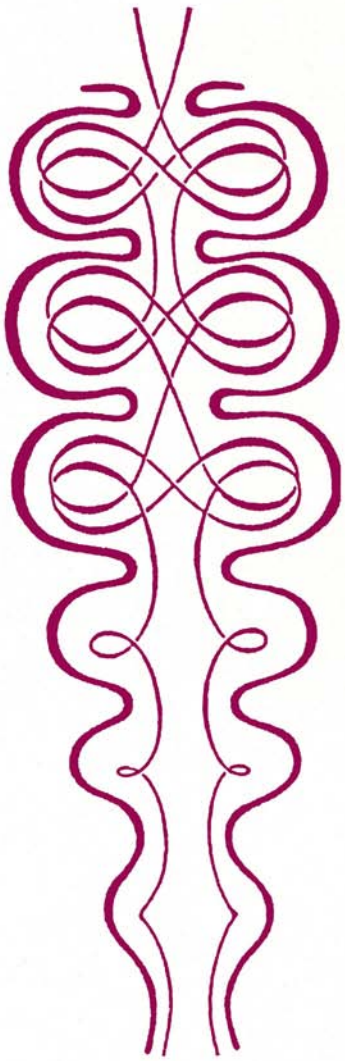


Volume 13, #23
Spring 2007



WALDORF SCIENCE NEWSLETTER

David Mitchell, Editor
Bob Amis, Assistant Editor
1158 Quince Ave.
Boulder, CO 80304
davidm@awsna.org
303/541-9244



Waldorf Science

Explorations in Phenomenology as Practiced in Waldorf Schools

A Science News Roundletter

Editor: David Mitchell
Assistant Editor: Bob Amis
1158 Quince Ave.
Boulder, CO 80304
Phone and Fax: 303/ 541-9244
E-mail: davidm@awsna.org

© Copyright 2007 by AWSNA Publications

All materials may be reproduced for individual use in Waldorf/Steiner Schools but not published without permission of the editors.

VOL. 13, #23

Spring 2007

FROM THE EDITORS

Excitement reigns at the Waldorf Science Newsletter with the report from the Research Institute for Waldorf Education. For the past two years a study has been conducted on 523 Waldorf graduates from 1943–2005.

Statistics show that there has been a dramatic rise in the number of graduates majoring in science during the past decade with 42% of the graduates majoring in sciences/math as an undergraduate. **When compared with the general population of students throughout the United States:**

- Almost 3 times as many Waldorf graduates study social and behavioral sciences.
- About 50% more Waldorf graduates study science and math.
- Almost 3 times as many Waldorf graduates major in arts and humanities.

We can assume that the consciousness directed at science within Waldorf schools in North America and the circle

of AWSNA Delegates, the thirteen years of the publication of the *Waldorf Science Newsletter*, the intensification of science preparedness at Waldorf Teacher Training Centers, the initiation of “Teaching Sensible Science” by the Research Institute for Waldorf Education, as well as the focus of individuals writing about Waldorf science teaching in *Renewal*, the *Waldorf Journal Projects*, and so forth, have all had an impact.

This edition includes a meteorology discussion with Dennis Klocek; Michael D’Aleo’s views on presenting phenomenology to parents of eighth graders; stunning photographs from the Hubble Space Telescope; the second article on Lenticular Clouds with Julius Tonelli; an inside glimpse of a “Sensible Science” workshop with Bob Amis; and a survey presented by Jamie York on Computer education in Waldorf schools in North America. We hope you will find this issue stimulating,

Books of Interest

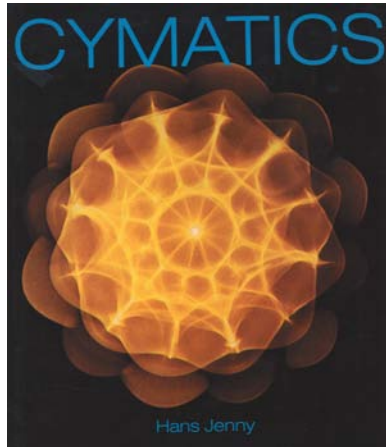
Cymatics

by Hans Jenny

Cymatics, the study of wave phenomena, is a science pioneered by Swiss medical doctor and natural scientist, Hans Jenny (1904–1972). This comprehensive edition documents over fourteen years of meticulous experiments using audible sound to excite powders, pastes and liquids into life-like, flowing forms. The stunning array of images reflects a variety of patterns found throughout nature, art and architecture. The photographs in this book are of entirely “natural” phenomena; there are no computer generated images.

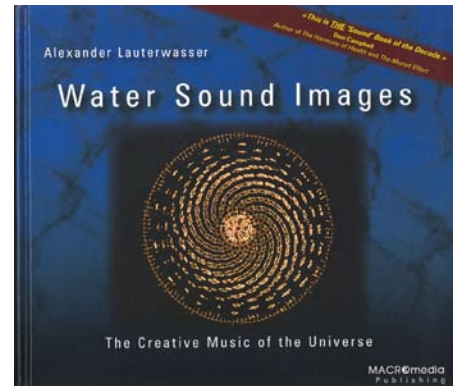
This revised edition contains the complete, English language text of the bilingual edition published in 1967, *Kymatic/Cymatics*, (from the Greek *kymatika*, “pertaining to waves”) as well as the entire text from *Cymatics, Vol. II*, published in 1972. It also includes all of the photographs from the original editions which illustrate these amazing phenomena in vivid detail.

ISBN 1-888138-07-6
296 pages 9.25 x 10.25 hardcover
illustrated with over 350 photos, including 16 full-page color images Price: \$60.00
MACROmedia Publishing
available from AWSNA Publications



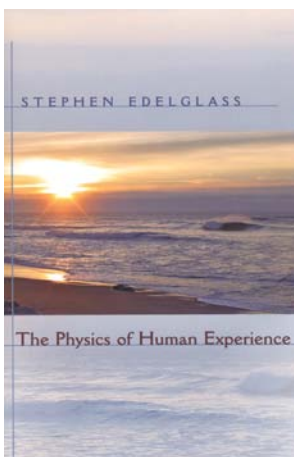
Water Sound Images

by Alexander Lauterwasser



Following Hans Jenny’s work in *Cymatics* this scientific/artistic study is an inspiration. It brings together a startling picture of the relationship between water and sound captured by photography. The resulting images suggest a universe based on beauty and harmony, vibration and tone. It opens environmental possibilities that should be considered by all students.

ISBN: 978-1-888138-09-2
176 pages, 9 x 10 hardcover
full-color throughout Price: \$40.00
MACROmedia Publishing
available from AWSNA Publications
www.awsna.org/publications



The Physics of Human Experience

by Stephen Edelglass

This book presents six key lectures from the life of scientist and Waldorf physics teacher Stephen Edelglass whose central impulse was to bring together physics with direct human experience—to enable each individual to experience a phenomenological encounter with the natural world—to allow the inquiring individual a direct perception of the forces which create beauty around us.

ISBN #0-932776-34-5
135 pages
5.5 x 8.5 inches Price: \$14.95
Adonis Press

Research Bulletin
Autumn 2006
Volume XII, Number 1

Editor: Stephen Keith Sagarin,
PhD

Dedicated to furthering research in education the *Research Bulletin* provides schools with studies and data that place Waldorf education at the forefront of the educational scene in North America. Key topics in this issue are:

- Reading in Waldorf Schools, Part II: Beginning the Flow of Warmth
- Rudolf Steiner on Left-Handed Children
- The Tricky Triangle: Children, Parents, and Teachers;
- Healing Children Who Have Attentional, Emotional, and Learning Challenges
- What Will Today's Children Need for Financial Success in Tomorrow's Economy?
- The Development of the Hand in the Young Child
- an excerpt from a newly translated book by Rudolf Steiner, *Education, Teaching, and Practical Life*

as well as the writings of our Research Fellows. If you have not seen the latest edition, you are encouraged to obtain a subscription from:

researchinstitute@earthlink.net

68 pages
7.5 x 11 inches \$12.00



Survey of Waldorf Graduates: Phase II

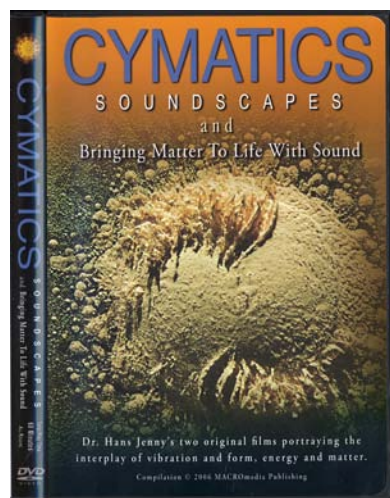
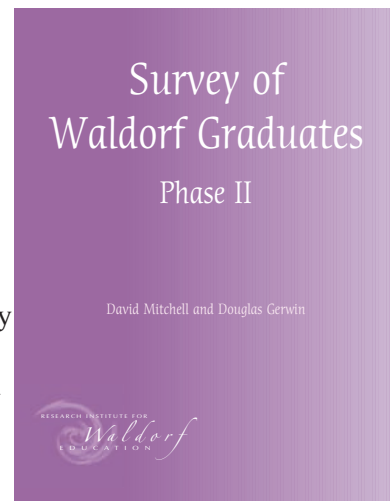
David Mitchell
Douglas Gerwin
Arthur Pittis
Ida Oberman

Participants in a recently release survey of Waldorf graduates in North America from 1943 to 2004 report that in the last ten years the science curriculum in Waldorf schools has improved steadily,

More than 42% of current graduates are selecting science majors in universities and colleges.

This survey contains many surprises supportive of Waldorf education. Filled with information, anecdotes, charts and graphs, this report will be interesting for faculty, parents, Board members and anyone interested in the results of Waldorf education.

ISBN: 978-1-888365-82-5
165 pages
8.5 x 11 inches \$25.00
available from AWSNA Publications
www.awsna.org/publications



Cymatics
Soundscapes and
Bringing Matter to Life with Sound

This video is a study of wave phenomena and vibration as filmed on the surface of liquids when subjected to external audible sound. The incredible patterns that result mimic geological forms, crystalline shapes, biological patterns (in Cytology and Histology), astronomical movements and patterns in atomic structure. The pictures portrayed on the video are actual physical phenomena and are not enhanced by computer manipulation. Sure to enliven the imagination of young and old, this video should be a resource available in all Waldorf schools with grades 8–12.



DVD \$30.00
60 minutes
available from AWSNA Publications
www.awsna.org/publications

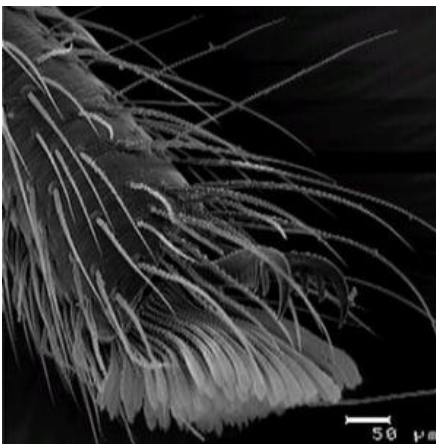
How Parachute Spiders Invade a New Territory

All spiders spin silk, but the silk is used in a wide variety of ways. Most spiders construct a silken case to protect their eggs, but not all spiders make a web. A few use silk threads much like a parachute to aid in dispersal on wind currents, e.g., parachute spiders.

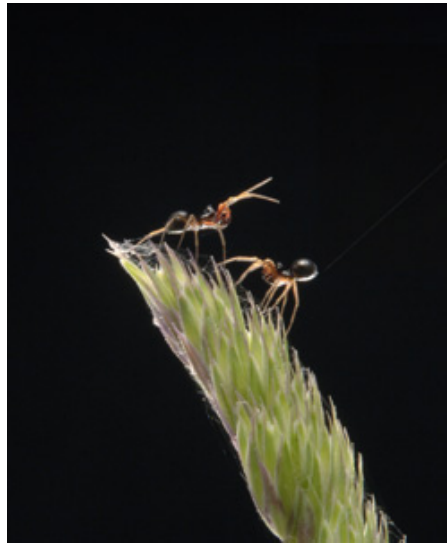
Researchers have recently developed a new model that explains how spiders are able to “fly” or “parachute” into new territory on single strands of silk— sometimes covering distances of hundreds of miles over open ocean.

By casting a thread of silk into the breeze, spiders are able to ride wind currents away from danger or to parachute into new areas. Often they travel a few yards, but some spiders have been discovered hundreds of miles out to sea. Researchers have found that in turbulent air the spiders’ silk molds to the eddies of the airflow to carry them further.

The new mathematical model allows for elasticity and flexibility of a ballooning spiders dragline—and when a dragline is caught in turbulent air the model shows how it can become highly contorted, preventing the spider from controlling the distance it travels and propelling it over potentially tremendous distances.



