2015-2016 Science Curriculum Report
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I believe that when we truly learn to see and observe,
our apprecation of the natural world grows, and, as a result,
we become better stewards of our environment.
-Paul W. Meyer, Director of the Morris Arboretum

The main goal of the science program at Miquon is to develop interested and engaged scientific thinkers. Science at Miquon is taught through inquiry based, hands-on instruction. The program emphasizes critical thinking processes that give children the skills they need to explore their own questions. We want students to understand how scientific knowledge is developed and to give them the tools they need to be successful problem solvers. We also want them to enjoy this process and become more than a little enchanted by what they find. Emphasizing the importance of curiosity and careful thinking, students practice methods for noticing, asking questions, experimenting, evaluating information and making connections to previous knowledge.

In designing curriculum for this year, I wanted to give all children real experiences with the scientific process and the Miquon environment. Science classes included time for observations, making predictions, gathering data, analyzing evidence, and decision-making. This was facilitated through hands-on activities, informational reading, discussions, and journal entries.

Miquon's campus greatly informed the orientation of the science program. The amazing resources at our fingertips provided students with the unique opportunity to directly learn the natural world. The curriculum was shaped to grow a knowledgeable love of the land and sense of environmental stewardship in each child.

We also spent a fair amount of time talking about what science does and doesn't do. The students continued their growth as they evaluated their previous knowledge through a scientific lens. I especially enjoyed talking with them about the relative truth of "facts" and the idea that scientific information is not set in stone, but rather that ideas are based on supportive evidence and open to revision.

Framing questions for the **fifth and sixth grade** groups included:

- What affects the way a stream flows?
- What lives in the Miquon creek and what does this tell us about its health?
- How can we measure and model something as large as the creek?
- How is energy changed from one form to another? How is electricity generated?
- What are the major sources of energy today? What are their benefits and drawbacks?
- How can we evaluate our energy use and make positive changes?
- What is a well designed experiment? What factors contribute to a poorly designed experiment?

Students in Lynn, Mark, Diane and Jeri's groups approached these questions through observation and experimentation. Our investigations were supported by reading literature and nonfiction and sharing ideas during group discussions. The year began with conversations about the upcoming creek stabilization project and in-depth observations of how flooding and erosion have shaped the course of our stream. Students learned how to measure the steepness of the creek banks by dividing the creek into two-dimensional cross-sectional slices. They measured the rise and run of each slice and used their data to create a one-sixth scale model in the spring. Both fifth and sixth grade classes also learned about macroinvertebrates that live in freshwater streams and conducted leaf pack experiments to find out what species are common in the Miquon creek. The results were analyzed to help students understand how pollution-tolerant and pollution-sensitive populations provide information about stream health. We completed these studies by creating descriptive poems about individual macroinvertebrates in the style of passages from The Important Book by Margaret Wise Brown.

Our energy unit began by messing about with mousetraps. The children were excited, scared and intensely motivated to figure out how to set a classic snap trap. We discussed how energy is transferred in a mousetrap and traced the origins of this energy back to its solar source (human hands need food grown by the sun). Lynn and Mark's group jumped into workshop mode during December to design and build mousetrap powered vehicles. Diane and Jeri's group worked on Rube Goldberg machines to explore how energy is transferred. Both challenges involved a great deal of

troubleshooting and persistence. After these projects, we watched a video on simple machines and constructed waterwheels to transfer energy to a small generator. Students experimented with the number of paddles on their waterwheel to find the configuration that would generate the highest voltage. This work was followed by classes that explored the relationship between motion and electromagnetism. Next, we learned about the human quest to create machines that produce electricity by spinning wire coils and magnets. We also studied the benefits and drawbacks of the main energy sources used today. Students continued these studies by conducting a school-wide energy audit. After assessing energy use at school, the groups brainstormed recommendations for reducing our consumption and shared these with the staff. Later in the year, we visited the Covanta Plymouth Renewable Energy waste-to-energy plant and debated the merits of this type of waste management and energy production.

In early March, we focused on experimental design. We conducted research and gathered evidence in an attempt to answer specific research questions. The goal was to work through the steps of an experimental process and then tear it apart. I wanted students to understand how unintended variables affect results and to appreciate the importance of standardized and thoughtfully planned procedures. The research topics included how exercise affects heart rate, the best household cleaning recipe for ketchup stains and determining the best bubble solution. After each round of testing, students met in small groups to identify all of the potential problems with the experimental design and improve the process. They then brainstormed their own questions and experimental procedures for gathering evidence.

