Teaching Sensible Science

Bob Amis with Contributions from Michael D'Aleo

As Waldorf school class teachers, we strive to fulfill the potentialities of Rudolf Steiner's vision in our own classrooms. This is a daunting task, but perhaps nowhere is it more intimidating than in the science curriculum of the middle grades. As teachers, how do we transcend rote practice of a string of demonstrations and experiments in the physical sciences, and embody a phenomenological approach to science? How do we empower our students to become active participants in developing their own relationship with the world, rather than passively accepting the concepts that are handed down to them by others?

In an effort to help teachers meet this challenge, Douglas Gerwin, director of the Center for Anthroposophy, and Michael D'Aleo, high school science teacher at the Waldorf School of Saratoga Springs, co-founder of SENSRI (Saratoga Experiential Natural Science Research Institute), and co-author of *Sensible Physics Teaching*, created a training program focused on physics and chemistry curricula for grades six, seven, and eight. Now in its second cycle, the course is composed of three one-week sessions. The first session took place this past June and focused on sixth grade physics. Session two convened for five days in early October and centered around seventh grade physics and chemistry curricula. The third session will take place over a full week in February 2007 and will cover eighth grade physics and chemistry.

Participants in the course represent schools from all over North America, from New England down the eastern seaboard to Baltimore, and across the continent to Arizona, Washington, California, British Columbia, and Ontario. They teach classes ranging from grade three to grade eight. Most are in their first cycle and are preparing to enter the upper elementary school years. Others are in their second or third cycle and are seeking to deepen their knowledge of phenomenology and share it with their colleagues back home. One participant is a veteran woodworking and science teacher from New Hampshire who brought with him a wealth of experience to share with the group.

The course is led by Michael D'Aleo, a mechanical engineer with expertise in thermal physics, a scientific researcher, and an experienced Waldorf school teacher and teacher educator at the Center for Anthroposophy and at Sunbridge College. His insights into the phenomenological approach to science and science education form the backbone of the course. He is assisted by Barbara Richardson, Lylli Anthon, and Bob Amis. Barbara is a gifted and experienced eurythmist, eurythmy instructor, and Waldorf school class teacher. Lylli is a highly experienced class teacher, taking a class from first through eighth grade and then repeating the middle school years many times. Bob has been a middle school teacher for the past five years after a career in business.

Our days begin with eurythmy, followed by an epistemological presentation and discussion led by Michael. A second eurythmy session brings the morning to a close. After lunch, we conduct experiments and demonstrations that are appropriate to the physics curriculum of the grade in question, followed by a lively discussion about the principles and relationships that unite the phenomena in the experiments, and how best to bring these experiences to students. Chemistry is covered in evening sessions.

The most recent meeting of the "Teaching Sensible Science" course, in October 2006, focused on seventh grade physics and chemistry, beginning with an evening session in which D'Aleo led us to a nearby pond to observe. This served as an excellent introduction to the seventh grade optics curriculum, but also provided a springboard for him to help us understand the importance of the intention of the observer in a sensory experience. In our discussion the next morning, we were all impressed by the variety of observations that people had made around the pond the night before. These included reflected images of objects across the pond, the quality of the light on the pond's

surface, the presence and absence of color, the patterns of shadows, the effect of ripples, and objects floating on the surface of the pond.

Taking the idea that observation is informed by conceptual understanding a step further, D'Aleo showed the group a series of images, like the Necker cube, that can be seen in multiple ways, and other images that may first appear to be random collections of light and dark shapes but that—with insight—are recognized as images of familiar objects. This exercise highlighted the way in which we constantly organize sensory experiences in order to "make sense" of the world. This capacity is necessary in order to function in the world, but we need to be keenly aware of it if we are to develop our observational skills. If we are to perceive the world clearly, we must constantly distinguish between what in our consciousness is sensory experience—percept—and what is a mental organizing, or naming, of that experience—concept. This ability enables us to distinguish between what we actually experience in the moment and what we have learned in the past. It keeps us awake to the moment, and it also opens us up to the possibility of a new way of seeing or interpreting what we experience. This activity is fundamental to innovation and scientific discovery.

