

Professional Development Institute for Educators



Program Evaluation

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Summary

Consistent with AMNH's ongoing collaboration with NYC schools and the DOE to enhance science teaching and learning, the Education Department developed a 3-day professional development Institute for Middle and High School teachers in conjunction with the temporary exhibition, "Water: H₂O=Life". The Institute took place from February 19-21, 2008 from noon to 6pm. This year's Institute made direct connections to the New York State Scope and Sequence Core Curriculum in Science, focusing on using "Water" to teach the Major Understandings. Days 1 and 3 took place at AMNH and Day 2 at partnering institution, the Queens Botanical Garden (QBG). Some 44 middle and high school teachers and 11 AMNH educators registered for the program. Participants were asked to evaluate the program: 23 evaluation forms were collected from teachers. (Eleven of the 44 teachers were part of NOAA ELL science teaching and did not participate in the Institute program or its evaluation).

Major Findings

The majority of participants (61%) said they plan to bring students to "Water." The major reason to bring students was fit with curriculum, followed by providing students with an enriching, interactive experience and raising students' consciousness about the importance of conserving water. Several teachers could not bring students due to budget and time restraints.

Teachers believe that their students benefit from the Institute in various ways: 1) Many will visit "Water," 2) Teachers will bring back new lesson ideas and teaching techniques; 3) Teachers will share increased knowledge with students; and 4) Students will gain awareness of water's scarcity.

The most personally satisfying aspects of the Institute for teachers were the materials and ideas that they can put to use in their classrooms. They also took personal satisfaction from learning new knowledge and networking with other teachers.

When comparing the Institute to other PD programs, participants said the Institute is more hands-on and interactive. They appreciated access to exhibits and experts.

Day 1 at AMNH: Labs, exhibition visit and lecture revolved around the theme, Properties of Water. Most teachers found the connections to the Core Curriculum in Science helpful for teaching these concepts. They said they would use the activities in their classrooms. The lecture by AMNH Curator, Jim Webster, on the Properties of Water was deemed "engaging"

by a number of teachers. The many questions his remarks engendered indicated how truly engaged the audience was. Teachers were looking forward to their “Water” visit: the exhibition was very crowded, making it difficult to see well.

Day 2 at QBG content adhered to themes of Living Communities and Environment, and Human Impact on the Environment. Jennifer Ward Souder, Director of Capital Projects, Assistant Director of QBG spoke about the Garden’s “green” new building and how it had come to be. The entire day focused on the Garden’s water recycling systems: bioswales, biotopes, planted roof and storm water drainage. Except for its repetitiousness, participants praised the program and found QBG’s practices relevant for teaching the Standards.

Day 3 at AMNH: All activities focused on conservation strategies and human impact on the environment. Teachers were impressed by the impact of our consumer society on water use and found much that they could bring back to their teaching. Examples from the exhibition and the lecture were quoted in the evaluation, such as the amount of water needed to produce the products we use every day, like coffee, cotton and rice: “I’ll never look at a cotton t-shirt the same way again.” The lecture by Erin Vintinner of AMNH’s CBC provided concrete examples of water use and misuse that teachers said amazed them. The 2nd “Water” visit was much less crowded, coming late in the day. Some 65% of the participants said they learned to use museum exhibits in their teaching. Teachers said the Institute program helped them teach the Major Understandings, particularly “Decisions of one generation affect the next” (HS) and “Ecosystem Balance: Community Members/Environment” (MS).

Overall response to the Institute was very positive. Teachers chose to attend a rigorous intellectual experience during a time when they could have been relaxing. It was inspiring to hear how teachers try to improve practice and pedagogy on their own, for the good of their students. Many praised the lab activities because they utilized simple materials that the teacher could bring from home, because the schools do not provide budgets for science apparatus.

Some aspects of the schedule might be reviewed for the next Institute: 3 days may be a bit long, especially for New Visions teachers who start at 9am and join the Institute at noon; the lecture might be a better orientation to the day’s topics if it came earlier in the schedule; the exhibition visit worked best late in the day after most visitors had left; the last item on the program—reading from textbooks—was not deemed an inspiring way to wrap up the day.

Overview

“Water: H₂O=Life” (“Water”) opened to the public at the American Museum of Natural History (AMNH) on November 3, 2007 and runs through May 26, 2008. In accordance with the Museum’s goal to create and nurture partnerships with formal learning establishments, the Education Department developed a 3-day professional development Institute for Middle and High School teachers to encourage them to use the exhibition and/or the museum’s resources for teaching science. The Institute took place from February 19-21, 2008 from 12 noon to 6pm. This year’s Institute made direct connections to the New York State Scope and Sequence Core Curriculum in Science, highlighting how to use “Water” to teach the Major Understandings.

Days 1 and 3 of the program began in the AMNH Audubon Gallery with lunch, introductions of the day’s schedule and icebreaker activities. Following the opening session on both days, the group split on grade level lines, with middle school teachers going to Calder Lab for a series of experiments and high school teachers heading for classroom 319 for their labs. There was a visit to “Water” was scheduled on each day as well as a lecture back in the Audubon Gallery. Day 1’s lecturer was Jim Webster, curator of Earth and Planetary Sciences at AMNH. Day 3’s lecturer was Erin Vintinner, from AMNH’s Center for Biodiversity and Conservation. Both days ended with readings from a textbook and a final wrap-up.

The second day of the Institute took place at the Queens Botanical Garden (QBG). Here too the program began with lunch, introductions and an overview of the day’s events. During lunch a QBG, Jennifer Ward Souder, Director of Capital Projects/Assistant Director, spoke about the Garden’s new “green” building and the various water conservation steps the institution was undertaking. Next the participants broke into four groups to tour four different activity stations with interconnected themes pertaining to water conservation were conducted by QBG education staff.