After spring break, fifth and sixth graders worked to create a one-sixth scale model of the creek for display at the Art and Science Show in May. They cut, sanded and primed Masonite boards before decorating them with art, poetry and memories about the creek. This project slowly transformed from a "model" to a "memorial" that captured the topography and experience of the creek before the stabilization project created a permanent change. Diane and Jeri's group had spent much of the year exploring sacred spaces in different cultures; creating a way to honor one of Miquon's sacred spaces, the creek, seemed like a natural extension. What I originally imagined to be a small project unfurled into an extensive process that involved all of the STEAM acronym components (science, technology, engineering, art and mathematics). Every age group in the school contributed artwork and memories to create a collective piece that captured why the creek is such an integral part of life at Miquon.

In May, students planted outdoors to control erosion and increase plant diversity on campus. The groups learned about competition between plants for resources and how introduced species, like garlic mustard, can quickly proliferate. Lynn and Mark's group also spent some time discussing diversity in the context of agriculture. They discussed the pros and cons of monoculture and permaculture farming after viewing brief informational videos.

We also returned to our energy studies with a visit to the Covanta waste-to-energy plant. To understand more about the fuel stored in different materials, students built and tested calorimeters. These devices measured the heat released when different objects were burned and provided data used to calculate calories. The groups tested a variety of foods to see how much energy they released when burned and learned why this is a very rough estimate of the energy absorbed by your body during digestion. We concluded the year by comparing the caloric content of a variety of foods and learning more about human digestion.

Framing questions for the **fourth grade** included:

- How are plant life cycles related to our food?
- What lives in the Miquon creek and what does this tell us about its health?
- How can we experiment to improve designs for catapults and vehicles?
- How do variables like stored energy, weight and friction affect motion?
- How can we use math to examine data and make decisions?
- How do water and land interact?

Wendy and Sara's group approached these questions through observation and experimentation. Our investigations were supported by reading literature and nonfiction and sharing ideas during group discussions. In the early fall, we tended the garden outside the library. Students harvested squash, eggplants and sunflower seeds. As we prepared delicious dishes, we learned about plant anatomy and plant life cycles. This led to a more extensive exploration of how plants reproduce and the variety of specially adapted species on our campus.

October began with discussions about the upcoming creek stabilization project and in-depth observations of how flooding and erosion have shaped the course of our stream. We also learned about macroinvertebrates that live in freshwater streams and conducted leaf pack experiments to find out which species are common in the Miquon creek. The

results were analyzed to help students understand how pollution-tolerant and pollution-sensitive populations provide information about stream health.

In December, the group switched gears to focus on engineering. Children worked together to build standardized catapults and then discussed how energy was stored in the designs before creating their own. We isolated and tested variables like angle of launch and evaluated the experimental evidence. Students were adept at recognizing unintended factors that affected performance. They used this information to enthusiastically revisit and improve their earlier designs. We also built and tested K'NEX vehicles to learn about forces and motion. Students strengthened visual-spatial skills by learning how to draw two-dimensional blueprints from their three-dimensional vehicles. This work required patience, persistence and the willingness to observe objects from an unfamiliar perspective. Next, we built standardized vehicles from technical drawings and used them to experiment with falling weight systems and rubber band power. Students recorded and analyzed the data they collected in their science notebooks.

In the spring, the group studied land and water interactions through experimentation, modeling and reading. They explored the properties of water, practiced using water cycle vocabulary in short stories and learned about watersheds by building and spraying three-dimensional models. This led to a water filtration project in which students had to design and test filters that would remove increasingly difficult contaminants like soil, dye and soap. I was amazed at their ingenuity and the way they applied and shared what they learned. Slow filtration was the way to go. After watching videos about water treatment, we visited the Waterworks museum in Fairmount. In addition to these studies, the fourth grade wrote beautiful creek-inspired poetry with Wendy and Sara. They also painted gorgeous murals on Masonite slices as part of the large creek memorial sculpture displayed at the Art and Science Show.

The cold spring and late snow meant that there was not as much time for gardening this year. However, the fourth grade worked with focus on damp days. They repaired the bamboo beds, tilled the soil and planted a variety of foods including herbs, strawberries, peas, lettuce, peppers, eggplants, carrots, beets and flowers. Students also learned more about earthworms including their movement, reproduction and habitat.

