In age-appropriate and enjoyable ways, children at the St Raphael Preschool are, from the earliest ages, exposed to science. They might be finding out about the needs of living things as they grow their own food in the classroom garden, investigating force and motion through the use of ramps, or observing up close and firsthand the life cycles of various critters. In the course of these investigations, these young students are learning the scientific processes of observing, predicting, and recording. They are using scientific tools such as balance scales, thermometers and magnifying glasses. They are utilizing math and language as they measure and compare and record and discuss. Their vocabulary is expanding, and they are learning to reason together. They are recognizing that often we learn by trial and error and that mistakes can help us learn. Throughout all of this activity, the students are discovering that they are competent problem solvers and that science is great fun!

A group of four-year-olds sat with their teacher examining some flower seeds. “Do you think these seeds are living or non-living?” Ms. Molly asked. The question was an appropriate one for Ms. Molly’s students for in the preceding months her students had tackled this question of living vs. non-living in a number of different ways.

Early in the school year, Ms. Molly had shown her students pictures of various living and non-living things. The children could fairly easily determine which objects were living and which were not. The teacher helped the children make a list of the characteristics of living things. The children were quick to volunteer: Living things need to eat! Living things get bigger. Living things have eyes and noses and mouths! Living things can run! Living things go to the bathroom! (giggles) Ms. Molly did not correct these early observations.

The next school day, however, Ms. Molly once again presented some pictures to her students: flowers, animals, insects, a human baby, etc. The children expressed easy agreement that all the represented items were living. But then Ms. Molly pulled out the students’ earlier observations for a comparison activity. Wait a minute; do all living things have mouths? No, let’s cross that out. Do they all run? Well, no, but they all can move in some way. By the time the children went through the pictures and compared them to their original list, they had refined their list of the characteristics of living things to: Living things need food and water and can grow and move.

The following class session, Ms. Molly read some simple non-fiction books explaining the characteristics of living things vs. non-living and even once-living things. A class chart listing the newly discovered characteristics was created. Children had opportunities to bring in pictures and check whether each of these characteristics applied to the pictured items. Children
conducted similar activities in their personal science journals. Throughout the year, each time the children encountered a new experience—whether it was observing their ant farm or class pet crab, the actual metamorphosis of frogs and butterflies or their growing class garden—they referred back to what they already knew about living things. This knowledge grew through each of these hands-on experiences. They even conducted some scientific experiments to study the effects of growing plants with and without light and water.

So when Ms. Molly asked whether the flower seeds were living or non-living, the children were ready to reason it out for themselves. Well, the seeds can’t do anything right now. They can’t move or grow. But if we plant them and give them water and light, they will probably start to be alive. Seeds have ‘aliveness’ inside them.

Ms. Molly’s students were capable of using their reasoning abilities in this case because their teacher had intentionally planned to spend an entire school year focusing on one big question: How do living things interact with and adapt to their environment? She had created a web of varied learning opportunities that would allow her students to investigate this question in hands-on ways (see Illustration A). She began by helping the children discover some basic knowledge about living and non-living things. Then throughout the year, as a wide variety of topics about plants, animals and humans were studied (e.g., dental health, nutrition, habitats, camouflage, senses, plant parts and their functions), the children were referred back to the focus question. Each investigation helped the children assimilate a growing vocabulary in the ever-more rich and detailed conceptual schema they were constructing.