Method

Some 55 people (44 middle and high school teachers, 11 AMNH educators) registered for the Institute, of whom 11 were part of the New Visions program for high school science teachers and 11 were with the NOAA program for teaching science to ELL students. (NOAA teachers were not part of the Institute program and are not included in this evaluation). Fifteen (15) registrants teach in middle schools and 16 in high schools. Teachers received a 5-page evaluation instrument in their registration packet, covering all aspects of the program. They were offered a packet of resources and 2 tickets to return to the museum when they returned their Institute evaluations. Twenty-three (23) evaluations were returned with extensive and thoughtful feedback on the program.

The instrument consisted of both open- and closed-ended questions (see instrument in Appendix A). Data were coded and analyzed using SPSS and Excel. The data is supplemented by observation of teacher interactions during the program and verbatim quotes from their evaluations. Statistically significant variation based on grade level taught, subject taught and experience (years of teaching) was tested for and reported where found.

An additional evaluative instrument (“3-2-1”) was distributed each day by the Education Department, asking participants to note 3 things they learned, 2 things they had questions about and 1 issue they were concerned about. The responses are transcribed by category in Appendix C.

The Participants

The makeup of the Institute participant group was similar to the Institute on Human Origins held during mid-winter break in 2007. The 2008 respondent sample is considerably smaller, however, consisting of just 23 teachers, while the 2007 report was based on 39 teacher responses. Both Institute evaluation respondent pools consisted of more middle school teachers (52%) than high school teachers (42%). (See Appendix B for complete Water Institute demographic data). Almost all teachers in both samples teach in the New York City public school system, coming from schools in all boroughs except Staten Island. Most teach science, but a few administrators and pre-service teachers took part. The participants’ experience varied, but the majority had been teaching for either 1 to 3 years or 4 to 7 years. Fifteen teachers said they teach the Scope and Sequence curriculum—7 in high school, 7 in middle school and 1 “other.”

Findings: Participants' Overall Response to the Institute

Teachers who attended the Institute chose to give up their mid-winter break to attend a rather rigorous professional development (PD) program. How did they assess the time they spent at the museum? What was personally satisfying and how did the program compare to other PD programs they may have experienced? And how do they see their students benefiting from their PD experience at AMNH? Do they plan to bring their students to “Water”? Why or why not? A series of open-ended questions inquired about these issues. The responses are analyzed in the following tables and quotes follow to enhance the data.

School Field Trips to “Water”

First, did the Institute influence teachers' intention to bring their students to “Water.”¹ Overall, the majority of Institute participants who responded to the survey say they plan to bring students (60.9%, see table 1).

Table 1. Do you plan to bring your class to see “Water”?

	Frequency	Percent
Yes	14	60.9
No	3	13.0
No response	6	26.1
Total	23	100.0

When the data are analyzed by grade level, 7 of the middle school teachers and 6 of the high school teachers plan to bring students (table 2 below).

Table 2. Do you plan to bring your class to see “Water” by Grade level (counts)

	Grade level			Totals
	Middle school	High school	Other	
Yes	7	6	1	14
No	1	2		3
No response	1	3	2	6
Total	9	11	3	23

The most frequently cited reason for bringing students was fit with curriculum (more middle than high school teachers cited this reason).

¹ It must be noted that field trips are limited by more than teachers' interest in taking them: financial constraints and timing often prevent teachers from obtaining their principal's permission. As one teacher noted: “I would like to but I have to try to recruit other teachers and ask the principal permission.”

Fit with Curriculum

Introduce H₂O as major factor in earth systems conclude unit about conservation.

Ties into ecosystem curriculum.

I am focusing my last unit on a study of the Bronx River to explore human impact on the environment. The exhibit will tie in to that study well.

We are currently studying a watershed in our community.

An enriching, interactive experience

It provides the interactive experience that excites learning in children!

The visuals will hopefully get them excited about the topic.

It is terrific and very student-friendly.

Understanding the importance of water conservation

They need to wake up to the reality that water is very valuable and that it can be easily abused - we need to conserve.

It connects very well with our school's idea of social responsibility and human impact.

Of the 3 teachers who said they would not bring students, 2 gave logistical reasons (no time, budget or permission from principal) and 1 said it did not fit with her curriculum.

Unfortunately, I can only recommend this exhibit and it may be too late to do so because there is a limit to the amount of field trips per year. But I'll try.

I'm a part-time teacher and opportunities will be rare.

Lack of time to cover [existing] curriculum: human impact/ ecology is focused upon in the grade taught before mine.

Participants' Satisfaction with the Institute

What was the most personally satisfying part of the Institute for participants? After all, they were attending the Institute during what would have been their personal time during mid-winter school break. The 3 top responses (in order of frequency) were Experiments and lessons learned that can be used with their students, Learning new things (presumably for the joy of learning) and Networking with other teachers (see table 3). Almost all teachers responded (21).

Table 3. Most Personally Satisfying Parts of the Institute

	Frequency	Percent*
Experiments, lessons I can use in my classroom	10	47.6
I learned new things	8	38.1
Networking with other teachers	5	23.8
QBG visit	3	14.3
"Water" exhibition	2	9.5

*Percents add up to >100 due to multiple responses

Teachers' open-ended responses were difficult to categorize, since many included more than one category. The following quotes from the survey illustrate their thoughts on most personally satisfying parts of the Institute.

Experiments and lessons to use with students and networking with other teachers:

How to invigorate Earth Science curriculum with H₂O connections.

The exploration into the NYS mandated labs on osmosis and diffusion, and the planning of curricula events around these investigations.

Working with other science teachers to effectively plan inquiry-based units and lessons

Learning about water management at QBG. Discussions with other Living Environment teachers.

Being introduced to new science experiments and collaborating with other science teachers in the city.

Getting new lesson plan ideas. Meeting wonderful people.

Personal enrichment

Learning new things about ecosystems and human impact.

Personal enrichment and knowledge and ideas.

