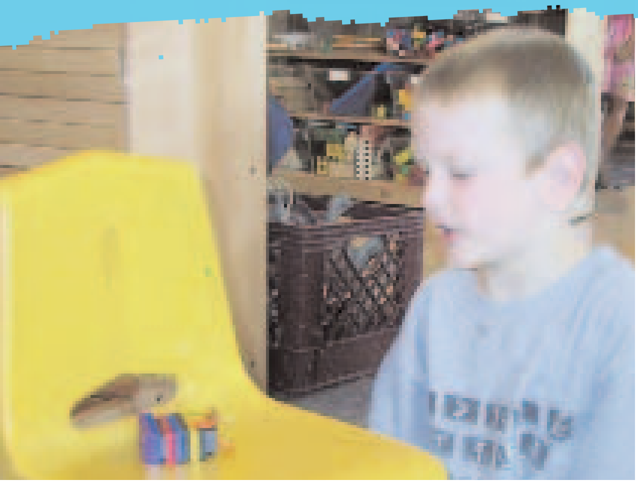

Magnets Can Dance and Vanilla Smells Warm

by Alison Lutton

"Images are the currency of mind."
— Antonio Damasio

Imagine . . . you are far, far away on the other side of the world. You are lying on a warm beach . . . are beaches ever cold? You are gazing up at a big, blue sky . . . feeling and smelling a slightly salty breeze . . . this must be the ocean. It is very quiet, but you hear a soft rustling . . . it sounds like a leaf . . . a cornfield? Not here . . . maybe a palm tree. Otherwise it is very quiet . . . no one around . . . unless you'd like someone to join you . . . after all, this is your imagination. Let it flow and just feel the pleasure of it. Analyze it and you'll see that it is made possible by your understanding of science and math. Watch children and you'll see that your understanding of science and math is fueled by your imagination.

I used to think I knew what science and math were. They were piles of information that normal people do not really use, described in words that normal people do not really understand. Scientists and mathematicians were odd, gifted with a genius for esoteric abstract details but lacking in common sense. As it turns out, my imaginings about these things lacked an adequate knowledge base. But, fortunately for me, I began to learn science and math all over again, with and from children. They are still teaching me the answers to big questions: What is science? What is math? They are still teaching me to ask smaller questions relentlessly: "What's that?" "How big is it?" "How did it get here?" "What's it doing?" "Why?"

Magnets can dance

Sally calls me into the preschool room. "Come watch MacLean."

He is sitting at a table with a cafeteria tray, magnet wands, and magnetic chips. MacLean is moving the wand under the tray as chips jump crazily. "Whoever can make them jump right off wins!"

M'Kenna follows MacLean as he carries the wand and chips away. "Let's get more in case we lose one."

MacLean dumps the chips on a chair seat and waves the wand under the chair. "Let's try them here. Look! Two can dance together. They can dance crazy! Ahh! Get off there! Now they're apart. This one says, 'You're too crazy!' "

M'Kenna waves a second wand under the chair seat. "I got these. Look how many!"

MacLean slides a few more chips into his pile. "Hey! I need some!"

Sally sees a math moment. "How many chips do you have?" After some counting debates and agreement on a fair division of chips, Sally tries a science question. She looks closely at a magnet wand. "How does it stick?"

The children examine their wands. "I don't see any glue."

"Or tape."

MacLean strokes the surface, frowning. "It sticks 'cause this has magnet."

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M'Kenna gets a horseshoe magnet from the shelf. "These could try this." She lets one lucky set of chips try her special magnet. "Ooh! Dah! It works!" A brief pause for a smile and then . . . "Fire!"

MacLean and M'Kenna are on to a new game. "This one's trying to get away! This one's trying to jump on!"

M'Kenna shifts from drama to pattern construction. "How about we just make a square with them? How about a rainbow?" MacLean continues making chips jump and dance, talking to himself. "I have more reds than you. I have 50 reds. Sing pitta pitta pit minna minna mine. I have a lot; I have a lot. But I have fifty thousand for M'Kenna. Oh you left me by myself. How do they jump together? It has a snapper . . . oh a snapper a snapper it has a snapper . . . . "

Sally's question, "What makes it stick?" was posed at a timely moment and stayed with MacLean. Drama fueled his game of experiments. Imagination fueled his hypothesis. "It" — the surface — "has magnet." But what is magnet? MacLean has learned to use these words: magnet, magnetic, magnetism. But what do they really mean? How do they take shape in his mind and connect to other mental images? Maybe being a magnet means, "It has a snapper."

