Teaching Sensible Science:
Report on a new course for Waldorf Class Teachers

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What is the nature of our sensory impressions and what are the resulting relationships by which we develop an understanding of the world and of ourselves? These questions lie at the heart of comprehending a phenomenological approach to science, which we are exploring in depth in a new course for Waldorf middle school teachers.

The course was envisioned two years ago by Michael D'Aleo, high school science teacher at the Waldorf School of Saratoga Springs, researcher with SENSRI (Saratoga Experiential Natural Science Research Institute), and co-author of Sensible Physics Teaching. Michael approached Douglas Gerwin, director of the Center for Anthroposophy, and out of their conversation arose the vision for this course. The Research Institute for Waldorf Education, SENSRI, and the Waldorf School of Saratoga Springs sponsored the course for the first cycle.

A three-week long series was chosen because Michael's experience showed the need for a longer period of time for the class teacher to be confident with the methodology underlying a sense-based approach to science teaching and to practically explore the breadth and depth of the physical science curriculum. Each week would be devoted to the experimental topics for each of the three middle school grades. The first week took place in March 2005, and the second at the end of June. The third, which has not yet occurred at the time of this writing, will take place over a long weekend in October. This format also allowed for teachers to try out the approach in their classroom and return with fresh ideas and questions.

Gary Banks and Lylli Anton were chosen to present experiments and lead discussions about practical aspects of the method. Lylli was also asked to lead the group in exploring ways to artistically render experiments through writing and drawing. Gary comes out of a background in aerospace engineering sciences. He taught a class from first through eighth grade, taught high school science, and began a new first grade in 2004. In her 25-year teaching career, Lylli began by raising a class through the eight grades and has repeatedly taught middle school for many years. Barbara Richardson was selected to lead eurythmy because of her background in Eurythmy in the Workplace and as a class teacher. Eurythmy was added to the course as a way to further explore the nature of experience and working together, and to enliven our long days of discussion and experiments.

After a planning meeting in November, the presenting group was eager to meet the group of 15 teachers who had signed up for the course. We were not disappointed by the richness of experience and questions they brought. The participants were actively teaching in Waldorf

Schools in every grade from third to eighth. Many were from New York and New England, while some came from as far away as Washington D.C., Minnesota, California, and Canada. A few already had a bent to science, while others came more from an artistic background.

Participants related a variety of experiences in their own relationship to science. Some recounted they had loved science as a student, often through the inspiration of a teacher who made it interesting. Others related that they had horrible experiences of science as a child, and these negative experiences left them feeling unprepared and apprehensive to teach the science curriculum. Several teachers had already taught science, and each one of these was enjoying the experiential approach to the curriculum.

Our mornings were filled with discussions of epistemological questions led by Michael D'Aleo. These sessions covered a broad scope of topics, ranging from the nature of sense experience and how we form concepts about our experiences, to the roots of materialism in our age.

Michael's talks were punctuated with interesting examples from his experience as a mechanical engineer in the electronics industry. In his first presentation, he noted a story about an engineering graduate he had interviewed for his engineering group. Fresh out of college, the young man had performed brilliantly whenever he was asked to make a calculation. But when asked to identify the metal out of which pennies are made, he was unable to offer any possibility. When asked to identify a resistor, one of the most basic components of every electronics device, he was befuddled. Even after four years at one of the best engineering schools in the country, he had no connection to either copper metal or a resistor, two common elements of modern technology. For Michael, this emphasized a common shortcoming in science and engineering education, which tends to center around theoretical and mathematical models rather than actual experience.

The intention of the morning sessions was to ensure that the course participants developed a clear understanding of the distinction and rightful role of sensory impressions (observations) and conceptual relationships, as the foundation for understanding any scientific experiment or everyday experience. Our present culture and society are filled with instances of concepts that are presumed to have phenomenal qualities that are not sensory based. An example of this is the common picture that heat is an object-like entity that can be transferred between other objects. In fact, nothing (*i.e.* "no-thing") is transferred, but we do experience that when a warm object and a cool object are brought into proximity, the warm object cools and the cool object warms.

Such sensitivity to language may at first seem unnecessary. However, reliance upon non-sensory, hypothesized objects as causal entities for all phenomena limits the students to a nineteenth-century view of physics and the world. Such a view can also give the student and teacher the impression that the world is "not as it appears" and they can no longer rely upon their sensory impressions and the concepts they develop. Such a view encourages alienation from the world since it can never be "truly" known.

By using language that focuses on relationships between sensory impressions, the students have the foundation for a later understanding of modern field theory in twenty-first century physics, which is more relationally based and no longer relies on the object-like entities of the older models. Additionally, teachers and students practicing this approach build up a deeper connection

to the world and other human beings by having developed a more subtle sensitivity to their own sense impressions and activity of finding relationships.

