . .
This reminds me of. . .
I think that. . .
What really me say "Wow!" was. . .
I want to know why.. .

We did a fast tour through the Exploratorium. Exploring the Exploratorium with three different approaches to learning on a paper guide let students pick which approach they would prefer. Noreen mentioned having students create a Wonder Wall where they listed their current questions for discussion and/or research. Having a record of our inquiries is a good way to help students reflect on their learning.

Fostering inquiry requires a mind-shift. Last year Noreen came up with the questions and this year students generated more of the questions.

How do you grade such an experience?

.How do you grade when there isn't a right answer and the kid wants to have a right answer? Grading by reflection helps. Have students generate their own criteria…like what would we see if you are doing better?… What are indicators of a curious person? Jane discussed the inquisitiveness inventory. (See Appendix B)

Students can from early ages identify what a curious person is like and what we would observe when a person becomes better at asking good questions, thinking critically and being a good investigator.

Key Idea: We must experience inquiry and investigation and be willing to share these experiences with our students, reflect on and learn from them.

III. Research on Inquiry. Dr. Hector Reyes, Principal Investigator of Project Inquiry, Region One (NYC)

Dr. Reyes described his Project Inquiry, a 4.8 million dollar teacher enhancement grant that offers 27 Elementary Schools the opportunity to implement a systemic science and technology program for 810 teachers. The Program provides teachers with a five year professional development sequence. A science teacher facilitator in each school receives over 270 hours of inquiry-based science and methodology.

Results of implementing an inquiry-based program includes the following:

1. "Preliminary evidence shows a relationship between the number of inquiry-based science trained teachers at participating schools and the student outcomes on the 4th grade science test.

2. A correlation between the number of years students have been served by the project, and student outcomes on the 4th grade science test is also becoming apparent

3. It is also hypothesized that there is an association between schools with strong inquiry-based science programs and their overall Reading and Mathematics scores." (2004)

Dr. Reyes concluded by saying that "It is very difficult to establish that achievement is a direct consequence of the project's work. We continue to collect data generated from science pre and post tests given to students to assess knowledge improvement."

In addition to Dr. Reyes' results we provided participants with additional research findings derived, in part from the National Research Council's *Inquiry and the National Science Education Standards* (2000). See Appendix A.

IV. Buffet with Scientists: Drs. Adriana Aquino and Rob Steiner (AMNH); Drs. Bob Marraccino (NYC) and Trish Camp (NJ)

For the Convergence finale, we met in small rotating groups with the four scientists who have actually conducted long term inquiry in an attempt to learn from them about the inquiry project. We divided into four small groups and the scientists rotated three times, not four because the program over time.

Here are some of the insights derived from all four scientists related to the process of inquiry:

A. Scientists are people with very different dispositions. Some are explorers; some are poets, some are mystics and some are detectives.

B. You take different pieces of data—ones that present you with a puzzle, a conflict, a opening for a question. E.g. Aged adults lose muscle and bone mass and add fat in places they didn't have it before. In young healthy adults with Growth Hormone deficiencies you have the same problems. You take these two discrepant events and look for similarities to run an experiment. These puzzles and "discrepant events" lead to inquiry.

C. When you examine the data, you must be open to what it does say and to what it DOES NOT say.

D. Some scientists ask the big questions,, e.g. "What are the basic forces? What are particles? Was there a time before the beginning of time?" These questions create the framework within which others work..

E. The more you inquire the more questions that keep popping up.

F. We live inquiry all the time.

G. The hard part is getting money for investigations.

H. A curious person has many different talents. A curious person takes many different pathways to ask questions and attempt to find the explanation to how things work.

I. We ask three kinds of questions--those related to form, time and space. Form helps us to differentiate organisms which help us identify characteristics (characters) as in size, shape, and those elements that change. . . We now classify based on similarities and time. Backbones of vertebrates indicate that these adaptations are based upon common ancestry.

J. We must teach the ethics of science and inquiry.

Conclusion—Issues of Control

One of the recurring themes presented by teachers during this 2004 Convergence concerned the issue of Control—Who makes what kinds of decisions and when.

Several of the teachers reflected what Dorian and Noreen said, in effect, **"Last year I was more directive and posed the questions. This year students asked more of the questions."**

This is, in part a story of our growing comfortable with students' posing good questions about the major concepts, ideas and principles within our existing curriculum and using effective management and instructional strategies to guide their investigating for answers and sharing results.

And we return to the vital role played by parents and other important models within our growing up:

Sheindel Rabi, an immigrant from what is now southeastern Poland and not formally educated asked her son daily when he came home from school, "Izzy, Did you ask a good question, today?" That difference—asking good questions—made him become a scientist and can help our students embark on marvelous journeys of meaningful learning.

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Appendix A--Research on Teaching Inquiry

"Inquiry is the set of behaviors involved in the struggle of human beings for reasonable explanations of phenomena about which they are curious" (Novak, 1964)

General

"Inquiry focuses on a scientifically-oriented question, problem, or phenomenon, beginning with what the learner knows and actively engaging him or her in the search for answers.

This search involves gathering and analyzing information; making inferences and predictions; and actively creating, modifying, and discarding some explanations. As students work together to discuss the evidence, compare results, and, with teacher guidance, connect their results with scientific knowledge, their understanding broadens.

As they develop their abilities to question, reason and think critically about scientific phenomena, [students] take more control of their own learning. They can use their broadened science knowledge and inquiry abilities to address other questions and problems and to develop or test explanations for other phenomena of interest."

Inquiry and the National Science Education Standards–A Guide for Teaching and Learning, 2000. Washington, DC: The National Research Council. P.120

Specific Findings

1. "Studies of inquiry-oriented curriculum programs (Shymansky et al., 1983; Shymansky et al., 1990; Mechling and Oliver 1983) demonstrated significant positive effects on various quantitative measures, including cognitive achievement, process skills, and attitudes toward science."