With preschoolers, often the words are wrong but the mental connections have a logic of their own. Listen to a group of children surrounding teachers Sally and Lindsay as they get ready to make ice cream. Sally asks, "How do we know it will turn out to be ice cream? What if it turns out to be pizza?" Children shout out, "You need to have instructions! We need to follow the tracks!" Later they pass a bottle of vanilla around the table. What does it smell like? "It smells like chocolate! It smells warm!"

Knowing — More Than Naming

Richard Feynman was a Nobel prize winning physicist, a professor, a drummer, and a stamp collector. He had a lifelong dream to visit the nation that produced one of his favorite boyhood stamps — Tannu Tuva in Outer Mongolia. Although he died of cancer before making his visit, you can find web sites today dedicated to Feynman's lively intelligence and to his "Tuva or bust!" daydreams.

In his autobiographical book *What Do You Care What Other People Think*? Feynman includes a fascinating chapter called, "The Making of a Scientist." In it he describes a field trip. A group of fathers took their sons for a walk in the woods. The next week, one boy tested Richard. "What kind of bird is that?" Richard didn't know. The other boy taunted, "Your father doesn't teach you anything!"

But Feynman's father taught him to think like a scientist. His father taught him that a bird has many different names in many different languages. "You can know the name of that bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird. You'll only know about humans in different places, and what they call the bird. So let's look at the bird and see what it's doing — that's what counts."

PHOTOGRAPHS PROVIDED BY THE AUTHOR

The bird was walking around pecking at its feathers. Richard's father asked, "Why do you think birds peck at their feathers?" Richard speculated, "Maybe they mess up their feathers when they fly, so they're pecking them in order to straighten them out." They designed an experiment to test this hypothesis. If true, the birds who are just landing should peck a lot more than those who have been walking around a while. The experiment did not support this idea. His father offered a new idea. Maybe the birds have lice?

This nurturing of "a curious character" fueled Richard's scientific imagination. "I've been caught, so to speak — like someone who was given something wonderful when he was a child, and he's always looking for it again. I'm always looking, like a child, for the wonders I know I'm going to find — maybe not every time, but every once in a while."

Chatting at the Water Table

I see Paula at the water table, pouring water through funnels into containers. I expect some math and science talk here, but Paula takes me in a direction I couldn't have predicted.

"The baby's coming in three weeks. I'm going to kindergarten in September. I go to my grandmother's farm for one week while the baby comes, then I come home in August." Paula's teacher Lindsay lives on a farm, too. Paula exclaims, "My grandmother has 40 cows! That's a big farm!" Lindsay agrees. "Forty cows! That's a lot!"

I ask Paula if she has met her kindergarten teacher. "Yeah, but the one I like is circling up to first grade."

I suggest maybe she will be Paula's first grade teacher. Paula thinks, then giggles, "Or maybe she'll keep circling up to second grade! And I'll keep chasing behind her!"

I laugh. "Maybe you'll circle behind her through middle school and high school and college!"

Paula's eyes and smile are wide. "Then I'll get a job and then she'll come there!"

"And you'll teach her how to do her job!"

Paula and I share a big smile. We are delighted with ourselves. Paula has imagined and successfully shared a complicated and funny picture of circles spiraling through space and time. I feel that early childhood teacher's rush of joy — a glimmer of the exhilaration young children must feel when they successfully create and share new ideas.

Visualization, Analysis, and Deduction

According to the work of Pierre van Hiele and Dina van Heile-Geldof, children's mathematical reasoning develops through three essential stages from visualization (by kindergarten), to analysis, to logical deduction (by grade 8). Along the way, the child's own language makes a "flip" into mathematical language.

In the first visualization stage children are able to name and recognize shapes but are not yet able to analyze object properties or use deduction to solve logic problems. A rectangle is a rectangle "because it looks like a door," not "because it has four sides and the opposite sides are equal." This visualization and comparison phase is an essential foundation for mathematical reasoning and a foundation of science and math curriculum in early childhood education.

When children move from simple identification and naming of shapes into play with manipulatives in the classroom, they move into deeper levels of math and science. Sorting, identifying, describing, building, drawing, making, putting together and taking apart shapes — children engaged in these activities become engaged in visualization, analysis, and deduction. Children learn the real uses and process of measurement as they visualize and then test non-standard units. Will these blocks fill that space? Will this dress fit that doll? How many cows do you need to have a lot of cows on a big farm?