Participants in the course remarked that even though they had received an overview of the content of the science curriculum in teacher training and in summer courses, they were unfamiliar with the nuances of the phenomenological approach and the use of language in forming concepts. There was a universal sense that the morning sessions led by Michael prepared the way for a deeper understanding, and it was clear that practical experience with the approach would be key to intensifying our preparation.

Unexpectedly for some, eurythmy provided a first means of deepening the method. The eurythmy sessions were done twice in the morning and were integrated with themes from the other sessions. Doing eurythmy helped us get to know each other, brought us life forces, helped us be alert to learn, to be in ourselves and to find ourselves in the group. Eurythmy also helped us to perceive and observe in a new way. One of the poems we worked with the second week spoke to the mobility of perception we found ourselves developing.

The hand moves
And the fire's whirling
Makes different shapes.
All things change when we do.
The first word, "Ah!"
Blossoms into all words.
Each of them is true.

- from "Singing Images of Fire", Kukei, 8th c. Zen Master

Throughout the course, all of us, participants and presenters, were grateful for the expertise and skillful weaving of themes Barbara provided and the true refreshment and rejuvenation we experienced through eurythmy.

The afternoon sessions were spent exploring the experiments that form the heart of the middle school curriculum. Each week was formed around the physics curriculum of a particular grade, starting with grade six. Gary and Lylli performed new experiments each day, but waited for a discussion of them until the next day, as practiced with our students. The second week also saw the addition of the chemistry curriculum of grade seven, led by Gary in evening sessions.

Many teachers face an intimidating obstacle in setting up experiments, especially in developing schools where materials may be scarce. Experiments in physics and chemistry involve unfamiliar equipment, and often more complicated experiments require particular conditions and careful preparation. Safety is also a genuine concern that American schools cannot ignore. The long experiment sessions and hands-on approach allowed the participants to become more confident with this practical aspect of teaching science phenomenologically.

However, as we discovered in the first days, setting up and conducting experiments is not the only obstacle to teaching well. The way we form concepts about the experiments before and during our classes with the students ultimately determines whether our teaching is healthy. Unconsciously,

we are faced with the challenge of recognizing and often overcoming our habituated patterns of thinking. A first experiment was a testimony to this.

In this experience, appropriate for a grade six introduction to thermal physics, the participants felt five different objects in the room and noted their thermal characteristics. The objects were a blackboard, a metal music stand, a piece of glass, a wooden desk, and a piece of carpet. We ranked them according to how hot or cold they felt, noting at the same time how some of them warmed over the course of the experiment.

After sleeping on the experience, we returned for a discussion next afternoon. We noted how we had conducted the experiment, and then proceeded to characterize the results. Everyone agreed that some objects felt warmer and some cooler. There was some variation in the way we ranked the order from warm to cool, but all agreed that the carpet and wooden desk felt warm, while the blackboard and piece of glass felt colder.

Then came a difficult moment, as we tried to understand why these objects did not all feel the same. One would hardly think that so simple an experience would warrant much discussion, yet an hour and a half later we were still discussing the experiment passionately. Preconceived notions kept creeping in. One participant was finally able to articulate the problem: she believed that the objects were all at different temperatures. We pointed out that, even though it was late winter in upstate New York, all objects were in the room and therefore must have been at the same temperature. We even measured the temperature of each object with a thermometer to demonstrate this. For her, this was a shocking realization that she had already superimposed a concept on the experience, and until she could escape the trap of her concept, she could not explore the actual experience any further.

Also arising out of this discussion was a great deal of frustration. "*Why don't you just tell us the answer?"* Through this we learned that the discovery of our own answer has more meaning than any "answer" given by an outside authority. The presenters fell into the role of being identifiers of preconceived notions (concepts) that did not connect with the experiences (percepts). The medium for this discovery was language, and in each experiment we carefully crafted the language that would help us form living, meaningful concepts. We carefully avoided model-based explanations that were not verifiable through the experiment itself. The goal of each dialogue became reuniting the concepts with the percepts, as they really existed. This took time, and the first half of the afternoons were filled by discussions of the previous day's experiences and presentation of new experiments.

Later in the first week we did a classical physics demonstration in which a very thin steel wire hung with weights at either end passes through a solid block of ice over a period of several hours, leaving the ice in a single piece at the end. During the recapitulation of the experiment, the frustration that teachers feel at leading a dialogue with students became apparent. "*How do we conduct a presentation and come to meaningful conclusions without forcing them upon our students?"* One teacher bravely noted that he did this experiment during his internship when he was in training. The discussion started going awry, and the students just weren't getting it. In a moment of near panic, he blurted out, "I'll tell you what it is. It is PSI, pounds per square inch." The mentoring teacher at the back of the room shook his head vigorously from side to side and

buried his face in his hands. In retrospect, he could find humor at this situation, but at the time, it represented a crisis of soul in the presenting teacher.