‘foot’ and discovered that a molecular force sticks the spider to almost anything. The force is so strong that these spiders could carry over 170 times their own body weight while standing on the ceiling. The research is published in the Institute of Physics journal *Smart Materials and Structures*, April 2004.



Two male Erigone spiders on a grass seed head. The lower one is in a pre-ballooning posture, known as the “tip-toe” position, ready to disperse. (Credit: Rothamsted Research)

Source: Biotechnology and Biological Sciences Research Council
Date: July 12, 2006

Parachute Spiders

It's the bait of broken things —
burrowing into a borrowed place
that you need never give back —
it's the spastic snap of little hands
that aren't hands, forming a nest
of webs in the cushions of dry rot and dust —
it's the knack of losing things with grace,
parachute spiders spinning down their strands
in front of your face like a kind of rain,
the things you pass and that pass you by,
it's all these days, it's all the time.

— Noah Grey

A scanning electron microscope (SEM) micrograph of the foot of the jumping spider E. arcuata. In addition to the tarsal claws, a tuft of hair called a scopula is found at the tip of the foot, which is what the spider uses to attach itself to surfaces. The long hairs which are distributed over the entire foot are sensitive to touch. Magnification 200x. (Image courtesy Institute of Physics).

DSM

ADVICE ON TEACHING 8TH GRADE METEOROLOGY

by

Dennis Kloeck

transcribed by Bob Amis

BA: What are some of your thoughts about how a teacher might want to approach the Meteorology block in 8th grade?

DK: In working with Meteorology, especially in a phenomenological way, there's always the danger of not having any phenomena. In other words, you schedule your block and then have three weeks of bright, clear weather. So you want to schedule your block for a time of year where you are more likely to have a variety of weather in your area. Another challenge is that the sequences, such as a warm front sequence, are not as cut and dried as they are in the books; so it takes a certain amount of discrimination to be able to actually say, "Are these clouds building or are they not?" It is also very difficult to avoid abstract concepts in an attempt to answer a student when he or she asks why a certain phenomenon acts the way it does.



There are, however, some basic phenomena that can be demonstrated very simply that help in the beginning to build up some concepts. The most fundamental concept is that warm air rises. Now I can say to you, "Warm air rises," and you can say, "OK," and then write it down. But what I usually do is light a candle, and ask for a volunteer, and we hold both our fingers together, and bring them to the bottom of the candle flame; we can get to within a quarter inch of the bottom of the flame. And then together we move our fingers about a foot and a half above the candle flame and come down directly above it; when we're about 8 inches above the flame we have to pull our fingers away. So everybody gets the idea that warm air rises, but then I ask, "OK, but why can we get our finger so close to the bottom of the flame without getting burned?"—and right there is a little door to the idea of convection. So then I take a piece of tin foil and make a little collar around the candle at the bottom, in the shape of a grail cup, and I bring the collar up the candle until it is around the flame. When the collar is around the flame, I squeeze the bottom of the collar and pinch off the airflow around the candle, and the flame goes out. Then I try the opposite, which is to take the cone off the candle, invert it, and squeeze the end, closing it off; then bring the cone down on the top of the flame, and I can bring it all the way down until the bottom of the cone is at about the same level as my finger

had been (without getting burned), and that is where the flame will begin to sputter. In both cases I have cut off the airflow to the flame. So then I would say to the students, “Well, suppose we could see what is happening around this candle, could we draw it?” Basically what they draw is the warm air rising and getting refreshed from below, and that’s your fundamental convection cell, which is the basis of all meteorological phenomena.

Another way to show this is to place some miso into a large beaker and mix it with a little warm water until you get a paste. Then, in front of the students, heat some more water and pour it into the beaker with the miso. The miso flakes are light enough so that what you will see is flakes of miso rising in the center of the beaker, and on the sides the solution gets dark because this is the return current going down. Every once in a while you get a burst, or blurb, of this stuff that gets warm enough on the bottom and suddenly gets lifted, and you have an example of a low pressure cell. So the miso reveals the same pattern that is around the candle.

BA: So these demonstrations create an awareness in the students of the nature of a convection cell. Where does that take you meteorologically?

DK: That’s a cloud. That’s a high or a low pressure air mass. That’s a semi-permanent Hawaiian high/ Aleutian low relationship. It points to world wind patterns. It’s a worldwide phenomenon at all levels: the candle, the little dust devil, the local low above the parking garage at the airport, the Hawaii high, or the Bermuda high, are all the same structure at different scales. So there’s something in those demonstrations that makes all the diverse phenomena coherent. That’s the real task, to make sense out of all the diverse phenomena; very few texts will explain that this principle is actually what is behind all of these phenomena.

Once you have that concept, then you can ask, “What is wind? What if there was a candle flame inside a glass box that was one foot by one foot by one foot and I was an ant at different levels inside the box. Which way would the wind be blowing at each place?” What you’re doing is extrapolating from this one phenomenon that the students can observe, and you keep returning to it and suddenly you have wind, air circulation, high and low pressure systems, and all these other complex events, but behind them is the candle flame.

BA: Are there any other concepts that are important to build up?

DK: One is the idea that warm air can hold more moisture than cold air. You can illustrate this with a still. You have a flask with a stopper, and then you bend some tubing, and then you heat some water in the flask, and then in the space between the surface of the water and the stopper you can’t see anything, although there’s water vapor, then at the top there’s a condensate. Why is there a condensate? Because at the top it gets cold again. Yet you can’t see the water in the middle. So basically, the cloud is a kind of still.

Another important concept is the relationship between pressure and warmth. If you press your hands together lightly and rub them back and forth rapidly, they will warm slightly. If you increase the pressure between your hands as you rub them together, then they will get noticeably warmer. So the law is that an increase in pressure will create warming, while a decrease in pressure will have a cooling effect.

Now we can build a picture of cool air coming down to the surface of the Earth, and the air above it pressing down, increasing the pressure on the air at the surface, which warms, picks up moisture, and rises. As this air moves up, it expands, and as it expands the pressure decreases and the air cools. As the rising air cools it releases the moisture it was holding. Finally, it cools enough so that it starts to sink back to the surface. This is a more complex, and complete, picture of a cloud, or of a low and high pressure system, that we have built up with these simple demonstrations.

Now where the phenomenology is the best is in keeping a logbook. You can start out by asking the students, “Well, what do you think would be important to pay attention to if we were going to try to predict the weather? Do you think the direction of the wind is important, or the strength of the wind? What else? Clouds? Are all the clouds the same?” Out of that conversation you’ll probably end up with a log that contains wind direction, wind strength (using the Beaufort Scale), cloud type (growing horizontally or vertically), cloud height (high, medium, or low), and cloud cover. You assign a group of students to make a set of observations early in the morning, then the whole class can make another set during the morning lesson, and then again after lunch, so three times a day. A fundamental question with this is, “Can you watch a cloud long enough to tell whether it is growing horizontally or vertically?” That’s a big one. It takes about three minutes. During the morning lesson discussion of their observations you can ask the students what they think is important in all of this. As they get a little more adept, you can introduce the Sailor’s Rule. The Sailor’s Rule says that you put the wind to your back, and turn 45 degrees to your right, and the nearest low will be to your left, and the nearest high will be to your right. That’s the way they check the wind aloft; the wind on the surface is always 45 degrees clockwise from the wind aloft. Once they get that, then they can start tracking the fronts that are coming, and that’s cool. The cloud type and height can also tell them something. Then they can track the wind; if the wind moves from the north to the west to the south aloft, then the troughs are coming towards them; if it moves from the south to the west to the north then they’re moving away. So these fundamental phenomena can start to build a little more into observation. This is also where the old rhymes can start to make a big difference, because they were very wise; the old rhymes were very wise.

BA: That's wonderful. Any other thoughts?

DK: An excellent biography is the classic story of Benjamin Franklin. He was the first Postmaster of the United States, and he kept getting complaints that the mail that was sent on package ships directly from England would arrive later than mail and freight that was put on a freighter which would go from England south past Portugal and the Azores, then across the Atlantic and up the coast to Philadelphia. So he asked his cousin, who was a captain on a whaling ship, about this and his cousin said, "Oh, well that's because there's a current coming from Philadelphia towards England, and the ships coming across have to sail into it." That current is what we know today as the Gulf Stream. The whalers knew about it, but they hadn't given it a name. Franklin made eight trans-Atlantic crossings in his lifetime, and during his later years he always carried a thermometer and a long piece of rope. He would throw the thermometer overboard, and he found that the temperature was different in the current than it was outside the current, and so he found this big gyre. This started a thought process in him that these things are circular over large areas. Later, he was in Philadelphia, waiting to see a lunar eclipse. Just before the time of the eclipse, a storm arrived and obscured the eclipse, and he was very disappointed. Then he heard that one of his relatives in New England had seen the eclipse. But the winds from the storm had come from the northeast, and the prevailing wisdom at that time was that a storm came from the same direction as the winds, because no one had a concept of winds circulating around an air mass. But Franklin's work with the Gulf Stream had shown him that between Philadelphia and England there was a big circulating gyre, so he began collecting information from newspapers from Virginia and Tennessee about this eclipse and pieced together the idea that the circulation around the storm was counter-clockwise, and that the wind coming from the northeast was actually the air circulating around the storm, but the actual storm was traveling from the southwest. He was one of the first people to recognize this phenomenon of circulation through observation and gathering data. This is an early example of how phenomenology, when it comes to meteorology, has to include data that you haven't observed yourself, because the phenomena are too big.

Dennis Kloczek earned a Masters in Fine Arts degree from Temple University's Tyler School of Art, and his Waldorf Teachers Education diploma from Rudolf Steiner College. Dennis has been the director of the Consciousness Studies Program at Rudolf Steiner College since 1992. He is engaged in research, teaching, and writing in many fields, including weather, gardening, color therapy, meditation and the human organism, embryology, and sensory transformation. He is the author of numerous articles and books, including *Weather and Cosmos*. He also administers the website, docweather.com, devoted to meteorological information and weather forecasts based on his twenty-four years of research.

AN EXPLANATION OF THE PHENOMENOLOGICAL APPROACH FOR PARENTS OF MIDDLE SCHOOL CHILDREN

by

Michael D'Aleo

transcribed by Bob Amis

BA: How would you explain the Waldorf approach to teaching science to the parents of middle school-age students?

MD: I think there are a couple of questions that are on the mind of a parent when they ask about how we teach science at a Waldorf school. The first one is, "Is my child going to be able to relate to the world in a meaningful way?" meaning that later in life, if they're so inclined to become an engineer or a scientist, will they be able to do that. In my experience the Waldorf approach to science prepares the students especially well to do that. And so what is the Waldorf approach to science? As science is often taught, there is a book in which a "natural law" is described, one that was discovered some time ago, and demonstrations are conducted to show that this law holds up. What the teacher is able to do in this case is to show that there is a relationship, but he is actually not asking the child to enter into a scientific process. So in a Waldorf approach, instead of giving the student the concept at the beginning, we actually build up an experience of the phenomena under which it is possible for the student to draw that conclusion. For example, instead of saying, "Well, hot air rises, and cool air falls," we might do an experiment in which we have some small sticks of wood burning and giving off smoke, and then ask the students to observe what is happening to the smoke. Then we might take a few smoking splints of wood over to a freezer door, open the door where the students could see the smoke actually going down, and then out of this encourage the students to find their own meaning, their own relationship, what was different between the first case and the second case, that kind of thing. We might also have a student hold a balloon over a candle, and feel the balloon expand. So that ultimately the student comes to an understanding that, in general, as things warm they expand and, in the case of gases, that means they become less dense, and they rise, and as they become cool they contract. You see, in this case, the conclusion is left to the student, guided by the teacher. And that is what is really quite unique about the Waldorf approach: it is constantly asking



the student to draw conclusions from his own sensory impressions, rather than simply verifying a statement that someone else has already made.

BA: What do you think are the capacities that we develop in the child in this approach?

MD: There are several different capacities that we develop. First of all, since the student is not told what to look for, but is simply asked to observe, the first thing that is developed is the ability of the student to observe, not just with their eyes but with all of their senses. Is there a characteristic smell, is there a sound, do they feel some other experience within the space? With electromagnetic phenomena, you can actually experience some other sensations within your body. So, instead of just relying on their eyes, the students begin to develop the ability to use their whole body as a sensory organ. The second thing that happens is that after the demonstration is over, the teacher asks the students to recall it sequentially. So there is an incredible power of imagination that is developed, not imagination in the fanciful sense, but in the ability to run through the steps of an experiment in one's mind, in one's imagination, and see this activity happen again. The next day the teacher comes back and asks the students to recall what they observed the previous day, so the student learns to observe, remember, and now articulate their own experiences, and then to place them in the context of others' experiences, in other words, "Was this an experience that just happened to me, or did others have a similar experience?" So there is this judging and weighing capacity, a certain level of discernment is also developed. Then finally, the teacher encourages the students to listen to each other, to hear the insights and observations of other students, and then, as a group and individually, to synthesize all of these observations and ideas, and see if there is some sort of lawful or predictable relationship that arises. So rather than simply proving some theory, we are developing the key capacities for practicing science: keen observation, being able to re-imagine the phenomenon, articulate one's own observations, integrate those with others' experiences, and find a relationship. These are the activities of all the leading scientists in their fields, working collaboratively with others.