The learning of up-to-date data.

I thoroughly enjoyed learning and discussing all the varying aspects of H₂O.

The visits to "Water": "Being able to wander through and personally view the exhibit."

The Institute Compared to other PD Programs

When participants compare the Institute in the museum setting to other PD programs they had participated in, the most frequent response was that the Institute was a more hands-on, interactive and complex experience (table 4). Other programs apparently use a more lecture-like format. Some 21 participants responded.

Table 4. How does the Institute compare to other PD programs?

	Frequency	Percent*
Institute is more interactive, hands-on, complex experience	10	47.6
Access to exhibits to use in teaching	9	42.9
Access to experts	4	19
Access to resources	3	14.3

* Percents add up to >100 due to multiple responses

A More Interactive Experience

Education that appeals to multiple intelligences for a more complex informational experience.

More relaxed, hands-on, personal way of learning

It is highly interactive and visual.

*Easy to ask question***Access to Exhibits and Experts**

The availability of exhibits to serve as focus areas and to model the principle.

The amazing resource of the exhibit and learning how to use it to reinforce my teaching.

Access to excellent exhibits and scientists.

The setting for the PD—the museum—the ability to immediately see opportunities to use the museum in our curriculum.

Non-formal science education Institute allows access to collections and exhibits that help to make science more concrete.

The diversity and richness of the experience with the environment and the visiting guests.

The resource of the exhibits and the museum if it wants to follow curricula Scope and Sequence should look into developing traveling exhibits with that in mind.

Benefit to Students

How do teachers think their students will benefit from their participation in the Institute? The 20 teachers who responded were divided among the reasons illustrated in table 5 below.

Table 5. How will participants' students benefit from Institute

	Frequency	Percent*
Lessons and activities teachers bring back	6	30.0
Trip to AMNH for enrichment, use of museum resources	6	30.0
Teacher will share increased knowledge with students	5	25.0
They will gain awareness of water's scarcity	5	25.0

*Percents add up to >100 due to multiple responses

Lessons to bring back

I can do the lessons we did and I can create lessons that we can have in class.

My own knowledge increased, better teaching practices.

They will have concrete activities that will help to deepen their understanding of diffusion.

All the resources and activities I intend to use in my classroom.

Field Trip to AMNH

Students with diverse learning styles will be provided with a learning experience that cannot be duplicated in the traditional NYC classroom.

I have [gained] experience with using the museum resources.

Field trips that will support science and social studies curriculum.

Visuals will hopefully get them excited about the topic.

Share Learning

What I learned in this PD will be used in the classroom for the students to learn.

I can share what I know.

It touched different aspects of science, which I really didn't get into [before].

Detailed Findings

Day 1 at AMNH

After some confusion associated with finding the “Audubon Gallery,” participants partook in a generous lunch. Following introductory remarks, a series of “Icebreakers” had the dual function of putting everyone at ease and providing fun water-associated activities for the classroom. When asked about the individual “icebreakers,” virtually all the teachers said they would use them in their classrooms, as illustrated in tables 6 through 8 below.

Table 6. Ice Cubes in a Bag

	Frequency	Percent
Would Use	21	91.3
Would Not Use	1	4.3
No response	1	4.3
Total	23	100.0

Table 7. What's in the Bubbles?

	Frequency	Percent
Would Use	20	87.0
Would Not Use	1	4.3
No response	2	8.7
Total	23	100.0

Table 8. Freezing Ice

	Frequency	Percent
Would Use	20	87.0
Would Not Use	1	4.3
No response	2	8.7
Total	23	100.0

A high school teacher commented, “This would be good for my kids.”

Classroom Activities

The activities were divided into grade level appropriate tracks: high school teachers attended a session entitled “The Internal Environment of Organisms” and middle school teachers attended a session called, “The Special Properties of Water.” Teachers were asked to respond to survey questions only about activities they had attended.

The Human Origins Institute provided two sequential activities, but when assessing this aspect of the Institute, teachers commented that they felt too rushed and did not have time to ask questions or delve into topics in depth. The Water Institute offered just one lab/workshop, allowing teachers more time to explore content and teaching techniques.

High School Teachers

The HS teachers paired up and did two experiments— “Eggsperiment” and a diffusion experiment with capillary tubes. The design of the experiments was very open, to show inquiry-based learning. The teachers were asked to read through the instructions in the textbook and design their own hypotheses to test. There were materials provided in the back of the room for the teachers to use in their experimental design. The session leader acted more as a facilitator than an instructor. Table 9 illustrates participants’ overall response to the activity.

Table 9. High School Living Environment: The Internal Environment of Organisms

	Frequency	Percent
Learned new material	8	61.5
Already familiar with material presented	1	7.7
Will use in classes	4	30.8

The following comments were overheard by the data collector/observer during the activity and illustrate participants’ response to the activity as it took place.

Teachers’ ideas for using metaphor to teach osmosis

Make some people water molecules and let them pass, and have other students be molecules that can’t pass the ‘membrane’.

Make it like a limbo contest and those that can limbo can pass through the ‘membrane’.

Comments about the “Eggsperiment”

Problems with the open format

I’m lost. He’s being an inquiry-based teacher, he won’t tell us anything.

My kids have a hard enough time following instructions on a designed experiment. I don’t think they would be able to create their own experiment.

These all say to design an experiment—I don’t like that. I like more of a cookbook approach. Even my AP students, they need the steps. If students can’t follow 10 steps [in written instructions], I don’t think they can create their own experiment.

Well they have to be taught how to design/develop an experiment.

In college they are going to be given steps. They need to learn to follow steps.

No, I think it’s more important to learn to design an experiment.

It’s harder to compile class data when everyone does different experiments.

Problems with the “eggsperiment”

My kids couldn’t do this, they would smoosh the eggs.

I would have to rewrite this for my kids and that takes a lot of time.