Illustration A

Preschoolers are natural scientists. They ask “why?” questions all the time. They are motivated to solve problems they daily encounter and then to organize the new knowledge they acquire. Renowned developmental theorists Piaget and Vygotsky brought welcome attention to young children’s active role in constructing knowledge in their interactions with their environment and with others. It was unfortunate, however, that for a time these theorists’ work often led educators to focus on what children could not accomplish prior to reaching important developmental stages. Before the turn of this century, such notions often led educators to withhold certain types of learning experiences presumed to be beyond preschoolers’ developmental readiness. For example, since Piaget hypothesized that children could not conserve number before the age of 7 or so, what was often dismissively termed ‘rote counting’ was discouraged in preschool/kindergarten classrooms. Fortunately, some researchers at this time were more interested in what young children could do rather than the competencies they lacked. It was this research that began to reveal the amazing abilities young children do possess.
One such researcher was Rochel Gelman who, with C.R. Gallistel, published research in 1978 on very young children’s number abilities. She and Gallistel discovered evidence that children as young as three-years-old could reason about number when quantities were small, suggesting that innate mental structures combined with a developing counting schema assisted preschoolers in eventually achieving a stable concept of number. As a fledgling teacher of young children, such findings supported my decision to reinstate counting and number activities to their privileged and enjoyed place in my early learning classroom. Natural opportunities to count and compare the number of students in each of two lines, to discover the difference between how many children were normally in our classroom and how many were actually present on a given day—these and similar activities were actually helping my students progress toward Piaget’s stage of number conservation.

There has since been a great deal more research examining young children’s cognitive competencies and what these abilities might suggest for their early learning capabilities. In addition to latent arithmetic abilities, these have included implicit understandings of cause and effect and distinctions between animate and inanimate objects (Gelman and Brenneman 2004, Gelman et al 2010) as well as inherent geometric knowledge that allows children to succeed at spatial tasks (Shusterman, Lee, Spelke, 2008).

Uncovering such competencies has led some developmental theorists like Gelman (whom I reference in the following) to suggest that young children possess innate, domain-specific mental structures that facilitate their learning within certain areas of knowledge. Unlike traditional learning theorists like Piaget and Vygotsky, who saw children making global advances from one stage of development to the next, domain-specific theorists recognize that children’s early inborn competencies lead them to search out and assimilate unique types of information and inputs, depending on the domain. For example, a child engaged in counting is concerned with quantities; physical attributes such as color and size are irrelevant to this domain. He can count a group of his classmates without concern as to whether they are boys or girls, short or tall. On the other hand, a child constructing a ramp to propel a toy vehicle downward is quite interested in the physical qualities of that ramp, coming to realize the steeper its grade, the faster the vehicle will go.
So what are the implications of this research for early education? If children have some rudimentary abilities in determining why things happen as they do and if they are obviously motivated to ask these ‘why?’ questions, what better focus for the early learning classroom than that of Science which could be characterized by the same asking and answering of questions. There is research evidence to suggest that children ask these causative questions precisely when they are in the process of building more sophisticated knowledge structures. (Chouinard, Harris and Maratsos 2007). Additionally, if children are active learners who seek inputs within particular domains to build conceptual knowledge, it further suggests providing children with conceptually-connected experiences within those domains would advance their learning. Rather than planning discrete, unconnected weekly themes in the preschool classroom, what if the teacher intentionally provided experiences to build up and enrich those areas of knowledge that are inherently motivating and relevant to young students?

*Preschool Pathways to Science*, developed by Gelman, et al (2010), is a framework for using science activities, content and processes to extend preschoolers’ learning and knowledge while harnessing their unique and emerging capabilities. This framework recognizes that knowledge is constructed within organized conceptual structures that allow one to make inferences from what is known to what is unknown. For example, the young child who has had many opportunities to discover the characteristics of various kinds of living things, when told a *gerunk* is an animal, will be able to infer that gerunks can move, eat, breathe, and do all the other things that living animals can do. Important, too, is the notion that language and vocabulary cannot be separated from concept formation. The child who has had rich experiences with the concept of ‘living things,’ for example, will more easily understand the different meanings of the word ‘*moves*’ when applied to an animal versus a plant. Children need many opportunities to experience a concept and its language before they can begin to discover the connections between these experiences.