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

MD: One has to be really awake to what one means by the word "model." What often happens is that people lose the idea that the model is intended as an analogy and begin to think of it as "that's exactly how it is." When John Dalton explained his theory of the atom to people in the early 19th century, he used small wooden balls, painted different colors, to represent atoms. Now Dalton didn't intend to say that this is what atoms actually look like, in fact he was very awake to the fact that this was simply a teaching aid, but in time people began to think of atoms as made up of little colored balls. In my own work in science and engineering, those are

the places where we get stuck in time, where we run up against the model's limitations, because, in fact, it isn't true to the phenomena as they manifest in the world. The powerful approach then, is not to think in terms of an analogy but to work with the phenomena as they present themselves and try only to find links between phenomena. Getting back to Dalton's analogy for the atom, that isn't the way to conceptualize an atom any more; modern physics does not think of an atom as a hard little billiard ball-like particle, and yet every year there are millions of children educated around the world to think that that's the essence of matter, and then any that go on later in life to pursue science at a higher level have to unlearn that way of thinking—which is challenging once you've had it ingrained in you— and relearn a new way. So in a Waldorf school, rather than teaching the model, we work with the simpler phenomena and relationships in the younger grades, and finally build up to something as complex as the nature of the material world, and save that topic for eleventh grade. It's taught later, but by teaching it later the students can really begin to appreciate, understand, and think in a much more modern 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, come across this idea, especially in Waldorf education, because Rudolf Steiner wrote an entire series of books on this topic. The notion is that we separate things into observations and ideas, sometimes called “percepts,” from perceptions, or that which we perceive from the senses, and “concepts,” that which we conceive of out of the activity of thinking. Very often people will take concepts, ideas they have, and 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 as if it were particle-like and they could put it in a box, keep it, and take it out later. This leads to a much more static view of what's happening, say for example, in an industrial process where we have a large chimney stack, and we can see these great plumes of gases rising into the sky. What we are actually observing 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 where what we think we see and observe in the world isn't actually an observation, it's 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 in the world and, instead, believe we're seeing something other than what's present. This is often a great barrier to new

scientific insights. It is often the case that the person who is able to see beyond one of these conceptions is the one who takes the key step toward a new insight, discovery, or invention. This new insight may lead to something that becomes functional, but it may also increase humanity's ability to live into the world more deeply in our everyday life.

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

MD: The environmental issue is a big question in the scientific community and in society in general. One approach that some people advocate is that scientists just have to work a little harder and they'll find the answers. A different approach that one can take 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 approach. We not only develop an understanding of the outer world, but how the human being relates to that outer world. It creates a more intimate understanding that in and of 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 they often have an aesthetic quality that is environmental in its foundation.

If you study any of the great scientists, past or present, there is often an elegance to their theories. When they have really 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.

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 17 patents. Michael also holds a Masters degree in Education from Sunbridge College. He currently teaches high school math and physical science at the Waldorf School of Saratoga Springs and is on the teacher education staffs at both Sunbridge College in Spring Valley, NY, and The Center for Anthroposophy in Wilton, NH. Michael is a founding member and Director of Research of SENSRI (Saratoga Experiential Natural Science Research Institute, www.sensri.org), which hosts the Teaching Sensible Science teacher training course (see article in this newsletter) initiated by the Research Institute for Waldorf Education.

Ice field in Norway with Spectacular Crystals



Interestingly, the word “crystal” derives from Greek word for “frost.” The picture above shows giant ice crystals growing on an ice field in Norway. Water is one of the few substances to expand when it freezes. Just the right atmospheric conditions are required to allow massive ice crystals to form. An unusual feature of ice frozen at a pressure of one atmosphere is that the solid is some 8% less dense than the liquid water from which it formed.

Almost unbelievable to the human observer the crystals appearing above look like sparkling, elongated, crystalline flowers. This photograph was taken at dawn.

DSM photograph courtesy of Ted Warren

Blackback Crabs



A blackback crab sits next to the exoskeleton it has just shed.

Crabs rely on their rigid shell for protection and support. As they grow they must molt (cast off) their old shell (exoskeleton) and chemically create a new one. While molting, the crabs are extremely vulnerable to injury and attack by their predators. Marine crabs create a temporary exoskeleton by pumping their outer layers full of seawater. Blackback crabs, however, live almost entirely on land, returning to the water only to spawn. But how does a land crab deal with the inherent dangers of molting?

“They essentially secrete what looks like a whole [black shell] under the old one,” said Jennifer Taylor, a biology doctoral student at the University of North Carolina in Chapel Hill. The crabs use air in combination with internal fluids to increase pressure inside their bodies.

“They pump themselves up and inflate their gut, and that increased pressure will cause the old outer skeleton to crack, so that the crab can back out of it.”

The higher internal pressure creates a temporary turgidity, much like a child’s balloon tightens before being inflated, and the crabs employ that pressure to move their legs and claws for several days until their newly-secreted larger shell hardens. After that, their exoskeleton can, in the usual way, resist muscle contractions, which thereby produce movement, the researchers said.

The gas-filled membrane acts like a pseudo shell while the new one is formed.

Source: *National Geographic*, April 2006.



Astronomy

Assembled in laboratories in Boulder, Colorado, and launched into space in 1990, the Hubble Space Telescope—a floating astro-observatory—has been transmitting back to earth some incredible pictures of outer space. Reporter Michael Hanlon says that these images “illustrate that our universe is not only deeply strange, but also almost impossibly beautiful.” Below are a few examples, but I encourage you to visit the web site below to see the sixteen most spectacular images.

http://www.dailymail.co.uk/pages/galleries/index.html?in_gallery_id=9139&in_1055

DSM



The Sombrero Galaxy—28 million light years from Earth—was voted best picture taken by the Hubble Telescope. The dimensions of the galaxy, officially called M104, are as spectacular as its appearance. It has 800 billion suns and is 50,000 light years across.



The Ant Nebula, a cloud of dust and gas whose technical name is Mz3, suggests the shape of an ant when observed using ground-based telescopes. The nebula lies within our galaxy between 3,000 and 6,000 light years from Earth.



The glowering owl-like eyes from 114 million light years away are the swirling cores of two merging galaxies called NGC 2207 and IC 2163 in the distant Canis Major constellation.



Nebula NGC 2392 is called Eskimo because it looks like a face surrounded by a furry hood. The hood is, in fact, a ring of comet-shaped objects flying away from a dying star. Eskimo is 5,000 light years from Earth.

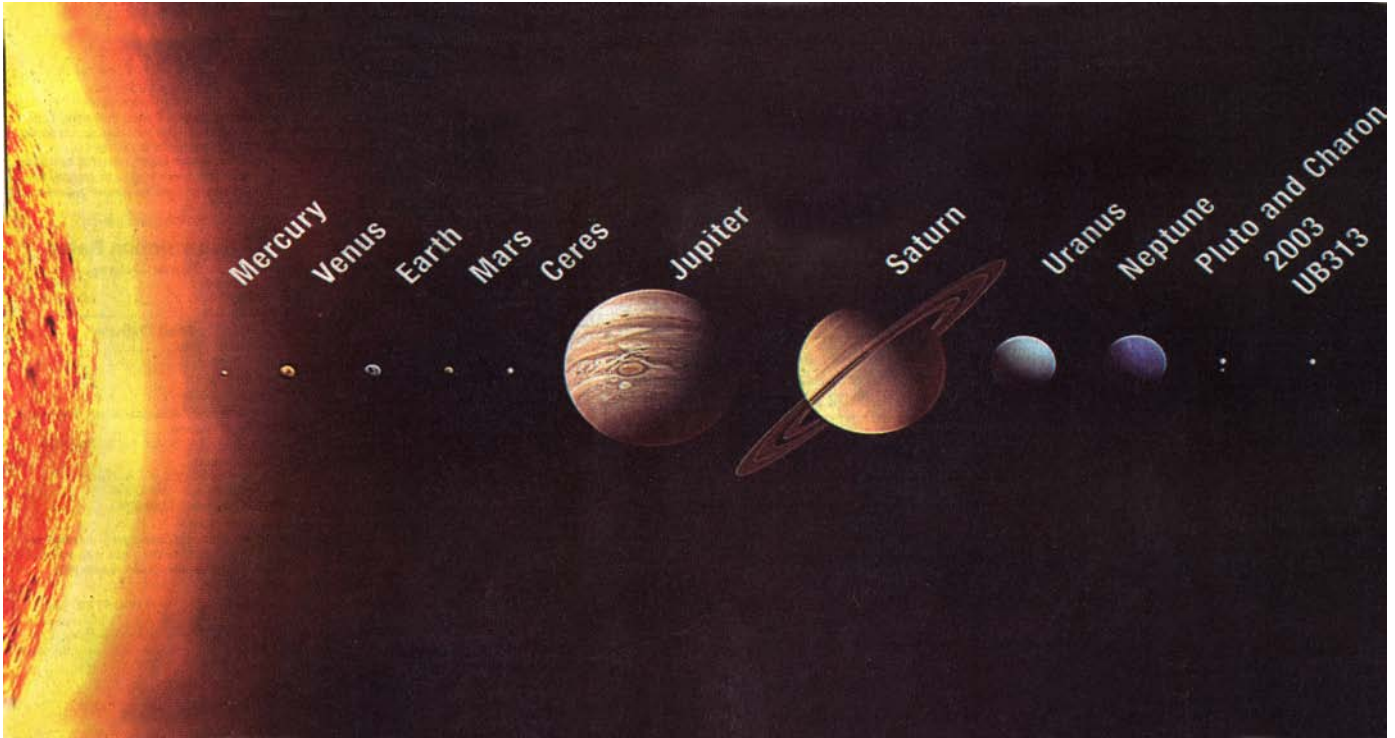


Starry Night, so named because it reminded astronomers of the Van Gogh painting, is a halo of light around a star in the Milky Way.



The Perfect Storm, a small region in the Swan Nebula 5,500 light years away, is described as 'a bubbly ocean of hydrogen and small amounts of oxygen, sulphur and other elements.'

Pluto Is No Longer a Planet



Last summer in Prague, Czech Republic, the International Astronomical Union, which decides on names for stars, planets, and other astronomical bodies, considered the asteroid Ceres, Pluto's moon Charon, and the recently discovered 2003 UB313, unofficially named "Xena," as possible additions to the nine planets we all memorized in elementary school (see the hypothetical chart above). Such was not the case, however. Instead the status of Pluto was demoted, and Pluto is no longer classified as a planet.

The new definition for a planet includes the requirements that the celestial body:

- **Is massive enough** that gravity makes it spherical,
- **Orbits** a star and
- **Is massive enough** to dance in nearly mutual orbit with partner planets.

The eight "classical" planets are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

The new planet category "pluton" applies to planets with orbital periods of at least 200 years, which applies to everything beyond Neptune, including Pluto, its moon Charon and the recently discovered 2003 UB313.

Pluto has a diameter of about 1,430 miles, and its orbit lasts 248 years. Its distance from the sun is about 3.7 billion miles.

Charon has a diameter of 748 miles and travels in the same orbit as Pluto. Charon and Pluto are now considered binary planets.

UB313 has an estimated diameter of 1,490 miles, and its orbit lasts 557 years. It is 9 billion miles from the sun.

DWARVES

The asteroid Ceres, orbiting between Mars and Jupiter and with a diameter of 591 miles, is classified as a "dwarf planet." **The plutons** can also be considered dwarf planets, but Ceres is too close to the sun to be a pluton.

DSM

Environment, Morphology, and Physical Principles for Waldorf High School Teachers and Students

by

Julius E. Tonelli

Part Two of Two Parts

The first part was printed in *Waldorf Science Newsletter Vol. 12, #22*

Lenticular Clouds and Waldorf Physical Sciences Classes

During a college geomorphology (surface processes) course, I went to bed one night at about 11:30 PM. At midnight, the phone rang. I answered, not knowing whom to expect. The geomorphology professor's distinct voice commanded, "Tonelli, Landslide. Route 7, three miles south of town. Be there." I arrived about twenty minutes later, and there were three of us in sleeping clothes, measuring the sizes of debris before the state could bulldoze it away. This was science alive and well.