Ideas for the experiment

It would be cool to have the kids write their names on the egg, but it may come off with the vinegar.

This could be good to teach about circumference and volume.

We used just plastic bags, and it works. The dialysis tubes you have to order.

When you do this, do you think we should have lots of stuff out? More than they need? I wonder if they would get overwhelmed....

Our kids really like the glucose strips because you can compare the colors.

Yeah, but for the Regents lab they have to use benedicts strips.

From a student perspective what did you learn?

I think that reducing the variables is very important, and teaching them how to design an experiment is very important, and I think having tools to measure in a variety of ways is also important.

When you have students create their own experiments you invite a certain level of chaos.

General comments on teaching

I think it makes me a good teacher that I get confused when I read through things so I can know where the kids will get caught up. Because if you get everything right away it makes it harder.

Problems with teaching experiments

I was doing an experiment with photosynthesis and using BTH strips to detect carbon dioxide, but it didn't turn blue. So, I literally had to add blue drops to each students set up.

One of my kids wrote a 20 page AP Bio report and titled it the Lab of Errors, and when I asked why, they said because there were so many things that went wrong with the lab.

We have to teach a required lab and some of the kids have done it before so they just cause trouble.

I had one kid who was just mixing all the chemicals to try to make things explode.

Dialysis tubing didn't work for my kids they kept tearing it and stuff.

We used baggies though, and the glucose test didn't work.

That's funny. My first teaching experience was an internship here at the museum and while everyone was at lunch we ran around and made sure all the experiments were working.

Middle School Teachers

The session started with a discussion of teaching strategies. A teacher said he likes to ask students to reflect on prior knowledge when beginning a new science topic. Another teacher suggested using a demonstration to catch students' attention, encouraging them to speculate on "why:" observing a "mystery will cause students to experience a desire to learn. The session leader asked teachers to think about and compare pedagogy of today with that of the days of their parents and grandparents, that is, the lecture vs. the inquiry method.

Several stations were set up around a large table, with experiments to investigate the properties of water—mass/density of water and ice, surface tension, solvency, etc. Participants worked in teams of 2 or 3, trying each experiment in turn.

Table 10. Middle School: The special properties of Water

	Frequency	Percent
Learned new material	2	25.0
Will use in classes	6	75.0

Teachers commented:

[These activities] are good because they don't require specialized equipment, just everyday materials that we can procure easily. We don't have a budget for special equipment.

You need to modify the activities according to your students.

The activities are good but I couldn't set up all the stations at once [the way they are here] because I have 5 classes with 30 students in each [and I can't get around to help them at each of the 6 different experiments].

Some of the more experienced teachers lost interest when presented with familiar activities.

The more diligent among them continued with the more challenging experiments. They enjoyed the challenge of trying to make a paper clip float and were surprised when static electricity on a balloon diverted a stream of water. More lengthy experiments involved measuring and comparing the temperature of flasks of water embedded in ice and sand

During down time, teachers talked amongst themselves about teaching strategies, giving advice in collegial conversations.

A textbook series, "It's About Time," had been selected for its modeling of inquiry method. Participants read the relevant chapter in the new text and critiqued its descriptions of experiments. Several items were cited for lack of clarity: the text doesn't specify water temperature in one experiment, doesn't specify materials, teachers would use disposable materials (cups) to simplify. The textbook does not supply lab sheets to copy so that students can fill in the data from their observations.

“Water” Exhibition Visit

Participants visited “Water” during the afternoon for about 45 minutes. The exhibition was quite crowded with museum visitors, so teachers were not able to get a great deal from it. They were promised a return visit on Thursday late in the day when there would be fewer people. Nonetheless, teachers said their visit gave them ideas for teaching about the properties of water, Tuesday’s focus.

Table 11. The visit to “Water” gave me ideas for teaching about the properties of water.

	Frequency	Percent
Strongly agree	11	47.8
Agree	11	47.8
No response	1	4.3
Total	23	100.0

Table 12. I learned how to use “Water: H₂O=Life” in my teaching.

	Frequency	Percent
Strongly agree	5	21.7
Agree	14	60.9
Disagree	3	13.0
No response	1	4.3
Total	23	100.0

Middle school teachers were significantly more likely to agree “strongly” and high school teachers to just “agree” that they learned how to use “Water: H₂O=Life” in their teaching ($X^2(2, N=16) = 9.50, p < .01$).

High School comments overheard

The teachers were rather quiet while exploring the exhibit. They spread out and went at different speeds so it was difficult to hear their comments to each other.

Albatross: So, they drink salt water and they excrete it out their face-cool.

Around the Blue Planet video teachers were trying to figure out how it was projected.

At the damn area they discussed the utility of fish ladders: Do [fish] even know how to do that?

Good transitions, good spectrum of topics covered, like the progression from physical properties of water to ecosystem wide impacts of water, good design

It’s engaging for all ages.

There are too many bottlenecks; some displays were really hard to see because people would bunch up.

Middle school teachers' reflections

Again, it was difficult to hear teachers' comments because they did not stay together, did not converse much with each other and other visitors were quite noisy (children were on break as well as their teachers).

How water is used around the world was impressive. Women walk miles to get clean water; our kids take water for granted, you just open the faucet.

Water used in the production of food—how much it takes to make a hamburger—and cotton: I will never look at a cotton t-shirt the same again.

It will be impressive for kids to see the [Blue Planet] globe showing the ocean water, then fresh water, then usable fresh water. It's scary, with glacial water melting.

A teacher from the U.N. School said she really liked the entrance with the different languages; she said she connected there but no were else in the exhibition.

Lecture: Properties of Water, Dr Jim Webster

Dr. Jim Webster, Curator of Earth and Planetary Sciences at AMNH, discussed the day's topic—properties of water—from the perspective of a scientist. Teachers were asked how useful they found the lecture for their teaching. All respondents found the talk useful, and more than half found it very useful (Table 13).

