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13. Schooling Perception

Stephen Edelglass

On a sunny morning in early May, senior class students of the Green Meadow Waldorf School in Chestnut Ridge in New York's lower Hudson Valley can be seen at the pond mentioned in chapter three. The pond and surrounding woodland are just a short walk from the school campus. As part of their senior physics course in optics, these boys and girls have been asked to observe the pond and its environs. With no instruction other than the injunction to remain silent, they examine and explore whatever catches their interest.

One of the girls, while walking along the grassy margin of the pond, notices a gelatinous mass in the water, filled with small, seed-like, dark brown spheres. She crouches and peers through the water, wondering what this strange, jelly-like universe is doing in the pond. But then she sees a shadow on the bottom and picks out a slowly undulating, fat, and bewhiskered fish hovering nearby. A catfish. Her face lights up as she realizes that the gelatinous conglomeration is a mass of eggs, the spawn of the catfish.

Another girl, drawn by the pure clear tones of a thrush, is standing motionless, trying to locate the source of the birdsong. But within her own silence she becomes aware of the grinding gears of a truck laboring on a road at the top of the rise where her school is situated. Even as she tries to focus her concentration, she becomes aware of the engine of a small plane flying overhead. It begins to dawn on her that the inner peacefulness and openness to the world inspired by the setting (and by the silence requested of her and her classmates) has revealed the extent of the aural intrusion she lives with and habitually blocks out of her consciousness.

Meanwhile, a boy is staring intently at the shallow surface of the pond. He can hardly believe that he is able to see either the mottled bottom of the pond or, by a mere change of focus, a faraway, blue-gray sky

Other students can be seen attending to wavelike distortions at the edges of reflected images, bright halos framing the shadows of insects that rest on the water's surface, differences in brightness between the colors of objects in ordinary space and their reflected counterparts, and so on.

After awhile I call them together to share these various observations. Then, when they have done this, I change the focus of the discussion from describing particular phenomena to describing the process of observation itself. The students become aware that they had selected particular aspects from the whole of the phenomenal manifold. Awareness of particular aspects is a consequence of their own intentional focus. The phenomena the students described were, so to speak, highlighted out of the fabric of the whole of nature at the pond. And, in just the same way, the phenomena at the pond were selected for focus out of the whole of the world in accord with the teacher's intentions.

When awareness of the role of intention is achieved, the group can make a conscious choice to attend to one or the other of the particular phenomena that interest them. They can do this while remaining aware of the whole. In this way the connection of singular phenomena to the oneness giving rise to them is not severed. Preserving this connection is one of the conditions of knowledge.

With increasing awareness of how their own intentionality determines what they perceive, the students turn to the visual aspects of the pond itself. Now they are intent on describing what can be seen through the window of the pond's surface. Here again, as we discussed in chapter three, many distinct phenomena are available for observation. One possibility is to take the path described in that earlier chapter, through which the law of reflection can be gained.

What is different about such a class? Of immediate note is that it is not usual to begin optics lessons with visual experience of the natural world. Typically, for example, reflection is introduced by saying that a ray of light falling on a smooth surface is reflected from the surface at the same angle as that at which the ray was incident to the surface. Such a statement may have been preceded by a discussion of the reflection of traveling waves. In this customary approach, reflection of light and sound become different aspects of wave reflection. Sometimes there is even a discussion of reflection in terms of photons as well as waves. What is common in almost every treatment we have examined is that the gateway to the world of reflection is via a description of a model. Only seldom are mirrored images themselves mentioned. Human visual experience is ignored.

Vasco Ronchi, the renowned Italian physicist and founder of his country's National Institute of Optics, has written of his increasing perplexity, as his education advanced, in not knowing what knowledge optics encompassed. He was unable to define the term in spite of its being his own specialty. The root of Ronchi's puzzlement lay in his realization that the idealizations of optical physics were incapable of elucidating much of visual experience! Ronchi went on to develop a so-called new optics that combined physics, physiology, and psychology.