Distinguishing between percept and concept is also one of the key capacities we can nurture in our students during science courses. In setting the mood for these courses, D'Aleo encouraged us to invite students into fresh explorations of phenomena, as if they are seeing them for the first time. The teacher must also intend this if the students are to take each experience seriously. We can point out to students that most scientific discoveries occur not because someone witnesses a radically new and different physical phenomenon for the first time on the planet, but because someone notices something in a familiar phenomenon and then begins to think about it in a new way. This invitation is especially important for those students whose heads are full of half-understood scientific concepts, who may recognize one of the phenomena in an experiment, believe that they know what is going to happen and why, and then stop observing carefully, or, worse, blurt out some disconcerting prediction.

Later in the week, D'Aleo deepened the discussion by taking us through Rudolf Steiner's description of levels of motivation for action, showing us how we can guide students toward higher levels of motivation in the way we teach science. He also led us through a conversation about the role of our twelve senses in relationship with the outside world.

In our afternoon sessions, we tackled experiments in the fields of optics, mechanics, and electricity. Anthon, Amis, or D'Aleo led some of the experiments, while participants led others. Those who chose to lead a demonstration got valuable experience in the art of guiding a discussion and helping students to uncover the principles that unite the phenomena. Although this process is difficult, it is rewarding when a student has his or her own "Aha!" moment, one that arrives following willful striving.

Although our schedule was full, we took the time to explore each experiment as thoroughly as seemed fruitful. Discussion of the experiments was also given its full due, as it has to be in the classroom if students are to come to their own insights. Participants were much more confident in their use of the language of phenomenology during this second week than they had been at our first meeting. They were able to describe their observations more precisely, distinguishing more comfortably between percepts and concepts. This allowed us to move more quickly through the discussion of each experiment. Among the more impressive demonstrations we conducted and observed were the camera obscura, the law of rotational balance, the human mouth as a source of wet-cell electrical activity, and the lime kiln.

The lime kiln is part of a Waldorf chemistry curriculum, which was covered in two evening sessions. During the first night, Anthon presented an overview of a seventh grade chemistry curriculum, and then took the group through a study of acids and bases. The second evening session centered on a discussion of the lime cycle. A lime kiln was constructed during a lunch break and then fired up the next morning. The following day, when we dug through the smoldering ashes, the chalk and limestone were barely recognizable. When D'Aleo poured some water on them, however, they hissed and fizzed and smoked and steamed and crackled in a satisfying manner, eliciting "ohs" and "ahs" from onlookers. We com-

pleted the cycle by using our newly made mortar to adhere two bricks together.

Our curricular activities were leavened by Richardson's insightful eurythmy sessions. Always striving to complement classroom topics, she led us through a number of activities that helped us to find our places in the cosmos and in the group, work cooperatively with others, explore the power of effective speech, and provide a much needed out-breathing in the rhythm of the day.

In our final session together, D'Aleo provided a societal context for our work. He observed that modern science has lost its aesthetic sense. There is too much emphasis on the final product, and not enough on the activity of the process. When technology embraces the activity in which it is engaged, a new sense of beauty will arise, along with a deeper, more meaningful relationship with the process and the product. This will go a long way toward solving our current environmental problems. Then, as so often happened, Richardson provided us with the perfect passage, this one from Steiner's *The Michael Mystery*, and with it an abiding image for our time together:

One imagination of the Archangel Michael is the following: He reigns through the course of time clad in cosmic light as his essential being, shaping cosmic warmth as the revelation of his nature. As a being he conducts himself like a world, asserts himself only as he asserts the world, guiding forces earthward from every corner of the universe.

For those interested, a third cycle of the Teaching Sensible Science course is being planned to begin in the autumn of 2007 on the West Coast. For more information, please contact Michael D'Aleo at spalight@verizon.net, or Douglas Gerwin at researchinstitute@earthlink.net.

Copper distillate

Copper salt

Electricity experienced

Building a limestone kiln

The experience of a tingle from a low electrical charge

Exploring limestone extrusions