Table 13. How useful was Dr. Webster's talk for your teaching?

	Frequency	Percent
Very useful	12	52.2
Somewhat useful	10	43.5
No response	1	4.3
Total	23	100.0

Some 21 teachers responded to a question about what they as learners found memorable in the lecture (see table 14). The part of Dr. Webster's talk that impressed the greatest number of people was his explanation of water in the Earth's mantle and water's ability to "melt" rock.

Table 14. What was most memorable, surprising or interesting about the lecture for you as a learner?

	Frequency	Percent
Water is in rock, mantle, water melts rock	8	
Properties of water	5	23.8
Water and climate	3	14.3
Speaker's ability	3	
Water connections to Earth Science curriculum	1	52.4
Other	3	19.0

Teachers' written comments

Water in rock and in Earth's mantle

How water is spread around the earth, chemical bond, volcanism and water making rocks viscose.

How much water was "locked" in the mantle and rock systems.

Water lowers melting temperature of rocks to the point that they melt over many many years.

The most interesting thing about the lecture for me as a learner was the fact that there is H₂O in the Igneous rock and it is squeezed out to help flow of molten material

Properties of Water

The ability of water to dissolve different types of substances.

Hydrogen Bonding

The remarkable dissolving properties of H₂O.

Structure and polarity of the water molecule.

Water and climate

Greenhouse gases that are low in the atmosphere cause warming on the surface.

Climate change, particularly the warming of ocean, is responsible for more violent storms.

Also, minerals created in pacific rim and near volcanoes.

Effects of H₂O on climate.

The speaker

Speaker's ability to engage audience [was notable].

It was interesting to see the difference between how scientists explain things and how teachers explain things.

Good engagement no passive listeners.

Water connections to Earth Science curriculum

[The program made] great connections between Earth Science concepts and nature of water.

Other

Seeing the Pacific rim of minerals, how volcanoes and the water cycle are related.

Snowball Earth theory.

High school teachers' questions/comments for Dr. Webster

Where is the CO₂ in the atmosphere?

Is water vapor emitted from volcano evidence of water in the mantel?

What did you mean by equilibrium with regard to temperature?

A question that keeps coming up for me and my students when we talk about the phase transitions is where does the energy go?

How do you simplify the idea of energy and a Calorie of heat to kids?

Why is it that when you have hot and cold water the cold water goes to the bottom, but the ice floats?

Is ocean warming actually happening?

How accurate is it that warming of oceans is exacerbating weather?

The meniscus shape of water in a container, you said there were two reasons, what was the one about influence of the deeper section of the container?

Middle school teachers' questions/comments for Dr. Webster

The way ice freezes first on the surface of lakes allows life to remain beneath. Life evolves.

How does capillary action in plants work so water can reach the top of the giant sequoia?

Thermal haline currents: are they all over the planet?

What is the actual shape of the water molecule and how do the hydrogen and oxygen atoms bond?

End of Day 1 Readings

Middle school teachers reviewed the Teachers' section of the "It's About Time Text."

Table 15. Discussion of readings at the end of the day was valuable.

	Frequency	Percent
Strongly agree	1	4.3
Agree	13	56.5
Disagree	4	17.4
No response	5	21.7
Total	23	100.0

When asked if the readings were valuable, only one person strongly agreed and 13 teachers agreed. Some 4 teachers disagreed and 5 did not respond, perhaps because they had already left the museum. Teachers were tired after a full day of intellectual stimulation. HS teachers who participated in New Visions had been working since 9am and did not find this a particularly useful exercise (see comment in Appendix C, "issues" on day 1, 3-2-1, number 111).

Connections to NY State Core Curriculum in Science

How helpful was day 1 in helping teachers with the Major Understandings required in the Core curriculum? They could respond, Very much, Just a little, Not very much and Not at all.

Middle school Major Understanding

Table 16. Substances have characteristic properties

	Frequency	Percent
Very much	11	91.7
Just a little	1	8.3
Total	12	100.0

High School Major Understandings

Three HS teachers did not respond about Day 1's value to teaching the Major Understanding illustrated in table 17.

Table 17. Hydrologic (Water) Cycle - processes and influences

	Frequency	Percent
Very much	2	25.0
Just a little	5	62.5
Not very much	1	12.5
Total	8	100.0

Table 18. Processes that move materials in and out of cells

	Frequency	Percent
Very much	7	63.6
Just a little	2	18.2
Not at all	1	9.1
Not very much	1	9.1
Total	11	100.0

Any additional comments about day 1

Given LOTS of activities.

Would like to hear more about the exhibit itself and good ways to use it.

The classroom part for HS was a bit choppy and why were some people here at 9:00 am and others just getting here with me at 12? The combination of the 2 groups was a surprise.

It was wonderful in that the teachers were able to interact with each other according to their own classroom experience. This benefited in implementing instruction.

A teacher who had brought 120 students from the Marble Hill School (an international-focused school where the students ranged from basic ESL to high proficiency students) on the Friday before the Institute began, made the following comments about the exhibition:

The ice, water, and vapor display really hit home on the phases of water for his ELL students. He liked the Blue Planet globe video ("very engaging"). He thought there wasn't enough connection to New York City, like pollution in the rivers in the Bronx and Queens. He liked the canyon exhibit, because it showed the power of water, and hit home the message, "Wow, water did this?" and wanted more moments like that. Overall, he said he was disappointed in the exhibition—thought it was "unengaging." He had hoped coming to the museum would be a kind of "punch" in the water unit he was teaching, but the exhibit wasn't the "punch" that he had expected.

Day 2 at QBG

The second day of the Institute took place at the Queens Botanical Garden (QBG). Several Institute participants could not attend day 2. Again, lunch and introductions began the program. Following lunch, Jennifer Ward Souder, Director of Capital Projects/Assistant Director of QBG spoke about the Garden’s “green” new building. Her talk was entitled, “Dragons, Elephants and Mirrors... What Do We Need to Protect Our Sacred Resources?”