2. "Other studies have demonstrated a range of other specific outcomes from inquiry-based teaching, including vocabulary knowledge and conceptual understanding (Lloyd, 1988), critical thinking (Narode, 1987), inquiry abilities and physics understanding" and understanding science processes (Lindberg,1990)

3. "David Haury (1993). . . concludes that inquiry-oriented teaching can result in outcomes that include scientific literacy, familiarity with science processes, vocabulary knowledge, conceptual understanding, critical thinking and positive attitudes toward science."

4. ". . .students learning English can successfully engage in science inquiry and learn science concepts as well as the language in culture of science.

5. "In their research on students with learning disabilities, Scruggs et al. (1993) found significantly higher learning with an inquiry-oriented approach." (Ibid. p. 125-6)

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*Contributed by the research of Carmen N. Vargas, Region One, CUNY Graduate Center, 20 May, 2004

Appendix B:

Inquisitive Inventory

	Not at all	Sometimes	A lot
1. I enjoy asking questions about a lot of different things.			
2. Other people's questions fascinate me.			
3. I often pick books to read that are about characters that are curious.			
4. When I work in a group I usually ask questions that will help the group to focus such as "What's our problem?" or "How are we going to complete this project?"			
5. I ask, "What made you think of that?" when my friends and others say things.			
6. I keep a journal of my thoughts and questions.			
7. I love to examine complex, strange objects and interesting events over a long period of time.			
8. I look for problems to solve.			
9. I don't give up easily when I am trying to find the answer to a question.			
10. I say things like, "How come?" and "What if…?" when people tell me about things that happened to them.			
11. I like to make analogies by saying things like, "That reminds me of …" or "Oh, that's like…"			
12. I enjoy learning new things.			
13. When I find out something new I like to say things like "Wow! This is really cool!" or "Awesome!"			
14. I go out of my way to learn more than is expected.			
15. My parents and teachers make it a point to tell me new or additional information about what we're studying in school.			

Appendix B: (continued)

Inquisitive Inventory

16. List 3 words that come to your mind when you hear the word *curious*.

a. _____

b. _____

c. _____

17. How does a curious person act?

18. What does being curious feel like?

19. What was the last this that you were curious about?

20. Would you like to be more curious? (explain your answer if you wish)

NAME:_____ DATE: _____

Appendix C:

Assessments of the 24 May Convergence on Inquiry

What aspects of this Convergence were of most interest and value to you and why?

1. The brief time that we were able to spend in the Exploratorium was most valuable to me because I was able to put into practice the idea of inquiry-based learning. There is nothing like hands-on work to really instruct and allow for richer learning.

2. After our experience in the Exploratorium, we decided to restructure our Professional Development for next year. Instead of meeting weekly for 50 minutes, we are going to meet monthly for 3 1/2 hours for "exploratory learning" planned by teams of teachers. It should be an interesting year. (High School Principal, NYC).

3. The exchange among science, social studies and language arts teachers was so refreshing. Presentation of teaching stories. These were moving and inspiring. (Program Director, Bank Street College, NYC)

4. The various examples of teachers' experiences with inquiry-based science.

5. Listening to teacher experiences with inquiry.

6. The nature of the meeting. The selection of people attending. The variety of skills and expertise of the people. (Director, Project Inquiry, NYC)

7. Everyone was informative, but Dr. Hector Reyes's project was most interesting because I am teaching in the Bronx. I have been interested in knowing how inquiry science educations helps students in this community.

8. Listening to how inquiry is incorporated into other classrooms and how teachers are using technology in the classroom.

9. The "Scientific Buffet" [of AMNH and other scientists speaking on "What we can learn about the inquiry process."] This was an authentic picture of long-term inquiries and how to progressively deepen questions. (National science educator, researcher, CUNY)

10. The "Stories of teachers teaching for inquiry," because it was interesting to hear about some actual inquiry investigations that students were involved in at a variety of schools. (NYCBOE)

11. The scientists who brought experiences with inquiry in their own work.

12. The Exploratorium Exhibition at AMNH. I found the Hall to be very interesting. This was valuable because I didn't know the Museum had a Hall like this. I'd like to learn more about the exhibit.

13. Seeing how other teachers use inquiry within the school environment. How inquiry fits within "what must be taught."

14. To hear how other schools are involved in inquiry and what I can bring back to my region. (Science supervisor)

15. The Exploratorium because it was hands-on.

16. Seeing how other teachers use and apply inquiry-based teaching helped me gain other perspectives. (District Science Supervisor)

17. Listening to samples of inquiry-based models used in the classroom, because this gives me examples from which I can get creative in my class. Meeting with the scientists was edifying.

18. Simply the focus on Inquiry. It caused me to Reflect and Project about inquiry in my own classroom. Conversations with scientists.

19. I liked seeing the different projects other teachers are doing in their classrooms. The scientists were very interesting.

20. It was important to see Inquiry processes not only in Science, but also in Social Studies. It was important for me to see the processes that the teachers went through in doing their planning.

21. I loved hearing the social studies teachers. It has expanded my view of inquiry. Listening to the scientists was great.

22. The work that is being done in Caldwell at a Professional Development School sounds very promising because it is across grades and content areas and it sounds like it involves systemic change. (Regional Instructional Supervisor, NYC)

23. Networking and hearing about what others are doing to improve instruction. (District Science Supervisor)

24. The ways in which the Museum exhibits can be tied into the curriculum because these will be the most useful for HS students.

25. The small group presentations. The opportunity to listen and discuss topics relevant to science and inquiry-based teaching.

26. The actual teachers presenting their students' inquiries.