Teaching Science through Experience and Discernment:
Teaching Sensible Science

An Interview with Michael D'Aleo by Bob Amis

Bob Amis: How would you explain the Waldorf school approach to teaching science?

Michael D'Aleo: As science is too often taught, a textbook describes a "natural law," usually one that was discovered some time ago. Teachers then conduct demonstrations to show that this law is valid. Teachers are able, in this way, to show that there is a relationship between demonstration and textbook explanation, but they do not ask students to enter into a scientific process.

In a Waldorf school approach, instead of giving students the concept at the beginning, we create an experience of the phenomenon through which it is possible for students to draw a conclusion. For example, instead of saying, "Hot air rises, and cool air falls," we might do an experiment in which we ask the students to observe the smoke of some small splints of burning wood. We notice that the smoke rises. Then we might take a few smoking splints of wood over to a freezer, open the door, and allow the students to observe the smoke actually falling. From these observations, we encourage students to find their own meaning, their own relationship to the phenomenon. What was different between the first case and the second case?

We might also, for example, have a student hold a balloon over a candle, and feel the balloon expand. The student comes to understand that, in general, as things warm, they expand. In the case of gases, this means that they become less dense and they rise, and, as they become cooler, they contract. The conclusion is left to the student, guided by the teacher. That is what is unique about a Waldorf school approach: it constantly asks students to draw conclusions from their own sensory impressions, rather than simply to verify a statement that someone else has already made.

BA: What do you believe are the capacities that we develop in our students using this approach?

MD: There are several different capacities that we develop. First, since students are not told what to look for, but are simply asked to observe, they must be alert in all their senses. They learn to observe not just with their eyes but with all of their senses. Is there a characteristic smell, is there a sound, does the demonstration lead to some other experience? With electromagnetic phenomena, for example, we can actually experience sensations within our bodies that are different from those of the usual five senses. Instead of simply relying on their eyes, students begin to develop the ability to use their whole bodies as sensory organs.

Then, after the demonstration is complete, the teacher asks students to recall it precisely and sequentially. This develops a power of imagination, not imagination in the fanciful sense, but in the concrete sense of the capacity to run through the steps of an experiment in one's mind, in one's imagination, and see this activity happen again. On the following day, the teacher asks students to recall what they observed the previous day, rekindling this imaginative power.

Students learn to observe, to remember, to articulate their own experience, and then to place it in the context of others' experience. In other words, "Was this an experience that just happened to me, or did others have a similar experience?" A judging and weighing capacity, a certain level of discernment, is thereby developed. The teacher encourages students to listen to one another, to hear the insights and observations of other students, and then, as a group and individually, to synthesize all of these observations and ideas to see if there is some sort of lawful or predictable relationship among them. So, rather than simply proving some theory, we develop the key capacities for practicing science—to observe keenly, to re-imagine a phenomenon, to articulate our observations, to integrate these with others' experiences, and to find a relationship among observations and experiences. These are the same activities that many leading scientists practice, often working collaboratively with others.

BA: Why don't we use popular scientific models to explain what we experience in our demonstrations and experiments?

MD: We have to be really awake to what we mean by the word "model." What often happens is that people lose the idea that the model is intended as an analogy. They begin to think that the model is "exactly how it is." The model is mistaken for reality. When John Dalton explained his theory of the atom in the early 19th century, he used small wooden balls, painted different colors, to represent atoms. Dalton didn't intend to say that this is what atoms actually look like; he knew that this was simply a teaching aid. In time, however, people began to think of atoms as little colored balls. No contemporary scientist conceptualizes an atom as Dalton did; modern physics does not think of an atom as a hard little billiard ball-like particle. Every year, however, millions of children around the world are taught to think of these balls as the essence of matter. If they later go on to pursue science at a higher level, they have to unlearn the earlier way of thinking. This can be challenging, especially once they have had it ingrained in them, and now need to relearn it in a new way.

In my own work in science and engineering, we often get stuck when we run up against a model's limitations, because the model isn't true to the phenomena as they manifest in the world. A powerful approach, then, is not to think in terms of analogy, but to work with phenomena as they present themselves, to try to find links between phenomena.

In a Waldorf school, therefore, rather than teaching the model, we work in the younger grades with the simpler phenomena and relationships, saving for eleventh grade something as complex as the nature of the material world. Knowledge of atoms is imparted later than it usually is in other schools, but, by teaching it later, students can really begin to appreciate, understand, and think in a more modern way, a way that isn't limited by an outdated model.