Teachers were asked to assess the value of the talk for their teaching and its value for themselves as learners (tables 19 and 20).

Table 19. How useful was this talk for your teaching?

	Frequency	Percent
Very useful	10	52.6
Somewhat useful	7	36.8
Not very useful	1	5.3
No response	1	5.3
Total	19	100.0

Table 20. What was most memorable, surprising or interesting about the lecture for you as a learner?

	Frequency	Percent
QBG’s LEED building, sustainable water management program	6	31.6
How water is filtered through soil and plants	5	26.3
Water use in USA and elsewhere	2	10.5
Other	3	15.8
No response	3	15.8
Total	19	100.0

Overall, the teachers were impressed by the presentation of QBG’s ambitious green building project, wondering how it could be a model for building throughout the USA. Selected comments on what was most memorable follow.

- Filtering of grey water by soil and aquatic plants.*
- Storm water contamination of LI sound.*
- The eco-friendly way the building was created with compost toilets, solar panels, use of gray water and collection of storm water.*
- How can the QBG be used as a model for the Nation?*
- It was very inspiring and made me think about our own school's master plan and sustainability plans.*
- The QBG building is up for LEED platinum status.*
- The most interesting thing about the lecture was how biotopes work.*
- In the U.S. 80 gallons of water are used per person per day.*

Activities

The teachers divided into four groups to rotate through four activities located throughout the grounds and buildings of the QBG. The activities were “Just Passing Through” (how bioswales and biotopes work to filter impurities from waste water), “Using Plants for Water Management” (how plants help filter waste water), “Combined Sewage Outflow/Surface Permeability” (how to manage storm water without overtaxing sewers, including a tour of the building’s green roof), and “Point and Non-Point Pollution” (sources of water pollution, including a tour of the Garden’s compost toilet, located in the administrative office area).

Table 21. Just Passing Through

	Frequency	Percent
Very useful	12	63.1
Somewhat useful	4	21.1
Not very useful	2	10.5
No response	1	5.3
Total	18	100.0

Table 22. Using Plants for Water Management

	Frequency	Percent
Very useful	11	57.9
Somewhat useful	5	26.3
Not very useful	3	15.8
Total	19	100.0

Table 23. Combined Sewage Outflow/Surface Permeability

	Frequency	Percent
Very useful	10	52.6
Somewhat useful	8	42.1
Not at all useful	1	5.3
Total	19	100.0

Table 24. Point and Non-Point Pollution

	Frequency	Percent
Very useful	14	73.7
Somewhat useful	3	15.8
Not very useful	1	5.3
Not at all useful	1	5.3
Total	19	100.0

The teachers appeared to enjoy the activities, questioning presenters about where they might procure materials for their classes such as soil, perlite, types of plants and the like. However, the four stations tended to be quite repetitive. Although they addressed the issues from different perspectives, they all came down to collecting and recycling water, using bioswales, biotopes, and efficient use of natural plant and soil filtration systems. Some teachers expressed their frustration when listening to how a bioswale works for the fourth time. For example:

Excellent program connecting QBG water management to classroom activities—very interesting day. I liked the stations setup. My only complaint is that there was too much overlap between stations. The bioswale was explained 5 times (including the Keynote talk). By the end of a cold day, I was tired of hearing descriptions of the bioswale and biotope.

The program was incredibly redundant and many of the seminars could have been shortened and still made the same impact as or more of an impact.

Connections to the NY State Core Curriculum in Science

Middle school teachers found more connections to their teaching of the Major Understandings required by NY State, as illustrated in tables 25 through 28.

Middle School

Table 25. Ecosystem Balance: Community Members/Environment

	Frequency	Percent
Very much	6	75.0
Just a little	2	25.0
Total	8	100.0

Table 26. Organisms alter environments/ecological succession

	Frequency	Percent
Very much	7	87.5
Just a little	1	12.5
Total	8	100.0

Table 27. Overpopulation impacts environment/human activities' impact

	Frequency	Percent
Very much	7	87.5
Just a little	1	12.5
Total	8	100.0

Table 28. Impact of human caused pollution; need to protect environment

	Frequency	Percent
Very much	7	87.5
Just a little	1	12.5
Total	8	100.0

High School

The three Major Understandings covered at QBG that high school teachers found most relevant were “Human Activities that Degrade Ecosystems: Land Use, Pollution,” “Effects of Human Caused Reduction in Biodiversity” and “Industrialization Increases Demand for Energy and Resources” (see tables 29-31). High school teachers’ opinions of the Institute’s impact on their teaching other Major Understandings are illustrated in tables 32 through 35.)

Table 29. Human Activities that Degrade Ecosystems: Land Use, Pollution

	Frequency	Percent
Very much	10	76.9
Just a little	3	23.1
Total	13	100.0

Table 30. Effects of Human Caused Reduction in Biodiversity

	Frequency	Percent
Very much	8	57.1
Just a little	4	28.6
Not very much	2	14.3
Total	14	100.0

Table 31. Industrialization Increases Demand for Energy and Resources

	Frequency	Percent
Very much	11	78.6
Not very much	3	21.4
Total	14	100.0

Table 32. Results of weathering over time

	Frequency	Percent
Very much	2	40.0
Just a little	1	20.0
Not very much	2	40.0
Total	5	100.0

Table 33. Natural Agents of Erosion; Effects on Humans

	Frequency	Percent
Very much	3	60.0
Just a little	1	20.0
Not very much	1	20.0
Total	5	100.0

Table 34. Effects of moving water on earth features: Streams, Glaciers; Wave action

	Frequency	Percent
Very much	2	40.0
Just a little	1	20.0
Not very much	2	40.0
Total	5	100.0

Table 35. Sediment, Sedimentary Rock

	Frequency	Percent
Very much	1	20.0
Just a little	2	40.0
Not very much	2	40.0
Total	5	100.0

Additional comments about day 2

Amazing green building!