Framing questions for the **second and third grade** groups included:

- How are plant life cycles related to our food?
- How can we learn more about and help plants at Miquon?
- How do special features (adaptations) help organisms survive?
- What are the properties of objects? How can they help us identify things we find?
- How do rocks change over time?
- How do lenses bend light in specific ways in order to accomplish useful jobs?
- How does light usually behave? How can we describe it?
- How can we use data to answer questions? What makes data reliable?

We approached these questions through observation and experimentation. Our investigations were supported by reading children's literature and nonfiction and sharing ideas during group discussions. In the early fall, we tended the garden in front of the library. Students harvested squash, eggplants and sunflower seeds. As we prepared delicious dishes, we learned about plant anatomy and life cycles. This led to a more in depth exploration of how plants reproduce and the variety of specially adapted species on our campus. Students learned about animal adaptations as well through activities designed to practice nonfiction reading skills. We concluded our studies by experimenting to find out how our lives might be different if humans lacked opposable thumbs.

In the winter, we shifted our focus to learn more about geology and how scientists use evidence to make informed decisions. Students investigated the properties of ten common mineral samples and learned how to conduct tests that are used in identification. This work concluded in a scientific summit during which students used the evidence they had gathered and verified each other's work to make sure samples were correctly identified. I was impressed by the collaborative atmosphere and their understanding of appropriately using evidence to support claims. Our geology unit also included time for gathering interesting rocks on campus and smashing them to bits with hammers (wearing goggles). After identifying a few samples, we used a variety of interesting materials to model the three main ways that rocks are formed. Our minerals studies continued with discussions about the importance of certain minerals in our body; students then used magnets to isolate iron from fortified corn flakes.

We studied salt crystals to better understand how materials can be taken apart (dissolved in this case) and reform in similar patterns. Students learned about powers of magnification and used microscopes to observe their crystals. This work led to interest in how lenses bend light. We darkened the windows and spent a few classes exploring light with

flashlights, prisms, colored materials and mirrors. The children figured out all kinds of interesting things they could do with light and loved sharing with one another. After recording obsevations about how light moves, we examined Fresnel lenses and experimented with focusing light energy from the sun. Students were enthralled to burn small dried leaves and char their initials into cardboard squares. As part of this exploration, we discussed fire safety and the necessary conditions for experimenting with fire (most importantly with a supervising adult). Bree and Marie's group also listened to stories about the role of fire in forests and learned why fire is a necessary part of many healthy ecosystems.

In the early spring, students conducted experiments to consider how we might answer everyday questions using the scientific method. Students gathered evidence and looked for patterns in their data to support ideas. We also considered how these experiments might be improved. In May, second and third graders planted outdoors to control erosion and increase plant diversity on campus. Children learned about competition between plants for resources and how introduced species can quickly proliferate. We concluded by harvesting and feasting on garlic mustard. Bree and Marie's group also enjoyed nibbling their way through campus on a foraging hike with "Farmer Dave" Siller.

Framing questions for the **first grade** included:

- How can we use tools to learn about our surroundings?
- How are most seeds alike? How are they different? How do they change into plants?
- How do people use seeds?
- How are we alike? How are we different? In what ways do we compare things?
- Can we see useful patterns in what we observe? How much information do you need to "trust" your ideas about what is happening?
- What are the main forces acting on bridges? Which bridge shapes are more stable?

Ben and Elisa's group approached these questions through observation and experimentation. Our investigations were supported by reading children's literature and nonfiction and sharing ideas during group discussions. We began the year with a focus on the five senses and how people describe objects. Students learned how to use and care for a microscope so that they could observe natural objects in greater detail. We then went on seed scavenger hunts throughout the campus and began learning more about the basic needs and life cycles of plants. Students germinated and transplanted bean seedlings, created descriptive drawings of plant parts in their science notebooks and feasted at our seed celebration!

These studies were followed by a foray into the world of scat tracking. We learned how to look for tracks and fecal clues of animal residents at Miquon. Students were both delighted and disgusted to do this detective work on our campus. We found evidence of a variety of visitors!

During the late winter, we began examining identity through the lens of anatomy and fingerprinting. Students learned about the three primary types of fingerprints, graphed the types of prints in our class and made finger print art inspired by Ed Emberly. We also spent a lot of time practicing how to observe details closely, check findings with other researchers before sharing and make reasonable predictions about future patterns based on current information.