Inherent in teaching science is the simultaneous teaching of science processes. Posted on the wall in Ms. Molly’s class are the words ‘Observe,’ ‘Predict,’ and ‘Record.’ When it’s time for her students to *observe* a pumpkin, the children show they understand what this means by making their hands into the shape of binoculars and placing them over their eyes. They recognize they must look very carefully and try to be as clear as they can about what they see. Watching the children, one would think they had never seen a pumpkin before as their attention is so focused on this scientific task. When it’s time to *predict*, the children touch their brains. It’s time to think hard about what might be. For example, what do you think the inside of the pumpkin looks like? Will it look like the apple we have recently cut open? Will it have seeds? How will it smell and feel? The children hold up their hands in an imaginary writing position when it’s time to *record* their predictions and again later when they record what they actual observed when the pumpkin was cut open.

Students learn to carefully observe, to make predictions and then check the soundness of these predictions, to record their observations through drawing and writing, and to communicate their findings to one another. Older preschoolers often keep personal science journals, dating their observations and discoveries. These activities have the added benefit of communicating to young learners that their observations and ideas are important enough to write down.
Our young scientists are also given many opportunities to learn how science tools can be useful when observing, comparing and contrasting (see illustration B). They have frequent opportunities to work with scale balances, thermometers, magnifying glasses and rulers. Each tool is carefully introduced, ensuring that children have many opportunities to experiment with how the tool can be used effectively. So before Ms. Molly’s students actually begin to use balance scales as tools, they will have some time first just to explore them and then to solve problems using them (e.g., find the object that weighs the same as one counting bear, determine which of two objects weighs more or less, etc.)

Lest educators worry literacy and math are given short shrift in these science-focused classrooms, they need only listen in to hear how naturally children use such words as ‘metamorphoses’ and ‘observation’ to be convinced that children’s vocabularies are being enriched. They need only observe how often language, writing and math are being used in meaningful ways in the course of classroom science investigations.

As noted, *Preschool Pathways to Science* offers a framework for structuring learning activities in the early learning classroom, but it does not impose specific content or predetermined lessons. It suggests some broad central concepts and related ideas on which the teacher might focus. These include: Change and Transformation (e.g., living/nonliving, growth and decay, seasons and weather), the Animate/Inanimate Distinction (how different things move, insides and outsides of animate/inanimate things), Systems and Interactions (habitats and climates, the water cycle, plumbing) and Form and Function (animal and human movement, tools and their uses).

These are some ‘big ideas’ that have been suggested by research findings, but within these the individual teacher will seek to discover what is especially motivating to her students. Children learn best when they are active participants in their own learning, when their curiosity and desire to know influence classroom planning and when their investigations are hands-on. As is evident in the sample web shown in illustration A, any number of common preschool themes can be included with a bit of forethought. The key is for the teacher to be intentional in devising themes and activities that relate to a central concept or question while also being creative and flexible enough to take detours when those detours will enhance children’s participation in their learning.

Ask a class of four-year-olds if they can figure out how to build their ramp so the car coming down it goes very far or stops closest to a line or makes a turn and you’re likely to witness a burst of excited, goal-directed activity. Shared science inquiry is not only fun, however; it is also
confidence-building. The child who has had numerous positive experiences with science investigations begins to see him/herself as a capable problem solver, as someone who can seek out and evaluate information rather than expecting others to simply provide answers. What teacher does not hope to foster such valuable learning dispositions in her young students? Preschoolers and science indeed seem a natural fit.

References


Biography

Carrie Griffith is the director of St. Raphael Preschool in Raleigh, North Carolina. Ms. Molly that she mentions is Molly DeAngelo. Ms. Molly has a Master’s degree in elementary education and a Bachelor’s degree in psychology from the University of Virginia. She is licensed in elementary education with an additional certification in Pre-K. She taught third and fourth grade for four years before coming to Saint Raphael Preschool in 2006 to teach three-year-olds and four-year-olds. She is the mother of twin boys, both of whom are alumni of the preschool.