Lenticular clouds are no less impressive and beautiful a phenomenon than landslides and require teachers and students to act as 'Minute Men' when they are visible. As such, atmospheric science teachers in mountainous regions would do well to plan the study of them in a set curriculum. So common are they in most mountain areas that during the half year when the polar front is most active (late fall through early spring), sightings are extremely likely during a 3- to 4-week block, or during a semester-long skills course. Although the precise timing of these clouds' existence cannot be planned while setting the curriculum, the teacher who is even slightly flexible can anticipate their appearance sometime during the course's run and hopefully call the students' attention to them.

A: LENTICULAR CLOUDS: GENERAL DESCRIPTION AND DEFINITION

Generally speaking, lenticular clouds are formed of strong wind and moisture. They occur in many places throughout the world but are most common in temperate or polar climates, either directly over or within 200 miles downwind of mountains or mountain ranges. As such, for example, Floridians and people from East Kansas or Nebraska will almost never see these clouds first-hand.⁸ Although there are many dramatic photographs of these clouds available to anyone on the planet, and such pictures may well appear as part of a meteorology class' cloud study chart, there is no substitute for the real thing.⁹

1. Formation in Mountain Areas

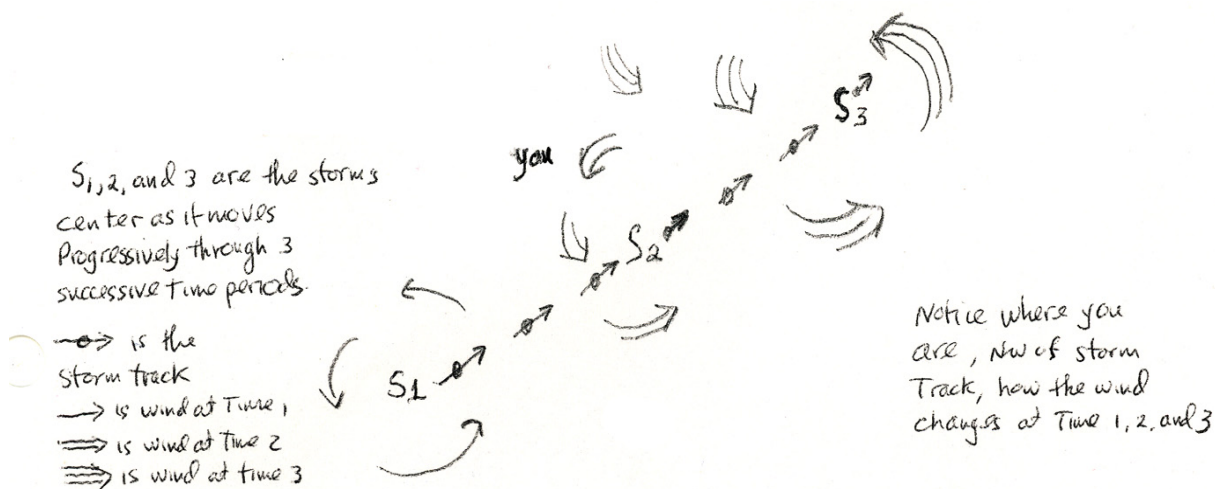
These clouds occur by far the most frequently over mountains and ranges of mountains, where winds go over the tops at high speeds. They can occur as isolated flying saucer-like clouds, or as whole banks of clouds. In all cases, their form remains stationary, even though the wind is howling, pushing other clouds,

above and below, quickly along. In all cases, they appear to have very smooth surfaces over most of them, and are usually devoid of any evidence of turbulent air flow within them. In a lenticular cloud, one rarely, if ever, sees puffy tops, swirls, or other signatures of convective activity. The underside sometimes reveals concentric circles, indicating layers which bend upwards into the body of the flying saucer-shaped form itself. The clouds described above are fairly illustrative. See Appendix for more photos.

As with any weather phenomena, lenticular clouds occurring over mountain-tops vary in form and endurance. Some are convex on the top and on the bottom, while others are convex only on the top and flat or concave on the bottom. Some are thousands of feet over the top of a mountain, while others may enshroud the peak itself. In many cases these clouds are one, very thin layer, while in others, they may appear as a stack, thousands of feet thick. In cases I have reported, these clouds have lasted from several minutes only to a couple of hours. In the cases of high mountain ranges, like the Rockies or the Cascades, these clouds sometimes linger for days. In all cases, much more research is needed to be able to determine whether there are correlations between strength of wind, amount of available moisture, layering of the atmosphere, and the extent, shape, and duration of these clouds.

2. Formation to the Lee Side of Mountain Ranges

Lenticular clouds also occur to the lee of mountain ranges, usually after strong middle latitude storms. Over North America, lenticular clouds form most often to the east of the Rockies and the Appalachians, and either before a mid-latitude cyclone's warm or occluded front arrives or after the passage of its trailing cold front. The storm can pass directly over the area, or its center can pass well to the location's north or west—the passage of a strong trailing cold air mass is nearly always associated with these clouds' formation. See Figure 7.¹⁰



a) Storm center passes to your south and east



Figure 7 (b).
Storm passes to your
north and west.

*S1, S2, and S3 are the storm
center at times 1, 2, and 3,
progressively.*

The lee-of-mountain form of these clouds is often either one, or a set of, elongate, single-layered clouds (contrast with the stacks one often sees over mountains). These clouds nearly always form with the long dimension perpendicular to the prevailing winds and parallel to the mountain range in question. For example, in the Washington, DC, area, these elongate clouds frequently parallel the part of the Blue Ridge or the Alleghenies over which the cold air is flowing. See Figure 8.¹¹

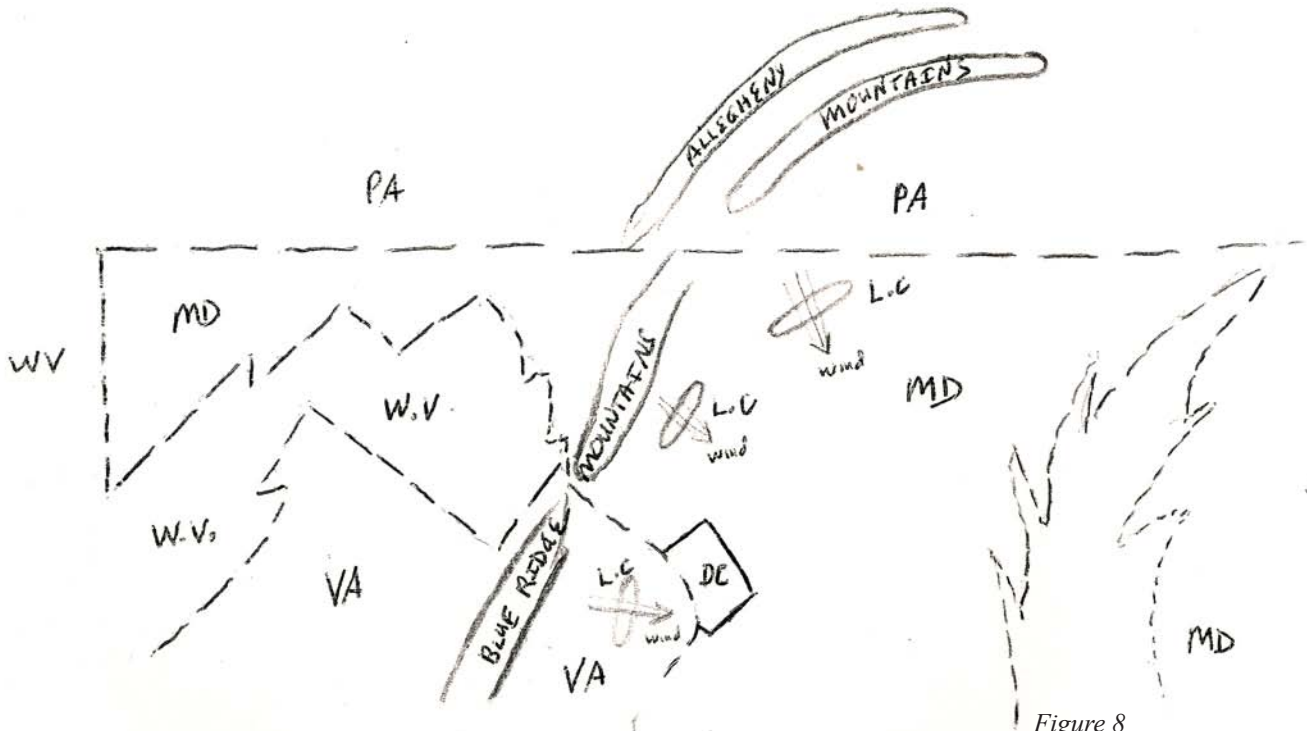


Figure 8

These lee-formed clouds stay stationary, even when clouds above and below them are moving laterally at great speeds. Also, these clouds rarely, if ever, show convective activity or signs of turbulence. They often appear to be silky smooth and look to taper off to nothing on the edges. So in spotting these clouds, one should look for stationary forms occurring on otherwise very windy days. The examples above are illustrative.

3. Limitations to Field Research on Lenticular Clouds

Research on the formation of lenticular clouds is paltry, though recently it has been perfunctorily noted in papers about tropical storm development and decay.¹² There are two primary obstacles to researching these phenomena: lack of scientific interest and inability to observe them directly. Although the reporting in this work's first ten pages has shown qualitative detail, it is lacking in wind speeds, relative humidities, precipitable moisture, and a host of other meteorological indices.

Lenticular clouds produce little to no precipitation, except for where they may fog-in a mountain top, adding to its annual precipitation total. Because these clouds are ephemeral by nature, seeding them is not practical for agricultural or research purposes. Because they are often hangers-on after large storms, they do not immediately suggest clues for predicting future storms.

Even if it were possible to closely research them, the task might be herculean. To study the winds within these clouds would require virtually unperturbed wind flow. This is not easily observed if the observer is on in aircraft or on a mountaintop, where the airfoil or mountain irregularities disturb the wind. Although meteorologists are now measuring precipitation remotely with satellite and laser technology, most of these efforts are concentrated around major storms and heavy precipitation. The small size of water droplets within lenticular clouds makes remote study of these water droplets difficult, if not impossible to observe accurately. One could release hundreds of weather balloons into single lenticular clouds to get precise pressure and temperature data inside and around each cloud, but the cost would be prohibitive. In the absence of such data, one is forced to look up, observe, and then ask the question of what data might help to answer the questions. This all bleakly said, there are several general physics principles that appear to be active in these clouds.

B: PHYSICAL PRINCIPLES RELEVANT TO LENTICULAR CLOUD FORMATION

From the realms of Mechanics and Thermal Physics arise several principles that form language by which a class can discuss the formation of lenticular clouds. These are explored as they occur in nature, as well as how some of them can be reproduced in the laboratory.

Water comes in the three phases of solid, liquid, and gas. Many students mistake the nature of these, believing clouds and fog to be a gaseous phase of water. But once the water has condensed to the point where it is visible, it has been restored to its liquid state, even though the liquid droplets are exceedingly small.

All visible clouds contain condensed water, and condensation requires the cooling of moist air to or below its dew point (temperature at which the air becomes saturated). Although it is possible to supersaturate air (raise the amount of water vapor above the air's predicted holding capacity), in a polluted sky such super-saturation is rare. In air which is separated from a moisture source (such as a large evaporating water body, or an evapo-transpiring forest of trees), the only way to saturate unsaturated air is to lower its temperature. This be-

comes especially important to consider when one examines the fast emergence and disappearance of lenticular clouds, which suggests a fast change from saturation to sub-saturation and back.¹³

For air to switch between saturated and unsaturated states, it must be cooled or warmed. Radiational, adiabatic, and orographic processes accomplish this. Radiational cooling is least likely to be operative in lenticular clouds: If these clouds form, they likely indicate a layer of moist air, and air rich in water vapor, having a higher specific heat than dry air, is more resistant to heating and cooling than dry air. Because the air involved in lenticulars downwind of mountains moves quickly, and radiational fog formation is usually a still-air phenomenon, radiation seems an unlikely relative of lenticular cloud formation.

Adiabatic and orographic processes lower the air's pressure and temperature in different ways. In the case of adiabatic cooling, the air simply rises up through the atmosphere to levels where there is less pressure from the atmosphere above. To understand adiabatic cooling, one can think of the process of pumping up a bike tire. As the tire gets harder and harder, the pressure inside the tube goes up, and usually the valve warms up. If one then lets the air out of the tire, the air coming out is moving from an area of very high pressure to an area of much lower pressure. Atop a mountain, the pressure is lower than on the bottom, as the air outside the tire is less compressed than that inside the tire. The air coming out usually feels ice cold, as the air at the mountain top is often much colder than on the bottom. In the case of orographic cooling, the air is forced up over a mountain ridge or peak, accelerating as it runs over the top, thereby lowering the pressure by Bernoulli's Principle, thereby lowering the temperature. Because lenticular clouds are mountain and wind phenomena, orographic cooling and warming suggests itself as the phenomenon most vital to our understanding of their rapid formation and dissolution.