Unlike model-based science lessons of the kind Ronchi was exposed to at school and university, the students at the pond encountered scientific questions *in the world.* Natural phenomena, not abstract, pseudo-phenomenal entities, are the starting point of their science studies. The different aspects of a subject are given their experiential context. Such an approach to science enriches the students' appreciation of the world. The obviously genuine interest and engagement of the students at the pond (who were not selected for their scientific inclinations) is engendered by the meaningful context in which they encounter scientific questions.

Visitors to science classrooms at the Green Meadow Waldorf School often note the extent and intensity of student involvement in the science lessons. Students really do care about accurately discerning details of the phenomena they meet, about inwardly participating in the development of concepts through which they comprehend their experience of phenomena, and about helping each other to gain that understanding. Class discussion is not only earnest, it is also personally generous.

Remarkable instances of student involvement occur repeatedly in the electricity and magnetism class, a four-week physics course offered the first two hours of every morning. Required of *all* eleventh-grade students, it is unusually challenging because it is taught solely in terms of field concepts. The usual metaphysics, based on flow of electrical charges and alignment of magnetic dipoles, is not at all engaged. Instead, attraction and repulsion are understood as a consequence of field reactions. Electrical conductors are materials without internal fields, insulators are partially transparent to electrical fields, and so on.

A field is an activity that expresses itself within a spatial region. Whether agricultural fields, playing fields, or electric, magnetic and gravitational fields, the activity is distributed in space. The farmer prepares the field of activity by plowing and sowing in conjunction with seasonal, climatic, and weather conditions. The physicist prepares an electric field by rubbing and separating materials or by moving a coil of wire in a magnetic field while touching the ends to the plates of a capacitor, all done in dry atmospheric conditions in order to achieve a strong field.

The activity of growth seems to be a direct expression of a causal power. We do not look behind that activity for an explanatory mechanism. While electric fields are not alive—their activity (movement) is not at all expressed as a temporally evolving form—they are nevertheless well conceived to be causally efficient. Unlike a shovel, whose causal activity is understood as a transmitter of the farmer's activity, electric fields are, like the farmer (but without consciousness), directly causal. The lawfulness of the field in conjunction with observed behavior *is* reality. Nothing extraneous has been introduced.

Via field concepts, students gain experience of developing phenomenologically appropriate understandings in situations where no sensible agent is active. In addition, working with fields requires a flexible imagination to assimilate the interactions of one field with another as they combine in new forms. Training the imagination in this way is, of course, pedagogically desirable.

Each year several adolescent girls have engaged this subject with uncommon devotion. Although such girls may be fairly proficient at their schoolwork, they seldom show a special affinity for physical science. For this reason their instructor was puzzled by the girls' ardor for this subject. However, some years ago a seventeen-year-old, Sarah, sought out her school advisor for a conversation about the course and why she so much liked working with the subject.

In seventh and eighth grade Sarah "experimented" with alcohol and marijuana. She drank and smoked repeatedly, while her school friends did not. Her schoolwork suffered. She was in danger.

In ninth grade, with the help of counseling at school, but with little support from her family, Sarah gradually was able to stop her substance abuse. She committed herself to conscientiously doing her schoolwork. But she faced a daily struggle. She often felt in danger of succumbing to her former ways. While her situation was less tenuous in tenth grade, Sarah still felt herself to be in peril.

A year later, however, Sarah told her advisor that when she discovered that she was able to actually think the development of electromagnetic field concepts, she gained the confidence that she could also think the concepts that would enable her to understand her own inner experience. Obviously Sarah was unusual in that she could so clearly articulate her experience. More recently, another girl said that while she is "not interested in physics," she very much liked the experience that "she could make the intangible tangible." In other words, she could grasp the field concepts and thereby understand the phenomena. Other girls say simply that they enjoy the physics courses because they understand it. They feel confident. These girls are confident they can do the course.

It may be that Sarah's inner voice, the voice of her own individual genius—what James Hillman, Rollo May, and others, beginning with Socrates, call the *daimon*, the inspiration for individual human creativity—was so irrepressible that it inspired both her substance abuse *and* her overcoming of it in a new, creative mode. This is what she meant when she spoke of gaining confidence to understand her own inner experience—that is, to gain access to her self. And it is not too far a stretch to understand the other girl's comment about "making the intangible tangible" in a similar way.