Observation, Communication, Comparison, and Organization

Through the "what will happen if . . . " play process children learn the method of scientific inquiry — observing and exploring what materials can do, sharing their observations with others, imagining what might be possible, applying prior knowledge, challenging misconceptions, and solving problems. In play children use the science process skills of observing, communicating, comparing, and organizing. As Lev Vygotsky imagined it, "In play the child always behaves beyond his average age, above his daily behavior; in play it is as though he were a head taller than himself."

Here is another story from Feynman's childhood. His father often read to him from the encyclopedia. "It would be talking about tyrannosaurus rex and it would say something like, 'This dinosaur is 25 feet high and its head is six feet across.' My father would stop reading and say, 'Now, let's see what that means. That would mean that if he stood in our front yard, he would be tall enough to put his head through our window up here . . . but his head would be too wide to fit in the window.' "

Through this practice in visualization and spatial reasoning, preschool and kindergarten children become ready for the geometry of elementary school. Through imaginative play, conversation, and art they learn to create mental images of geometric shapes, identify and draw shapes from different perspectives, recognize shapes in their environment, and build and draw geometric shapes from mental images.

How Big Is It?

Mathematical thinking begins in the infant-toddler room with learning to observe, compare, and measure. Mathematical literacy means being able to recognize, visualize, and think about patterns. Saying the words "one, two, three" is vocabulary development. Understanding that two is more than one; that big and little are opposites; that numbers can be used to compare, count, and measure — that's math.

Babies begin recognizing patterns as they distinguish things with faces from things without faces. Toddlers study the look and feel of food on a plate to decide whether there is enough or whether to call out for "More!" Is there still some or is it all gone?

One day the toddler adds "Uh-oh" to her vocabulary and the world is suddenly full of problems to be solved and jokes to be made. The teacher pretending to squeeze into a crib gets a giggle and exclamation of "Too big!" Things in the world are now big or not big, small or not small, too big or too small. Containers are full or empty. One is "one." Everything more than one is "two."

Two-year-old Brian agrees to give Kate two crayons. Then he studies the two piles of crayons to make sure his pile is adequate. He finally decides it is okay and tells himself, "Kate has a teeny tiny bit. Brian has a big bit." Three-year-old Kate arranges a collection of stones into families. Daddies are biggest, Mommies are not quite so big, children are smaller, and babies are the smallest. After making these family members walk and talk a while, she likes to arrange them in long lines and tap each object while chanting number words. "One, two, three, four, five, seven, nine, twelve!" That's a lot!

See the Flower?

Seeing and thinking like a scientist means seeing and thinking with imagination — like an artist. It means seeing complexity, seeing multiple perspectives, noticing the shadows and the light, looking for patterns that can describe and predict. It means using all of the senses to see, hear, and feel what is observable and using imagination to visualize what our senses cannot observe.

Some people believe that science takes the beauty away from the flower. Richard Feynman disagreed. "I can appreciate the beauty of a flower. But at the same time, I see much more in the flower . . . I can imagine the cells inside, which also have a beauty. There's beauty not just at the dimension of one centimeter; there's also beauty at a smaller dimension . . . the colors in a flower have evolved to attract insects . . . that means insects can see colors . . . does this aesthetic sense we have also exist in lower forms of life? There are all kinds of interesting questions that come from a knowledge of science, which only adds to the excitement and mystery and awe of a flower. It only adds. I don't understand how it subtracts."

Imagination, curiosity, wonder, the pleasure of discovery, and the thrill of exchanging ideas — these are fuel for science and math. These are gifts we have the power to give to all children.

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Vygotsky, L. S. (1978). *Mind in Society: the Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press. (Page 12.)

Using Beginnings Workshop to Train Teachers by Kay Albrecht

Knowing is More Than Naming: Explore this wonderful idea by asking staff to reintroduce themselves to each other using their "curious characters."

Real Practice: Collect a selection of children's books related to science and mathematics. Explore the books in pairs, asking each pair to identify five good questions to ask related to the information in the book. Encourage pairs to work hard to make the questions support curiosity on the child's part. Write the questions on note cards and tape them in the front of the books to remind teachers to support children's curiosity with good questions.

Toddlers at Work: This author gives a wonderful example of applying science and math concepts with younger children. Construct a curriculum web to explore the topics of big, more, and two. See how creative your teachers can be as they flesh out the curriculum support for this emergent curriculum theme.