The Bernoulli Principle says, simply, that given stationary air at a given pressure and temperature, moving this air will lower its pressure.¹⁴ It is common knowledge that on a windy day, the wind on the mountain peaks is nearly always much stronger than it is in the valleys. The flagged (branches growing on only the leeward side of the trunk) and stunted trees and bare peaks stand as testament to the high winds; the pressure is lowered adiabatically as well as by the raised wind speeds.

Combining Charles' and Avogadro's laws, we establish relationships among volume, pressure, and temperature:¹⁵

$$P_1 V_1 / T_1 = P_2 V_2 / T_2$$

If either the volume or the pressure of the air is lowered, then the temperature must also decrease. (More on this in the Demonstrations section below.) Lenticular clouds forming over mountain ranges often extend as far upwind as downwind of the mountain range itself. Both Mt. Ellen sightings manifested this. See Figure 9.

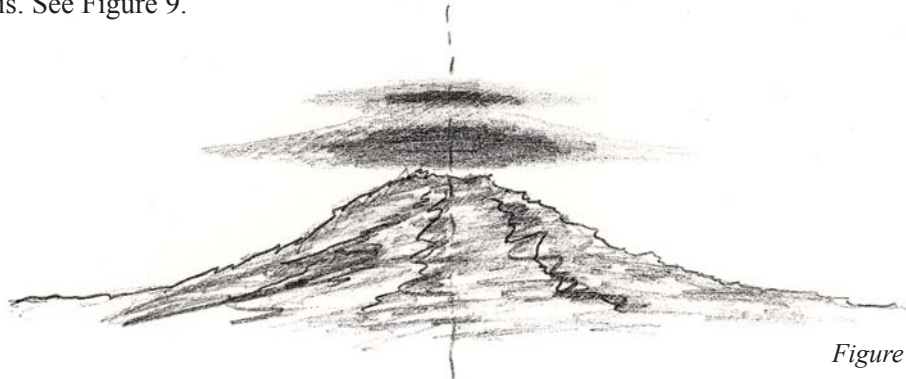


Figure 9

All this suggests that new moisture is not being added to this air blowing over the mountain, but rather that already existing water vapor is being made visible by the air's travel over the mountain. The conveyor-belt phenomenon I observed while climbing Mt. Ellen adds credence to this idea—the air flow, by all appearance, was laminar, rather than turbulent. Similarly isolated from new moisture, lenticular clouds well downwind of mountain ranges form as the result of their undulating winds, rather than through the addition of new moisture. These clouds' layered nature appears only in relatively stable air, rather than in air being mixed through heavy thermal activity from below. It is thus reasonable to infer from these observations that these clouds, occurring only in, or downwind of, mountainous regions in the presence of strong winds, are Bernoulli-borne phenomena. Therefore, studying condensation, the gas law, and the Bernoulli effect can help students to understand these beautifully strange clouds.

1. Lab Demonstrations of Cloud-Forming Principles

a) Making Visible Airborne Condensation in a Flask¹⁶

Anyone with a terrarium or a cold drink has witnessed condensation on glass; the demonstration here allows the students to see clear air become foggy in an instant. The materials needed are a 500 to 2000 ml. flask, a 2-hole stopper, hollow glass tubing with hollow width of at least 3 to 6 mm., hollow rubber tubing that fits over the end of the glass tubing, a liquid Celsius lab thermometer, a match, an insulating glove or flask clamp, a dark background, and a little water. Leave all ingredients at room temperature for at least half an hour, preferably overnight, before class.

Put a little liquid handsoap in the holes of the stopper, and then slide the thermometer and the glass tubing through the holes. Put the rubber tubing over the end of the glass tubing. The thermometer should stick into the flask so that its bulb is about an inch from the bottom of the flask; the glass tube can stick in a bit less. Put about 1/8 of an inch of water on the bottom of the flask and swish it around. (Condensation will likely form on the inside of the flask after only a few minutes.) Light the match and immediately snuff it out. Let a little smoke into the flask. 'Stopper' the flask, being sure to make the stoppage airtight. Do not 'stopper' the flask until the smoke has visibly cleared. See Figure 10.

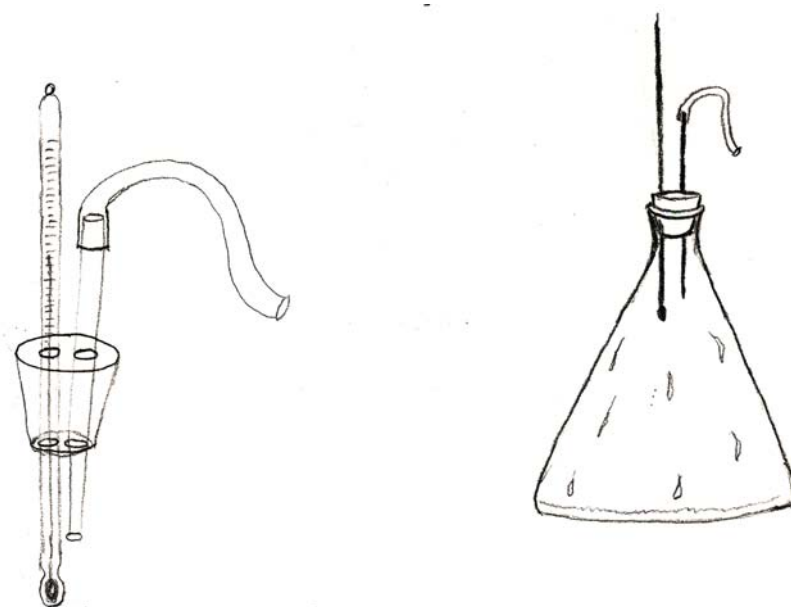


Figure 10

Wait a few minutes and record the temperature inside the flask. Hold the flask by the neck using the insulating glove or clamp—this prevents the flask from warming up by your hand. Then suck some air out of the flask using the rubber tubing. (Note that the glass tubing needs to have a hole at least 2 mm. across, or you will not be able to suck the air out quickly enough; the rubber tubing should be firm enough that it does not collapse under the suction alone.) At this point, the air in the flask should cloud up. (Doing this with the flask between the dark background and the students will help them to see it the best.) If airborne condensation appears, then pinch the rubber tubing to keep air from returning to the flask. After a minute or two, record the temperature in the flask. If you have held the flask by the neck with the glove, you should observe a subtle drop in temperature, although usually it will be less than a full degree celsius.

If there is no airborne condensation, then let the air back into the flask, and then blow hard into the flask through the rubber tubing. Pinch the tubing, wait a minute or two and record the temperature.

(At this point, the flask air should still appear clear.) When you un-pinch the tubing, the condensation should appear. Wait a minute or two and record the new temperature. Again, the temperature should fall subtly. Once you have observed the airborne condensation and recorded the temperature, you can easily make the condensate disappear and reappear many times by blowing into the flask (disappears) and sucking out from the flask (reappears).

This exercise demonstrates several principles: 1) If the pressure is lowered, the temperature falls subtly. 2) When the air is already saturated (evidenced by condensation on the inside of the glass), then 3) even a small drop in temperature causes atmospheric condensation if there are 4) condensation nuclei (the smoke particles). Redoing the experiment without the smoke particles will usually fail to cloud up the air, and students can then see how supersaturated air appears (it's clear!). The next question is how air temperature is lowered.

b) Bernoulli Principle

For this simple demonstration, all you need is 2 flat sheets of paper and a little breath. Hold the 2 sheets of paper vertically so that they represent parallel planes about 6 to 10 inches apart. These should be parallel to your line of sight, so you can look between them to the class. Be sure there is no static electricity pulling the copier paper sheets together. At this point, ask the class to watch very closely. See Figure 11.

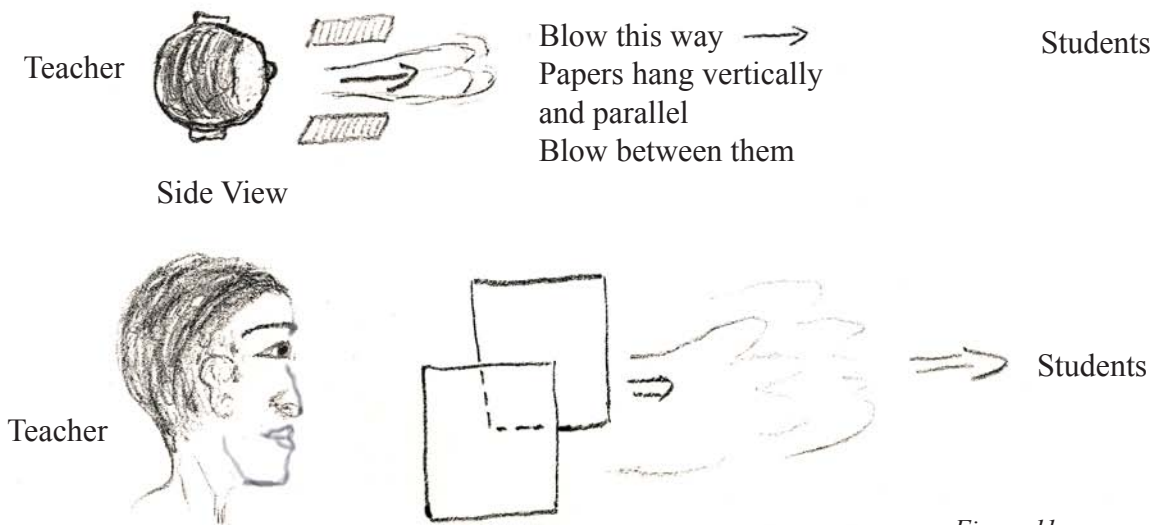


Figure 11

When you blow between them and they come together, the students, thinking that you are tricking them, will often demand to come up to the front of the class and try themselves. By all means, invite it! Those not coming up will often be observed to tear out two sheets of paper on their own and try it at their desks. After a couple of minutes of frantic activity, students usually quiet down in intense interest for what has just struck them as highly counter-intuitive (many of them will think the papers should have been pushed apart by more air being added between the sheets of paper by blowing it there).

At this point, you can review characteristics of gases, such as compressibility and the Bernoulli Principle. In addressing the Bernoulli Principle, the causes of the lowering of the pressure are far from settled knowledge. Classically, it is stated that the pressure goes down because the air, once moving, is being 'stretched out,' as a column of cars increases its length when released from a road behind where a lane is closed to that same road beyond the lane closure. While creeping at a snail's pace in the 3 lanes as they exist before the lane closure, the cars' collective density on the road is very high, but while traveling at 55 mph in the 3 lanes after passing the lane closure, their density is low—there is far more space amongst the cars. There are several problems with such an explanation. The first is that it takes an invisible phenomenon (lowering of the pressure), and it assumes that the air itself is composed of small, finite, particles of something. While this may be true, the world of physics is so unsettled on the question of what matter even *is* that it is an irresponsible assumption to give the students.

The second significant problem with this demonstration is that it does not work for all angles of paper-relative-to-air. In the demonstration, one blows approximately parallel to the sheets of paper, and they come together, showing a lowering of pressure. If one tilts the 2 papers so that they come together like a 'greater than, ($>$)' sign, with your head at the 'greater' end of it, the sheets may still come together if the angle is relatively acute. However, the more obtuse the angle gets, the more the papers get pushed apart—to the extreme that if one blows perpendicularly against a single piece of paper, it pushes strongly in the direction of the wind, indicating an increase, rather than a decrease of pressure, even though the air speed has increased! This is a subject of future research.

In the demonstration above, it is important to keep in mind that the result of lowered pressure is restricted to cases of primarily laminar flow, with physical objects like papers, wing surfaces, or mountain tops at angles close to parallel to the wind itself. Also, a teacher must not jump to conclusions as to why the pressure drops. Although the classical explanation is to state that the air, being compressible, gets 'stretched out' as it travels over a mountain or a wing top, such an explanation is far from certain and laden with materialistic assumptions, some of which are explained in the conclusions section of this paper.

That disclaimer having been made, in doing this experiment, you have established that moving the air can lower its pressure. Now you have answered the question of how to create suction as in the condensation-in-a-flask experiment. If you connect the lowering of pressure to the drop in temperature, you have helped the students to recognize the confluence of conditions needed for the lenticular cloud process to occur. In a broader sense, you have given the students simple principles to help them make logical and intuitive links among the mountains, the winds, and the lenticular clouds.

PART III: DISCUSSION: LENTICULAR CLOUDS IN WALDORF SCIENCE COURSES

Question: Why Should an 11th Grader Study Clouds?