Great!

Need more pictures visuals (in order to retain) and to take back to classroom in order to properly display grey and rain water flow in the Queens Garden Display to classroom.

Day 3 at AMNH

The third and last day of the Institute took place back at AMNH. The program began in the Audubon Gallery with lunch, introductions and an icebreaker activity. The overall topic of the day was conservation and human impact on the environment.

Reflecting the environmental theme, the icebreaker began with a bag of trash being placed on each table. The trash consisted of items found on a nearby beach. Each table examined the contents of the bags and made up a story about how it came to be on the beach. This was fun, and several teachers thought it would make a good classroom activity as well.

Table 36. I learned new techniques for the classroom during the lunchtime activities.

	Frequency	Percent
Strongly agree	3	13.0
Agree	12	52.2
Disagree	1	4.3
No response	7	30.4
Total	23	100.0

Classroom Activities

The activities were divided into grade level appropriate tracks: high school teachers attended a session about “Decision Making in a Complex World;” the middle school session was, “Investigating Earth Systems: The Quality of Your Water Resources.” Again teachers responded to survey questions only about activities they had attended.

High School teachers

The Day 3 activity format was very different from that of Day 1. The speaker began with a lecture on inquiry-based teaching and learning. The teachers were instructed to do an activity described in their textbook about a lake that had seen decline in fish populations. They were given a packet of materials and asked to figure out why the fish population had declined. No direct observational data was collected from this session.

Teachers’ were asked about the value of the activity. Responses are illustrated in table 37. Some were already familiar with the material and only 1 in 4 who responded said they would use the activity in class.

Table 37. High School Living Environment: Decision Making in a Complex World

	Frequency	Percent
Learned new material	5	41.7
Already familiar	4	33.3
Will use in classes	3	25.0
Total	12	100.0

Middle School Teachers

Middle school participants conducted experiments designed to test water for impurities. The QBG educator had brought samples of water that had undergone natural filtration in the Garden's system. Participants divided into teams and used various materials to test for a variety of chemical and biological pollutants. The same textbook from the "It's All About Time" series was used to guide the activities. Only 2 teachers said they would use the activities in their classes (table 38).

Table 38. Middle School: The Quality of your Water Resources

	Frequency	Percent
Learned new material	5	55.6
Already familiar	2	22.2
Will use in classes	2	22.2
Total	9	100.0

The Lecture

The lecture, "Human Impact: How do societal decisions affect our water supplies?" was presented by Erin Vintinner, a member of the Center for Biodiversity and Conservation staff at AMNH. Ms. Vintinner covered various topics to help teachers raise students' awareness of where their water comes from and how scarce it is. She raised the issue of political impact and why it is important to elect responsible officials. Ms. Vintinner touched on both societal and personal responsibility to conserve and avoid polluting water resources. As Table 39 illustrates, the teachers found the talk very useful for their teaching.

Table 39. How useful was Ms. Vintinner's talk for your teaching?

	Frequency	Percent
Somewhat useful	3	13.0
Very useful	17	73.9
No response	3	13
Total	23	100.0

Teachers were asked what was most important in the lecture for them as a learner. The teachers took away a variety of interesting facts from the presentation, most frequently consumerism's effect on water and ways to engage students in conservation behavior.

Unfortunately a large number of teachers opted not to answer this open-ended question. The responses were categorized and the results are illustrated in table 40 below.

Table 40. What was most memorable, surprising or interesting about the lecture for you as a learner?

	Frequency	Percent
Amount of water needed to produce products we use	4	17.4
Agriculture, global connections	3	13.0
What we can do to conserve	3	13.0
All is not hopeless, progress is being made	2	8.7
Other	2	8.7
No response	9	60.9
Total	23	100.0

Teachers' written comments

Effects of consumerism

Amount of water is involved in producing everything we buy.

How much water Human societies utilize in farming, agriculture and its effects on bodies of water.

The ineradicable statistics (i.e., 70 gallons of water [to produce] 1 cotton shirt).

A cotton t-shirt contains 700 gallons of "virtual water". Our consumer choices greatly affect water resources.

Interesting coffee - fish relationship

Ground water depletion.

Raising (students') consciousness about conserving water

[I liked] the part where she shared what we could do as teachers to help our students participate.

Ways that I can tell students how to improve conservation

What we can do locally to conserve water.

Such interesting facts, global context; great connections to stewardship.

Progress

I found it surprising that some positive progress has been made.

Iraq wetland example: they can regenerate. All is not hopeless!

Critique

The presenter was fine. But the presentation was slow and [there was] too much reading that had little to relate or engage students. The “tool” is an unnecessary graphic because it is too confusing for students. Water use facts and images - amazing!

Exhibition Visit

The exhibition visit took place late in the afternoon, shortly before the museum closed for the day. Consequently “Water” was less crowded than on day 1, thus the teachers had a better experience, not having to compete with so many other visitors to see. Some 3 in 4 respondents agreed that the visit provided ideas for teaching about conservation, the day’s main topic (74% when strongly agree and agree in table 41 are combined); only one respondent disagreed.

The majority of respondents agreed that they had learned how to use museum exhibitions in their teaching. Combing strongly agree and agree (in table 42), some 65% of the teachers learned how to use museum exhibitions in their teaching. Two people said they did not learn how to use museum exhibitions in their teaching.

The Institute ended with a wrap-up, including some additional reading from the texts followed by discussion. Many teachers were tired after three days of intense study and only 11 teachers responded to a question about the value of these readings (see table 43 below).

Table 41. Today's visit to the exhibition provided ideas for teaching about conservation.