In the spring, students looked at bridges as inventions. We read the fictional story Pop's Bridge about the building of the Golden Gate Bridge and then surveyed the types of bridge designs on Miquon's campus. We looked at the differences between materials (wood, stone, metal), shapes (flat, arched) and anchoring (pillars, rocks). We made guesses about why specific bridges were built the way they were and which materials were most suitable in different circumstances. We also examined how erosion on the creek banks affects bridge stability. Over the next few classes, we built our own bridges using gum drops and toothpicks. Students experimented with different shapes to identify strong supporting elements. We also learned about truss bridges, the variety of forces acting on bridges, weak spots and bridge failures. Students were very invested and showed steady progress in their understanding of how to approach three-dimensional designs as they practiced. A few students chose to display their final bridges at the Art and Science Show in May.

After spring break, we wrote and illustrated memories about the creek for the large creek sculpture created by fifth and sixth grade students. We also spent time outside as the group learned about competition between plants for resources and how introduced species can quickly proliferate. We went on a few harvesting hikes and feasted on garlic mustard. First grade students finished the year with a wonderful visit from Lucas' dad, Kevin Aptowitz. Kevin brought in a variety of fascinating materials to teach students about factors that affect viscosity. The kids were really excited to engage with his demonstrations of slow moving honey, dancing cornstarch slurries and mango juice spheres.

Framing questions for the **nursery and kindergarten** groups included:

- How can we use our senses to learn about the world?
- How can we use tools to learn about our surroundings?
- How can we affect objects to make them behave in a certain way?
- How can we use clues to make reasonable guesses about what has happened or will happen?

The nursery and kindergarten approached these questions through observation and experimentation. Our investigations were supported by reading children's literature and nonfiction, sketching observations and sharing ideas during lively group discussions. Classes were most exciting when students suggested ways of using materials that I had not anticipated. Their creativity and ability to see objects in a new light kept us continually fascinated by the world at our fingertips.

Science included time to observe and take care of a variety of creatures including composting worms and Madagascar hissing cockroaches. Outdoor learning included listening hikes, gathering dried flowers for Thanksgiving bouquets and gardening. In the winter, we emphasized hand washing through experiments on the best combination of water (warm or cold) and soap (with or without) to remove pretend germs (oil and cinnamon) from our hands. The winter cold also offered opportunities to learn about changing temperatures, freezing and melting, and making maple syrup snow taffy. Students learned about how animals stay warm in the winter and tested different insulators to keep their hands warm in an bucket of ice water; they were surprised at the effectiveness of air as an insulator and loved feeling the squish of Crisco-filled "blubber gloves."

We explored magnetism by using magnets as a tool to sort items, cast "repel" and "attract" spells, and paint using a "magnetic brush." In the kindergarten, our study of balance used the books Just a Little Bit and Mirette on the Highwire to help students think about how weight and position affect balance. Children built and tested seesaws, designed fingertip balance toys and learned how to compare mass in balance pans.

During late winter, we practiced with pipettes in the kindergarten, built catapults with the nursery, went on cold weather hikes to look for signs of animals, and tended the worm bin. Students chopped banana peels to feed the worms and checked to see how the waste was breaking down each week. Nursery students then mixed the castings with soil and planted Honesty or "money plant" seeds. Creating a gentle rain on the young plants was a favorite activity for both groups throughout the spring.

In the spring, both groups wrote creek memories and created artwork for the Art and Science Show. The nursery also explored sound through a variety of materials and had a great time talking on their string-can telephones. We finished the year by learning about how plants compete for resources and quickly reproduce. We then harvested and dined on invasive garlic mustard, confirming that everything tastes delicious when mixed with olive oil and salt.

Lunch Choice and Mini-courses

In addition to scheduled classes, many children in first through sixth grade also enjoyed visiting the science room at lunch choice to build creations, extend explorations from class, use computer programs, and just hang out. I really enjoyed getting to know students in this way and during our more personal mini-course times. In the fall, I co-taught a "Mobiles" class with Jeri. Diane and I co-hosted "Kitchen Chemistry" in the winter and in the spring, Deborah (the Director of Development) and I shook things up with the "Dance Party" mini-course.

Thank you for supporting your children's interests and encouraging them to be curious, creative investigators. Their enthusiasm is what made our time together this year so much fun!