(NOTE: This discussion focuses on the physical sciences and mathematics. This is intended to concentrate the discussion, and not to slight the other sciences or the arts and humanities!)

In a world where the politicians and press corps treat our atmosphere and the rest of the natural world as objects, devoid of life, and simply there for human usage, it is incumbent upon us as teachers to preserve human contact and feeling for the living world about us. Nobody who watches clouds closely for any period of time can leave the observation without some sense of the sky's aliveness. The unusual shapes and appearances of lenticular clouds lend themselves especially well to inspiring observation and wonder in students of all ages. Lenticular clouds, unusual in their shapes, their lack of lateral movement, their quick appearance and disappearance, are as alive as any sentient phenomenon nature displays. An 8th grader can see them to stay still almost stubbornly while the clouds around them are moving. A 4th grader can see their smoothness and gentle shapes. However, it takes a student with well-developed qualitative and quantitative skills and a good imagination of both visible and invisible phenomena, plus the ability to think logically, to consider conditions necessary to create these clouds.

Because of all that must develop in a student's thinking during the first 2 years of a Waldorf High School curriculum, the best time for a Waldorf student to study these clouds is during an 11th or 12th grade Atmospheric or Environmental Science class. The thinking one must engage fully to consider the formation of these clouds is certainly synthetic and well beyond the capacity of a 9th or even late-year 10th grade student.

To fully appreciate and attempt to understand how a lenticular cloud forms, a student should already have worked with the history of the development of the Plate Tectonic Theory, introduced in a typical 9th Grade Geology Main Lesson. In such a course, students learn that even without seeing the 'plates,' there is voluminous evidence of them, including thrust-, transverse-, and block-faulting visible on the surface, the Ring of Fire, and observable movement of the ocean's floors away from the spreading centers and towards zones of subduction. From concrete observations emerges a view of the whole world.

To understand the formation of any cloud, a student must be aware of relationships between temperature, pressure, and condensation. Such concepts should already be part of the student's language. When a student sees a cloud in one place or set of conditions, but not another, the student may then be able to wonder what is cooling what.

As noted above, the other course work is far from irrelevant. The 9th grade studies of polarities in Comedy and Tragedy and Black and White Drawing, for example, are essential to developing a sense for opposites and the play between them.

If a student is to think soundly about the formation of a lenticular cloud, the student should be able to think logically and sequentially and should have well-developed confidence in his or her own thinking. The bedrock of such thinking is laid in 10th grade with the strict attention to step-by-step proofs in Geometry and Trigonometry, in the intricate story of Galileo's discovery of his law of falling bodies, and in Newton's extension of this law to dynamics and gravity. The

10th grader gains laboratory experience with Acids and Bases, again working sequentially. A Surveying block adds field experience to their logic repertoire. In the humanities, the work at understanding Revolutions and the development of civil laws is also fundamental, as is the artistic structure manifest most obviously in the study and writing of poetry in its various forms.

This is not to suggest that a 9th grade student should not observe lenticular clouds: quite the contrary, the more attention a student pays to the natural world around him or her, the better for the world! (The eyes of far too many paid meteorologists, for example, are trained too much on Doppler Radar and too little on the actual sky. So many 24-hour forecasts make professional scientists' separation from the phenomenon painfully evident.) A teacher of 9th grade students should keep any discussions of these strange clouds restricted to the 'what' level: what is happening with the wind, what is happening to the cloud, where is the cloud (not) going, how high is the cloud, what kinds of other clouds are present, and what can we use to tell ourselves how fast the upper level winds are moving? Lenticular clouds can be a wonderful tool for working on the 9th grader's ability to observe much that is visible and invisible.

However, to ask a 9th grader why or how these clouds form is to push beyond the student's thinking abilities and into the realm of formulaic thinking. The teacher asking 'why' or 'how' in this case would almost certainly have to ask the student a series of leading questions which would then close out the student's own thinking or imagination.

By the end of 10th grade, however, when the student has worked and thought through simple geometric constructions as well as strict formal proofs, when the student has written poems of many forms, and when the student has worked as part of a contentious class at planning a Constitution—then the student has developed the type of thinking needed to ask how the lenticular cloud formed.

Although the late-in-the-year 10th grade student can likely ask a series of his or her own questions out of a nascent logical imagination, it is better to wait until the 11th grade for considering the 'hows' and 'whys' of lenticular clouds. The question of why such a cloud exists, although somewhat answered thermodynamically in the 9th Grade, is important Junior-level inquiry. Why the cloud is there and how it got there are questions at least as important to ask as what the cloud is. In fact, the 'how' and 'why' are essential to understand 'what' a cloud really is! In asking the how and why, a student can look at a cloud, isolated in the sky, behaving unlike the other clouds and shaped differently from other clouds, and then ask why it is not moving, why it is shaped as it is, or why it so suddenly disappears.

The questions of how and why these clouds come to form and pass so quickly to clear air are similar to those which Juniors and Seniors ask about the human spirit, as it has existed throughout history, or even in their own lives. Such questions are best considered only when the students have spent some time looking inwardly at the biographies and stories of human beings, as in *Parzival*, or even within themselves, or only after a class discussion or essay about Dante or Faust. A lenticular cloud can be compared with some heroic figure who 'stands his ground' while the others run on 'with the flow.'

Therefore, although lenticular clouds are great candidates to consider at almost any time in the education of a child or young adult, the best time to fully consider the what's, how's and why's of their existence is late in high school.

When and Where to Observe Lenticular Clouds

In any Meteorology or Climate block occurring in places featuring the most likely occurrences of these clouds, planning to witness them is still a hit-or-miss proposition. If a school is located in or very near the mountains, the students will have seen them many times; in places downwind of the mountains, the students may or may not be familiar with them. Because these clouds are associated most often with major weather events, any teacher hoping to observe them during a block should schedule the block for times of the year statistically more likely to produce them. As discussed above, in most mid-latitude locations, late fall to early spring generates the strongest mid-latitude storms with the greatest frequency.

The teacher of a Junior- or Senior-level Atmospheric Science class conducted outside of a mountainous region should not plan to study these clouds as part of a set curriculum. However, if these clouds appear during such a block, the teacher can do well by being flexible. If lee-of-mountain lenticular clouds appear during class, a teacher should be ready to leave the lab for an hour or two and take the students outside for a real treat and a challenge.

PART IV: CONCLUDING COMMENTS

As we have seen above, lenticular clouds are really not the material result of a combination of ingredients. Rather, they are best understood as an on-going process that transforms invisibly fast-moving air into visibly fast-moving air. Although this may strike one as semantics, it is not. When one considers the observation that the lenticular cloud, as seen close-up from the top of Mt. Ellen, acted as a conveyor belt, rather than a bowl over the mountain, one begins to understand that the cloud itself was far more than just the condensed water vapor that the viewer could see. The cloud was moisture in motion that needed to be in exactly the right place at exactly the right time and in the exact right movement conditions to be seen. Beyond 1000 yards laterally from the summit, the air was invisible. Only when the air was moving close to the summit of Mt. Ellen itself did the air become visible. When one considers that the same air that one could not see when it was a mile away, became visible $\frac{3}{4}$ of a mile away, stayed visible directly overhead, and then became again invisible when it was $\frac{3}{4}$ of a mile away on the other side, one can appreciate the transformative quality of what it means to be a cloud.

A number of senses are required to participate in observing a lenticular cloud: One needs to be able to not only see the shape of the cloud, but also the motion within it. One must feel the wind. One may also feel or measure temperature and humidity. It is only when all these are possible to sense that the cloud's shape is apparent to the eye. One may object that the observer saw the spaceship-shaped clouds long before ever witnessing the conveyor belt effect, and that the observer therefore did see the cloud long before the observer saw into its inner qualities. This may be true, but that state of affairs left the observer still wondering what was afoot—knowing that there was something unseen behind the spaceship shapes that were motionless in the high wind. Without sensing the motion and other observations that go into understanding how these clouds come to be visible, one has not fully experienced the cloud as a process.

The same can be said about magnetism or electricity. Although nobody can 'see' either, there are ways to sense their presence. One can feel the attraction or repulsion if one is holding things, such as other magnets or nails,

in the case of magnetism, or pieces of paper or cat hairs, in the case of electricity. One can place a magnet next to a cathode ray tube and watch the 'ray' get deflected. One can sprinkle iron filings on a piece of white paper over a bar magnet and sketch the shapes the shavings make as they seem to line up and loop in special ways about the magnet. Likewise, one can observe sparks or flashes when there are static discharges, or when 2 wires are rubbed together to form a DC circuit. In observing electricity or magnetism, although nobody can see either, one can use one's senses not only to determine whether the phenomenon exists, but also to describe it in terms of size, shape, strength, and character of its influence.

In considering light, although physicists have long called it wave or particle or some combination of these, and have long broken it into colors, wave lengths, and quanta, the fact is that the world of physics has yet to determine what light actually is. The after-images one sees after staring at one place for half-a-minute and then quickly glancing elsewhere lend some credence to Aristotle's idea that light might actually require the participation of the human eye, rather than solely the outside phenomena, to exist. Nobody has ever seen light, but rather things in light's influence.

One can cite scores of examples of such phenomena. To consider any of them sensibly, one must observe them qualitatively. Much has been learned of light, electricity, gravity, magnetism, and other phenomena through qualitative inspection. Mass and matter, however, are usually placed into their own category of 'stuff.' When one has something in one's hand, not only can the object be seen, dropped, and pushed; the object can also be felt as existing within a very definite location. The sharpness of the object's boundaries is quite unlike the fuzzy boundaries of electric, magnetic, gravitational, and light 'fields.' Yet, if one considers the qualitative properties of matter, one can describe them as one might describe the properties of light, electricity, or what-have-you. The great difference which matter has from so many other physical phenomena is that the observer is always looking for 'stuff' to be the end of the inquiry. This sort of thinking has often gotten in the way of sensible, phenomenological, qualitative descriptions of physical phenomena. The idea that there is 'stuff' behind everything stops us from experiencing our relationships to many processes.¹⁷

Clouds are an example of this. Even young children are taught to see a duck or an alligator up there in the sky. Clouds are so often looked at and described as 'things' in the air, or bunches of things—namely, tiny condensed water droplets—that we miss the process and transformation that clouds really are. Clouds are neither living, nor feeling, nor thinking, as are plants, animals, and human beings; nevertheless, they seem to be alive. The examination of lenticular clouds, which reveals their transformative nature, makes this abundantly evident. To reduce them to ducks and faces and clumps of condensed water is to miss utterly what clouds are really about.

In a broad sense, the physical sciences, which so often plunge headlong into material-based solutions to questions, are too often considered separately from the natural and human world, and are too often presented to students as separate from all else. Lenticular clouds are a perfect phenomenon to build interest in the natural world while, at the same time, studying fundamental principles of physics. They represent an excellent opportunity for people, young or old, to grow in their imagination of, and logical consideration of, the physical world as the activities these really are. To recognize and study these out-of-the-lab phenomena is to bring vitality to the sciences.