Many new and even experienced teachers feel such a moment of panic and fall back on the security of the concepts they learned in school or read about in preparation for teaching the course. In science in particular, teachers are expected to have a level of expertise for which many are unprepared. Living into the phenomena and forming vibrant concepts directly out of those experiences rather than our preconceived notions forms the antidote to the panic a teacher can feel.

Sometimes waking up to our habituated modes of living into concepts instead of experiences takes a bit of a shock. At several key moments in our experiment discussions, participants kept repeating what they thought should have happened or gave their concepts from previous experiences. In leading the discussion, Gary kept dramatically repeating, "It doesn't matter what you think happened or what you think should have happened. What was your experience?!" Experience is equally available to all people who have the sense organs to perceive, and a sense-based approach makes concept forming accessible. A class teacher who does not have a formal scientific training but who can penetrate the phenomenological approach has all the tools to provide an excellent science education in the middle school. In fact, through disciplining oneself into this practice, new discoveries can be made. There were many such moments in the training when, through our openness to the experiences, we uncovered new and unexpected aspects of the phenomena.

To give the participants more confidence in living into the phenomenological approach, they were invited to prepare experiments and present them, and also to lead discussions. In teacher training and in our faculties, we often don't take the time to do such model teaching, and we can feel intimidated by the prospect of making a mistake or being unclear in front of our peers. Michael helped put us at ease when he reminded us, "This is the cheapest opportunity in which to make a mistake." Everyone who jumped in to present an experiment and lead a discussion grew from the experience.

We came to realize what a delicate art is required to help a discussion about an experience proceed without being too leading or "teacherly" about it. When we have the conclusions fixed too rigidly in our own way of presenting, we rob the students of the essential activity of their own discovery of the concept. It is in this context that science education can either take on a deeper meaning and connect the students with their experience, or become a means of just imposing concepts without the actual experience. We came to realize that how we as teachers lead a discussion about an experiment determines whether the individuality of the child can begin to unfold. In this context, many participants expressed gratitude at the wisdom of carrying the "Teaching Sensible Science" course through three weeks, a time frame in which we can begin to transform our habitual ways of expressing ourselves to our students.

During the second week, we recreated and discussed many of the most challenging experiments of grade seven physics and chemistry curricula, including the limekiln, the *camera obscura*, and the Voltaic pile. Throughout this week, we noted how the discussions flowed much more easily and how all participants became more versed in avoiding misleading language and conceptual traps.

The course presenters recommended working with some experiments between the sessions to become more proficient in this approach. Two of the course participants who teach at the same school took up this suggestion by starting a weekly half-hour study open to the whole faculty. In these sessions, they focused on observing a particular experiment and forming meaningful concepts about it. We found this an inspirational example of how we can expand our work with the phenomenological method in our schools.

Lylli provided a unique presence in the course that was much appreciated by the participants. She stood as a model of what a class teacher without a formal scientific training can accomplish by using this method. Lylli conducted experiments, led discussions, and in particular led sessions in the later part of the afternoons in creating the record of the experiments we performed. Her gift was to help us understand how the teacher can develop the ability to capture the essence of the experiences. She also stood as an example of the path one can take in finding appropriate relationships arising out of the experiments rather than simply recording the concept by itself.

On Wednesday afternoon of the second week the topic turned to water as Michael took us to the Adirondacks. We gathered for informal conversations on the porch of his recently constructed log cabin while waiting for a soft and peaceful rainstorm to pass. Besides giving us some much-welcomed relief from the oppressive heat earlier in the week, we enjoyed making closer connections with each other.

Following the rain, we hiked to the base of a waterfall on a clear mountain stream where we observed the patterns and currents in the water, an activity we repeated on Thursday at Saratoga State Park. On reviewing these and other observations of water, we came to see that observing water could become a metaphor for moving into the middle school, where mobility and change are constant themes. One participant's response, written after the next eurythmy session, was a short poem:

A pool in sight
Just water and light,
Swirling, whirling,
The present unfurling.

Michael left us with a wonderful question to ponder as teachers: *Like water, do you have the mobility to go anywhere without being pushed anywhere?*

In the third week, we look forward to deepening our understanding of the sense-based approach, working through the grade eight physics and chemistry curricula, and strengthening our organs of perception through eurythmy. The aim is to prepare a group of teachers who feel confident to take a phenomenological approach to the middle school science curriculum and who can help spread this to the remainder of the faculty in their schools.

"Teaching Sensible Science" was conceived following a discussions between AWSNA delegates recognizing the need to strengthen science teaching in our Waldorf School movement. It is likely that another such course will be presented in 2006, perhaps again in Saratoga Springs or at another

school willing to offer a supportive environment. Further inquiries about the course may be directed to one of the course presenters or to the Research Institute (researchinstitute@earthlink.net).

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