	Frequency	Percent
Strongly agree	9	39.1
Agree	8	34.8
Disagree	1	4.3
No response	5	21.7
Total	23	100.0

Table 42. I learned how to use Museum exhibitions in my teaching.

	Frequency	Percent
Strongly agree	5	21.7
Agree	10	43.5
Disagree	2	8.7
No data	6	26.1
Total	23	100.0

Table 43. This afternoon’s discussion of readings was valuable.

	Frequency	Percent
Disagree	2	8.7
Agree	2	8.7
Strongly agree	7	30.4
No data	12	52.2
Total	23	100.0

There is a significant difference between the responses of Middle and high school teachers: 83.3% of middle school teachers strongly agreed that the reading was valuable while only 16.7% of high school teachers strongly agreed that the afternoon's discussion of readings was valuable ($\chi^2(2, N=10) = 6.03, p < .05$). Most of the high school teachers were in the New Visions program, whose day started at 9am, and were understandably tired by the late afternoon reading session.

Connections to the NY State Core Curriculum in Science

Teachers from both grade levels were asked to assess the extent to which the program helped them teach of Major Understandings related to organisms/human impact on the environment. Most high school teachers thought the Institute had at least some positive impact on teaching the Major Understandings (tables 44 and 45).

High School Major Understandings: how much did the Institute help teaching?

Table 44. Societies and Individuals Must Assess New Technologies

	Frequency	Percent
Very much	8	57.1
Just a little	5	35.7
Not very much	1	7.1
Total	14	100.0

Table 45. Decisions of one generation affect the next

	Frequency	Percent
Very much	9	64.3
Just a little	4	28.6
Not very much	1	7.1
Total	14	100.0

Middle School Major Understandings: how much did the Institute help teaching?

Most middle school teachers thought the Institute helped them teach the Major Understandings, “Ecosystem Balance: Community Members and the Environment.”

Table 46. Ecosystem Balance: Community Members/Environment

	Frequency	Percent
Very much	7	87.5
Just a little	1	12.5
Total	8	100.0

Table 47. Organisms alter environments/ecological succession

	Frequency	Percent
Very much	5	62.5
Just a little	2	25.0
Not very much	1	12.5
Total	8	100.0

Table 48. Overpopulation impacts environment/human activities' impacts

	Frequency	Percent
Very much	6	75.0
Just a little	2	25.0
Total	8	100.0

Table 49. Impact of human caused pollution; need to protect environment

	Frequency	Percent
Very much	6	75.0
Just a little	2	25.0
Total	8	100.0

Additional Comments about Day 3

The activity was focused primarily on scientific explanations, not environment impacts.

However, I found the approach relevant and useful.

Jim [Short] was great he needs more time to be most effective.

Conclusions and Recommendations

Overall response to the Institute and the “Water” exhibition was very positive. Teachers on their mid-winter break enjoyed the program and the ability to network with other teachers. Participants who attended lab activities by grade level were able to discuss teaching strategies and pedagogical ideas with peers. Teachers who never knew each other seemed to bond during these sessions, and during roundtable discussions at lunch, before and after lectures and during the day’s wrap-up.

Teachers found the Institute’s direct connections to teaching the Major Understandings in Science very helpful. Actually delineating each Understanding the Institute was designed to While the majority of participants said they planned to bring students to “Water,” whether they bring students or not, teachers say that the science they learned from the exhibition, the lab activities and the lectures, all provided resources for teaching and enriching the mandated middle and high school curricula.

Survey respondents supplied many ways that the Institute in the museum setting differed from other PD programs. Almost half of them said that the Institute is more hands-on, interactive and generally a more complex experience. They appreciated immediate access to exhibits and experts (experts in both science and educational pedagogy).

Teachers’ comments indicated that the Institute helped “re-energize” them, providing new ideas for inquiry-based pedagogy as well as concrete lessons easily transferable to their classrooms. They particularly appreciated ideas for experiments that did not require special, expensive equipment because they have to “make do” with recycled and disposable equipment, such as plastic soda bottles instead of glass beakers.

Partnering with another institution is a good idea to give participants broader access to informal learning sites. Queens Botanical Garden fit the “Water” program perfectly. The participants who came to BG (not everyone could make it) were enthusiastic about the “green” building and the teachable moments involved in touring the site. However, the material

presented in each session tended to be very repetitious, frustrating the participants with repeated descriptions of “bioswales” and “biotopes.”

Aspects of the agenda for Days 1 and 3 at AMNH could use some attention. For example, scheduling the lecture early in the day (as was done in the Human Origins Institute) prepares orients participants to the day’s main topic. Scheduling the lecture toward the end of the day tends to find participants somewhat tired and misses the orientation opportunity. The exhibition was very crowded on Day 1 during the 3:15 scheduled visit. The 5:00 visit on Day 3 was much less crowded and hence much more accessible for Institute participants. The museum is exceptionally crowded during the winter break period, so scheduling exhibition visits late in the day shortly before closing is preferable to midday. Three days may be a bit long for an Institute during a school break. Although having the two sites provided ample variety, teachers seemed a bit tired late on Day 3. This was particularly true for New Visions participants, who started their days at 9am and joined the Institute from 12 to 6pm.

Mid-winter school break seems to be a good choice for holding professional development Institutes for teachers. However, this year’s attendance was somewhat off from that of the previous year. Since teachers are giving up their vacation time, it might be wise to place greater emphasis on the social aspects of the Institute—the excellent refreshments and networking opportunities, for example. Respondents cite the difference between this and other PD opportunities—the hands-on, interactive nature of the program as well as the opportunity to access experts in science and education. When publicizing future Institutes, these opportunities for *personal* enrichment might be emphasized. And finally, many teachers have children who are also on school break and may have to stay home with them (one of the participants brought her middle-school-age son to Day 3 at AMNH). Perhaps linking the Institute with the AMNH camp program might attract more teachers who are also parents.