Early on in Mary Pipher's bestseller *Reviving Ophelia*, a book about "saving the selves of adolescent girls," the author describes a story told to her by a horticulturist friend. At a science fair on her campus the horticulturist showed a variety of grains, grasses, and trees to a group of junior high school girls. She noted how the younger girls, the seventh graders and some of the eighth graders, were full of questions as they pushed forward to see, touch, and smell everything. But the older girls, those in ninth grade, stood back unsympathetic with their younger companions' enthusiasm. They looked bored and disgusted. Pipher wrote, "My friend asked herself, What's happened to these girls? What's gone wrong? She told me, 'I wanted to shake them, to say, *Wake up, come back. Is anybody home at your house?'"*

Within the context of adolescent female experience, the Waldorf physics class just described is particularly interesting. The dissimilarity between the eleventh-grade girls' enthusiastic involvement in trying to understand electricity and magnetism and the prim non-involvement of the ninth graders at the science fair is striking. With the Waldorf eleventh-grade girls someone is quite definitely at home. Of course, the eleventh graders are more mature and may have passed through a stage of non-involvement (as did Sarah!).

In younger adolescent girls (thirteen- and fourteen-year-old eighth and ninth graders), non-involvement with the world goes hand in hand with an excessive preoccupation with superficial personal characteristics, a preoccupation encouraged by a contemporary culture in which adolescents suffer a media barrage that is both sexualized and drug-saturated. A pedagogy that recognizes this coupling is capable of helping students to gain their selves rather than trivializing them as so often happens.

Adolescents need to experience the sensual world directly rather than meet models, representations, or virtual realities. Students in early adolescence are only just beginning to develop capacities concerned with the form of reasoning rather than the subject matter itself. Such so-called formal operational capacities make it possible for students to think about their own thinking processes. They enable the rich prospects of the eleventh-grade students in the physics class described above. The younger students can prepare the way for these capacities through practice in grasping the "what" and the "how" of the world via a thinking engagement with actual experience. For example, ninth-grade physics students can immerse their hands in hot, cold, and tepid water in order to begin to conceptualize the concept of temperature from its basis in human experience. And they can take an engine apart in order to understand the application of expansion of gases under pressure in a potentially "embodied" way. This practice is a bridge between meeting the world in a concrete operational mode and in a formal one. Without the formal ability Sarah would not have been able to gain her self through confidence in her ability to understand her own inner experience.

While anecdotes such as the one we told of Sarah do not in any absolute sense confirm the claims we have made about the pedagogical value of phenomena-based science, they do highlight possibilities. In this spirit I would like to tell one more story, that of Teresa, a ninth-grade student. When she came to the Waldorf school in the eighth grade, she seemed withdrawn and angry. She had difficulty completing her schoolwork and would often make loud negative comments about her classmates, about school, about life, and about the world in general. During the ninth-grade physics class, however, she started to show interest in what was being done. She began to participate in discussions. She completed her work. Her attitude about life improved. At the end of the four-week course Teresa was first in the class to complete the test and asked if she could go quietly to the other side of the room and disassemble a few pieces of apparatus while her classmates continued to work. Presumably Teresa was empowered by the embodied confirmation of her understanding.

Phenomena-based science has significant potential to empower adolescent girls, as well as boys, in their science studies. The subject matter itself can be a significant means for overcoming the oft-noted lack of self-esteem and confidence of adolescent American schoolgirls, a lack that often expresses itself in girls' experiences with science. Assuredly, since teachers are part of the context within which science is met, it is very important that they be sensitive to gender issues as well as enthusiastic, knowledgeable, and caring. Given such teachers, however, the subject matter itself can become a means for accomplishing educational goals having to do with human development. Phenomena-based science, because of its insistence on awareness of the process of knowledge alongside the knowledge gained, seems to move concerns from the realm of gender-specific issues to those that are more generally human.