ENDNOTES

1. The Center for Anthroposophy is housed in Wilton, NH, and runs a 5-week summer program each year for the training of Waldorf teachers and others. Its director is Douglas Gerwin of Amherst, MA; the Physical Sciences instructor is Michael D'Aleo of Saratoga Springs, NY; and the students in the 2005 Physical Sciences class were John Cronin, Hezi Haut, Nathalie Payette, and your humble author. For more information on the Center for Anthroposophy, phone (603) 654-2566, or visit the web site at www.centerforanthroposophy.org.
2. For altitudes, I rely upon 35 years of weather watching, 5 years' experience as an airplane pilot, and 2 years experience as a hang glider pilot.
3. The investigation of many UFO reports shows many of them to be lenticular clouds (not inside the lenticular clouds!) over mountain tops. See, for example, Ahrens, *Meteorology Today*, 2d. Ed. (St. Paul, MN: West Publishing Co., 1982) at p. 195. See also the Appendix to this work for more photos over North America.
4. In this diagram, you will notice a circle with a plus sign inside. This depicts the tail end of an arrow, which is a way to show wind blowing away from you and into the page. To show wind coming out of the page toward you, draw a circle with a point in the center to depict the tip of the arrow.
5. See The Tornado Project, *Tornado Video Classics* (St. Johnsbury, VT: 1996 [ISBN # 7-4345-90016-3-0], Vol. 3, Part 4 (about 60 minutes into the video from the beginning). This tornado occurred on July 18, 1986, in Brooklyn Park, MN, and was photographed by a television reconnaissance helicopter from about a half mile away.
6. See, Jeppesen, *Private Pilot Manual*, 15th ed. (Englewood, CO: Sanderson Training Systems, 1996) at pp. 1–10 to 1–24. This is a very basic discussion of how wings and flaps on airplanes are believed to work. For reasons explained below, this explanation is suspect.
7. See *Tornado Video Classics*, supra, Vol. 3, Part 4. The tornado viewed here occurred at McConnell Air Force Base on April 26, 1991.
8. See Ahrens, *Meteorology Today*, 2d. Ed. (St. Paul: West Publishing Co., 1985), at pp. 194–195. See, also, National Audubon Society, *Field Guide to North American Weather*, (New York: Chanticleer Press, 1991), at pp. 476–481, and plates 136–145. Both briefly discuss why large scale topographic features are believed to be necessary to generate orographic lift sufficient to form lenticular clouds.
9. See, generally, Stephen Edelglass, et al., *The Marriage of Sense and Thought* (Hudson, NY: Lindisfarne Books, 1997), Ch. 4, pp. 72–105.
10. See, Endnote 2.
11. Ibid.
12. Some of the more advanced work in this area has been taken up by the University of North Carolina's Mesoscale and Microscale Meteorology Division. In an October 2000 paper on tropical storm growth and interaction with coastlines, for example, it noted briefly some of the effects of topography on tropical storms, especially as it can give rise to standing waves in the atmosphere above and around the topographic features. As for ancillary cloud development, however, the study said very little. See <http://www.mmm.ucar.edu/statplan.html>, at section 3(a).
13. See, *Meteorology Today*, supra, at pp. 195–197, and at pp. 147–162.
14. See, *Private Pilot Manual*, supra, at pp. 1–19. As noted above, this is a far from settled issue. There is much debate as to whether attenuation of air, viscosity, or even electrostatic effects are what actually causes lift. In a discussion with Michael D'Aleo, it became obvious that the classic explanation of the Bernoulli Principle applies only to cases involving laminar air flow nearly parallel to the affected surface. However, having noted the mostly laminar flow over wing surfaces, as shown by smoke and yarn streamers, it appears that the classical explanation may not be useless in all cases, either. For further discussion, see, N. Smith, "Bernoulli and Newton in Fluid Mechanics," (*Physics Teacher*, Vol. 10, p. 451, 1972); D. Webster, "What Shall We Say about Airplanes" (*American Journal of Physics*, Vol. 15, p. 228, 1947).
15. For a very basic discussion of the gas laws, see, Arthur Beiser, *Physics*, 5th ed. (Reading, MA: Addison-Wesley Publishing Co., 1992) at pp. 357–362. For a more

- in-depth discussion, see, Halliday, *Fundamentals of Physics Extended*, 5th ed. (New York, John Wiley & Sons, Inc., 1997) at pp. 485–489. Any number of college physics and chemistry texts contain similar coverage of this material.
16. This demonstration was inspired by a simpler one discussed in Craig Bohren, *Clouds in a Glass of Beer* (New York: John Wiley & Sons, Inc., 1987), at pp. 8–9. The addition of the thermometer and the particulars of when things happen have come through my own experimentation.
 17. See Endnote 1. This discussion is derived partially from a July 15, 2005, discussion the 3rd-year science class had regarding a draft of this paper, as relates to the nature of matter. Scientists mentioned in that discussion included John Dalton on atoms, William Crux on the cathode ray tube, J. J. Thompson on the deflection of cathode ‘rays’ by electricity or magnetism, Ernst Rutherford, Niels Bohr, De Broglie and Heisenberg on particle-wave duality, and Schroedinger on probabilities. Much of the biographical material had been brought in class the day before by Michael D’Aleo. The discussion also focused on Rudolf Steiner’s idea, presented in a December 16, 1904, lecture, that matter is the appearance of some underlying phenomenon, just as the lenticular cloud is the appearance of underlying wind and moisture. See, also, Rudolf Steiner, *The Light Course* (Great Barrington, MA: Anthroposophic Press, 1964, translated, 2001), especially Lecture 9, pp. 138–154.

BIBLIOGRAPHY

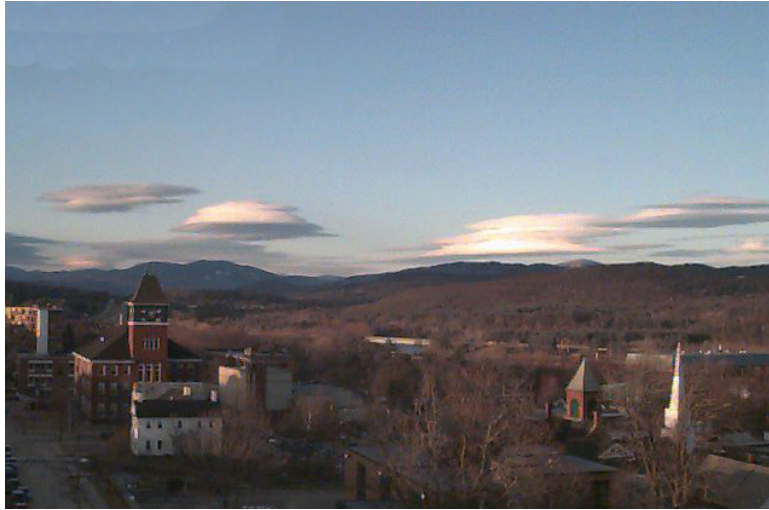
- Ahrens. *Meteorology Today*, 2d. Ed., (St. Paul, MN: West Publishing Co., 1982).
- Beiser, Arthur. *Physics*, 5th Ed., (Reading, MA: Addison-Wesley Publishing Co., 1992).
- Bohren, Craig. *Clouds in a Glass of Beer*, (New York: & Sons, Inc., 1987).
- Edelglass, Stephen, et al. *The Marriage of Sense and Thought* (Hudson, NY: Lindisfarne Books, 1997).
- Halliday, et al. *Fundamentals of Physics Extended*, 5th Ed. (New York: John Wiley & Sons, Inc., 1997).
- Jeppesen. *Private Pilot Manual*, 15th Ed. (Englewood, CO: Sanderson Training Systems, 1996).
- National Audubon Society. *Field Guide to North American Weather* (New York: Chanticleer Press, 1991).
- Smith, N. “Bernoulli and Newton in Fluid Mechanics” (*Physics Teacher*, Vol. 10, 1972).
- The Tornado Project. *Tornado Video Classics*, Vol. 3 (St. Johnsbury, VT: 1996 [ISBN # 7-4345-90016-3-0]).
- University of North Carolina. *Mesoscale and Microscale Meteorology Division* (Chapel Hill: see, <http://www.mmm.ucar.edu/statplan.html>, 2000).
- Webster, D. “What Shall We Say about Airplanes?” (*American Journal of Physics*, Vol. 15, 1947).

Internet Sites

- Bruce Barnbaum. <http://www.afterimagegallery.com>
- Crystalinks. <http://www.crystalinks.com/lenticular.html> (Photos by Jeff Hansen, Bill Towrie, and Thedra.)
- Plymouth State College. <http://vortex.plymouth.edu/lenticular3.html> (Photos by Jay Shafer and James Rufo) and: <http://www.millville.org> (Cloud boutique).
- Mt. Washington Observatory, NH: <http://www.weathernotebook.org> (Photos and comments by Dave Thurlow, observer).

APPENDIX

The following are reprints of lenticular cloud photos found on the internet. Most were taken in mountainous environments. I have included these rather than my own, as I am not a photographer and have been unable to capture images of these clouds in anywhere near the quality of those shown here. I have left the internet locations on the sheets to facilitate the reader's accessing the same and other photos. In all cases, the photographer's name or the project name appears for your reference.



Appendix #1 – Lenticular clouds over Plymouth, NH



Appendix #2 – Lenticular cloud over Mount Washington, NH



Appendix #3 – Lenticular cloud hovering over a mountain



Appendix #4 – Lenticular cloud over Hawaii



Appendix #5 – Lenticular cloud



Appendix #6 – Lenticular cloud over Estes Park, CO



Appendix #7 – Lenticular cloud over Mount Ranier



Appendix #8 – Lenticular cloud over Hawaii

BUMBLEBEES AND WARMTH

Bumblebees prefer warm flowers —perhaps to help them maintain their body temperature—and use color to predict the temperature before landing, according to a report published in *Nature* in August 2006. Pollinators, including bumblebees (*Bombus terrestris*), have long been known to use colors as indicators of nutritional rewards, but the scientists now suggest plants may also adapt their temperature to attract pollinators.

Lars Chittka of the University of London

and colleagues at Cambridge University exposed bees to artificial flowers of two different colors, one at a warmer temperature than the other, but each offering the same sugary reward. Chittka said the tests showed the bees learned to identify warmer flowers by their colors. The team believes its findings may have implications for the evolution of floral structures and also for understanding the connection between sensory cues and pollinator behavior.



A thermal image shows a bumblebee on a flower.

SENSIBLE SCIENCE WORKSHOP

by

Bob Amis

As Waldorf school class teachers, we strive to fulfill in our own classrooms the potentialities of Rudolf Steiner's vision. 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, the Research Institute for Waldorf Education, at the request of the AWSNA Delegates and together with Michael D'Aleo, high school science teacher at the Waldorf School of Saratoga Springs, co-founder of SENSRI (Saratoga Experiential Natural Science Research Institute) 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 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 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 D'Aleo. 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, e.g., the Necker

cube, that can be seen in multiple ways, and other images that may at appear first 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 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 completed 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

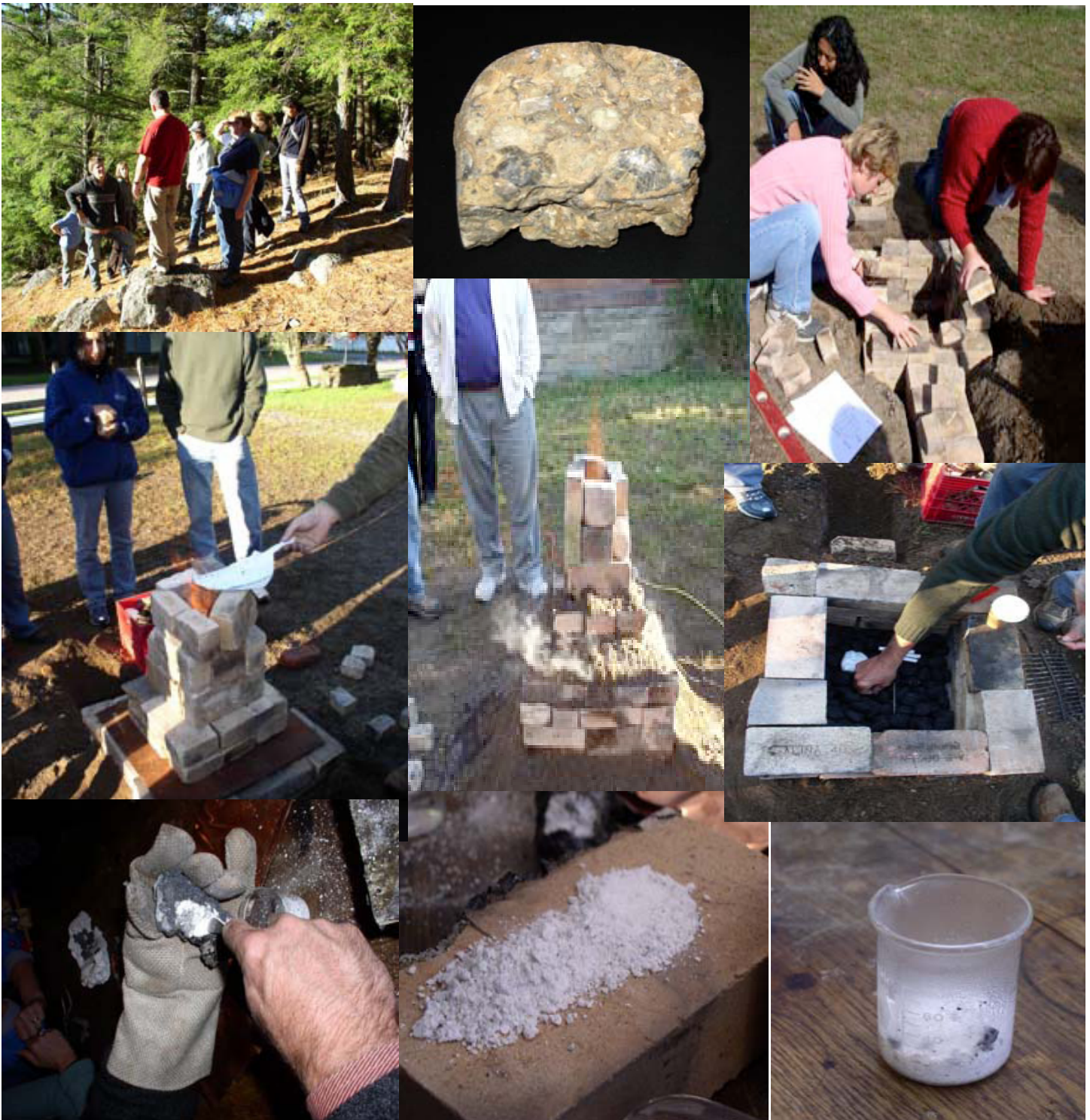
environmental problems. Then, as so often happened, Richardson provided us with the perfect passage, this one from Steiner's "The Michael Mystery," and with it an abiding image for our time together:

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 the Research Institute at researchinstitute@earthlink.net.