BA: What is a "percept" and what is a "concept" and why is the distinction between them so important to our approach to teaching science?

MD: Many people, when they find out about a phenomena-based approach to science, discover a new relationship to these terms, "percept" and "concept," especially in Waldorf education, because Rudolf Steiner wrote an entire series of books on this topic. The central idea is that we separate our experience of the world—which is one, or whole—into observations and ideas. We sometimes call observations "percepts," from our perception, that which we perceive through our senses, and "concepts," that which we conceive of out of the activity of thinking.

Often, people create a concept so strong that it begins to act as if it's a percept. For example, when people say, "Heat rises," they have begun to speak and think of "heat" as a thing, almost something particle-like that they could put in a box, keep safe, and unpack later. This leads to a much more static view of what's happening, say, in an industrial process in which we see great plumes of gases rising from a tall smoke stack into the sky. What we actually observe in these patterns gives us the sense that something is happening with the gases. We might be seeing steam, if the smoke is white, or carbon-based soot particles, if the smoke is black, that are caught up in air that has been warmed, has expanded and become less dense, and is now rising out of the chimney stack. We can observe these particles of steam or soot, but this idea of "heat rising" isn't actually observable. So if we're not careful we begin to live in a conceptual world in which what we think we see and observe in the world isn't actually observation, but rather what we think the world is. And as we live in that conception of the world longer and longer, we lose the ability to see the more subtle phenomena that are actually present, and instead believe we're seeing something other than what's present.

This illusion of our conceptualization of the world is often a great barrier to new scientific insight. It is often the case that the person who is able to see beyond one of these preconceptions is the one who takes the key step toward a new insight, discovery, or invention. This new insight may lead to something functional, a new invention, but it may also increase humanity's ability to understand the world more deeply.

BA: Is there any other distinction that you'd like to make between the Waldorf school approach and the conventional approach to teaching science?

MD: The "environmental issue" is a big question in the scientific community and in society generally. One approach that some people advocate is that if scientists just work a little harder they'll find the answers. A different approach is to ask if science can develop within its very nature a deeper understanding of the relationship that each human being has to the world. This is exactly what happens in the type of science that we develop in the Waldorf school. We not only develop an understanding of the outer world, but of how a human being relates to that outer world. This way creates a more intimate understanding that by its very nature leads to a more environmental approach to science.

Another point is that, because of our emphasis on the arts, and the relationship between truth and beauty, our students' ability to synthesize the arts and the sciences is very strong; because of this they are able to find solutions that are not only scientific, but often demonstrate an aesthetic quality that is environmental at its foundation.

If you study any of the great scientists, past or present, there is often an elegance to their theories. When they really have struck a deep truth, there is a certain beauty in it. The more elegant solution is often quite simple, and yet within its simplicity is a tremendous richness of complex relationships, and, in this sense, it is both beautiful and powerful.

BA: Should parents be concerned about any deficiency in their children's science education in a Waldorf school?

MD: Not if it's reasonably well done. Waldorf schools do not aim to produce little scientists. Later in life, however, if students are inclined to become engineers or scientists, a Waldorf school approach to science prepares them especially well, in my experience. They have less to unlearn, they have experience of the actual scientific process, and they have an appreciation for the environmental and aesthetic dimensions of true scientific inquiry.

Michael D'Aleo holds a degree in Mechanical Engineering from Rutgers University. Earlier in his career he held the position of Project Leader for New Product Development at an electronics firm, where his innovative solutions to technical challenges led to seventeen patents. He also holds an M.S.Ed. from Sunbridge College, NY. He currently teaches high school math and physical science at the Waldorf School of Saratoga Springs, NY, and is on the teacher education staff at both Sunbridge College in Spring Valley, NY, and the Center for Anthroposophy in Wilton, NH. D'Aleo is a founding member and Director of Research of SENSRI (Saratoga Experiential Natural Science Research Institute), which hosts the "Teaching Sensible Science" teachers course sponsored by the Research Institute for Waldorf Education and previously reported in the Research Bulletin *(Vol. XII, #1, Autumn 2006). The next cycle of this course will be held at Rudolf Steiner College in Fair Oaks, CA, starting October 2, 2007.*