FROM LIMESTONE IN THE FIELD TO THE KILN, QUICKLIME, AND MORTAR



SCIENCE HUMOR

Actual Responses from Children to Test Questions

Q: Name the four seasons.

A: Salt, pepper, mustard and vinegar.

Q: Explain one of the processes by which water can be made safe to drink.

A: Flirtation makes water safe to drink because it removes large pollutants like grit, sand, dead sheep, and canoeists.

Q: How is dew formed?

A: The sun shines down on the leaves and makes them perspire.

Q: How can you delay milk turning sour?

A: Keep it in the cow.

Q: What are steroids?

A: Things for keeping carpets still on the stairs.

Q: What happens to your body as you age?

A: When you get old, so do your bowels and you get inter-continental.

Q: What happens to a boy when he reaches puberty?

A: He says good-bye to his boyhood and looks forward to his adultery.

Q: How are the main parts of the body categorized (e.g., abdomen)?

A: The body is consisted into three parts—the brainium, the borax and the abdominal cavity. The brainium contains the brain; the borax contains the heart and lungs, and the abdominal cavity contains the five bowels A, E, I, O, and U.

Q: What is a fibula?

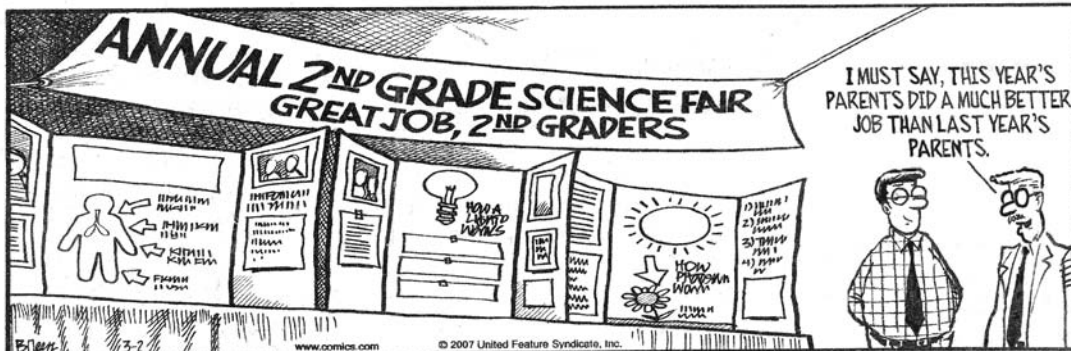
A: A small lie.

Q: What does “varicose” mean?

A: Nearby.

GRAND AVENUE

Steve Breen



Results from a Survey on COMPUTER CURRICULA IN U.S. WALDORF SCHOOLS

by

Jamie York

Winter 2006

Background

In the Fall of 2005, the College of Teachers at Shining Mountain Waldorf School asked me to find out what other Waldorf schools in the country had for a computer curriculum. This was part of our first review of our new computer curriculum. I decided to survey (via e-mail) the various Waldorf high schools in the United States in order to gather the information.

Method

The survey consisted of six short questions. Most of those who responded did so via e-mail. A few of the responses (Washington, Kimberton, San Francisco) I typed in after a brief phone or e-mail conversation. The completed surveys are attached at the end of this report.

Participation

Fourteen Waldorf high schools in the country responded. These schools were: Saratoga Springs, High Mowing (Wilton, NH), Santa Fe, Ann Arbor, Austin, Rudolf Steiner (NYC), Sacramento, Shining Mountain (Boulder, CO), Kimberton, Washington, Green Meadow (NY), Massachusetts Bay, San Francisco, Chicago.

Summary of Results (Note that 14 schools responded to the survey)

- Number of schools having no required computer courses: 5
- Number of schools having at least one required computer course: 9
- Number of schools offering at least three computer courses: 5
- Number of schools having a keyboarding (typing) course: 5
- Number of schools having an intro to computers/applications course: 4
- Number of schools having a circuits course: 7
- Number of schools having a programming course: 3
- Number of schools having a film/graphics course: 3
- Number of schools having a web design/internet course: 4
- Number of schools having a “media” course: 4
- Number of schools having a course with a man & machine theme: 2
- Number of schools having a dedicated computer lab: 6
- Number of schools reporting that they use a mobile stock of laptops: 3

Some of My Reflections

- Several Waldorf high schools in this country, if not most of them, are struggling with what to do about computers. What is offered varies greatly. Some schools have a relatively mainstream offering of computer courses; other schools’ computer courses are very “Waldorf.”
- In total six schools responding have a fairly well developed curriculum. But even with most of these schools I get a sense that their computer curriculum is in flux; next year’s offerings may be completely different than this year’s. And this seems to have less to do with the rapidly changing technology and more to with the school’s struggle to figure out how computers fit into a Waldorf school setting.

- Of these, only three (High Mowing, Ann Arbor, and Austin) require more than 40 classroom hours of computer study (which is about as much as two main lessons and a bit less than having one course that meets four times per week for a semester). The Austin Waldorf School has the most offerings with 9 required courses totaling about 180 classroom hours.
- Two schools (Steiner School in New York and Saratoga Springs) have found quite creative ways to work their computer curriculum into their school schedule without it taking up a great deal of classroom time.

Resources

- Bryan Whittle (from Saragota Springs) has written a paper on a computer curriculum which can be found at www.waldorflibrary.org/pg/research/research.asp. Also in February 2002 ASWNA's David Mitchell organized a three-day computer colloquium. The transcript from this colloquium is titled "Colloquium on the Computer and Information Technology" and can be found at www.waldorflibrary.org. John Kirkilis runs the digital arts program in Austin and can be contacted at john@austinwaldorf.org for more info. Cedar Oliver (High Mowing) has a paper on digital arts posted at <http://24hourhtmlcafe.com/cedar>.

1. Name of school: **Waldorf School of Saratoga Springs**

2. Name of person filling out survey: Bryan Whittle

3. Does your school offer any computer courses? Yes

4. a) Name of course: **Computing Machines**

b) Theme and topics of the course:

Themes: (1) show how computing machines have evolved, (2) show how the relationship between people and computing machines has evolved, and (3) give insight into modern machines.

Course description (this year): We made ancient style abaci from clay; 16th century Napier's rods from wood; 18th century human computing teams, using division of labor to "manufacture" numbers; a 19th century Morse code signaling circuit to introduce binary systems; 19th century Boolean functions of AND, OR, and NOT using first batteries with light bulbs and then transistor circuits; plus a 20th century transistor-based adder. We learned to operate each device, characterized its computational advantage, and identified its limitations. Last we took a tour of personal computer subsystems, guided by what we had learned so far. By comparing machines in transparency of operation, power of operation, and extent of human delegation we were able to see into historical trends in the relationship between people and computing machines.

c) Grade level of students taking the course: 10th

d) Is the course required or an elective? Required part of practical arts.

e) How often and for how long does the course meet? 2 double periods for 6 weeks.

f) Has the course been successful? In what way? Making working instruments seems satisfying. The social side of human computing teams and Morse code signaling is enjoyed. The circuits become very difficult for some to follow – per my AWSNA curriculum I see 11th grade as a better match but we cannot fit that into our curriculum. Out of this progression through simpler machines the students seem to come to appreciate the power, inscrutability, limitations, and extent of human dependence on modern computers.

a) Name of course: **Computing and Human Evolution**

b) Theme and topics of the course:

Course description (last year): A motif of this senior year has been to look for a synthesis of all that has been experienced by the students up to this point, both individually and throughout humanity, and to catch glimpses of the future of their own lives and that of civilization. We combined elements of computer science and human biological evolution in order to explore important questions about our future while being grounded in both individual areas. We examined several aspects of how technological advancements increasingly blur the boundary between humans and machines. From computer science we experienced examples of "intelligence" exhibited by contemporary computing machines, individually developed and analyzed an algorithm as the basis for such intelligence, and individually coded a "poetry maker" in Microsoft Q Basic programming language. From the biological side, we studied the basic processes involved

in evolution, the DNA genetic code, the record of human brain capacity, and human-machine prosthetic interfaces. The two sides were interwoven such as when exploring “life-like” evolutionary algorithms with a visiting practitioner and when assessing the differential fitness of computing machines and human intelligence for diverse tasks. The course concluded with an essay as an opportunity for a personal synthesis of thoughts on computing and human evolution.

- c) Grade level of students taking the course: 12th
 - d) Is the course required or an elective? Required.
 - e) How often and for how long does the course meet? 4 single periods for 6 weeks.
 - f) Has the course been successful? In what way? The students are interested in the Turing Test and concrete exercises where the human-machine distinction is difficult to make; they are also interested in judgment calls concerning what combination of person and machine can and should be used for a task. The students find designing an algorithm and then “making it work” through programming satisfying. The students find the computing-biology combination intriguing; I would say they are genuinely interested in how information technology, genetic engineering, and nanotechnology can be combined to create new possibilities.
 - g) Is the instructor of the course a full-time teacher? Yes.
5. Does your school have a dedicated computer lab? No.
6. Other comments about your computer curriculum: These two courses are based on a computing curriculum developed by Bryan Whittle. A 60-page two part paper is available in electronic form from <http://www.waldorflibrary.org/pg/research/research.asp> and print-on-demand form from the Association of Waldorf Schools of North America. The biological evolution component is added by our life sciences teacher.

1. Name of school: **Rudolf Steiner School of Ann Arbor**

2. Name of person filling out survey: Alex Perrin

3. Does your school offer any computer courses? Yes

4. a) Name of course: **Typing**

b) Theme and topics of the course: Mavis Beacon Typing software

c) Grade level of students taking the course: 9

d) Is the course required or an elective? Required

e) How often and for how long does the course meet? 3x/week for 1st quarter

f) Has the course been successful? In what way? Yes, it teaches students to type

g) Is the instructor of the course a full-time teacher? No

a) Name of course: **Introduction to Computers**

b) Theme and topics of the course: Windows, Word & Excel

c) Grade level of students taking the course: 9

d) Is the course required or an elective? R

e) How often and for how long does the course meet? 3x/week for 2nd quarter

f) Has the course been successful? In what way?

So far. The students acquire basic computer skills.

g) Is the instructor of the course a full-time teacher? N

a) Name of course: **Intro to Computer Science**

b) Theme and topics of the course: How computers work: Systems & Algorithms, Binary numbers and logic circuits.

c) Grade level of students taking the course: 11

d) Is the course required or an elective? R

e) How often and for how long does the course meet? 3x/week for 1st quarter

- f) Has the course been successful? In what way? Hard to say. Very challenging course taught at a college level. Students learned difficult material, but its applicability is questionable.
 - g) Is the instructor of the course a full-time teacher? N
- a) Name of course: **Intro to Computer Programming**
 - b) Theme and topics of the course: Programming in HTML and Javascript
 - c) Grade level of students taking the course: 10
 - d) Is the course required or an elective? R
 - e) How often and for how long does the course meet? 3x/week for 2nd quarter
 - f) Has the course been successful? In what way? Don't know yet -- in process.
 - g) Is the instructor of the course a full-time teacher? N
- a) Name of course: **Intro to the Internet**
 - b) Theme and topics of the course: Internet exploration, discussion, Web page construction.(may change)
 - c) Grade level of students taking the course: 12
 - d) Is the course required or an elective? R
 - e) How often and for how long does the course meet? 3x/week for 3rd quarter
 - f) Has the course been successful? In what way? Not sure, not yet begun.
 - g) Is the instructor of the course a full-time teacher? N
- 5. Does your school have a dedicated computer lab? Yes
 - 6. Other comments about your computer curriculum: It will be reviewed and evaluated in detail this year. Maintaining the computer lab is difficult because of the expense and there are significant concerns with this.
-

- 1. Name of school: **High Mowing School**
- 2. Name of person filling out survey: Dick "Cedar" Oliver
- 3. Does your school offer any computer courses? We don't call them that, but we offer courses where computers are often used.
- 4. If yes to #3, then for each course please give the following information: NOTE THAT SOME DIFFERENT COURSES ARE OFFERED EACH YEAR DEPENDING ON THE NEEDS AND INTERESTS OF STUDENTS ENROLLED AT THAT TIME.
 - a) Name of course: **Media Literacy**
 - b) Theme and topics of the course: Basic media communication skills, awareness of media culture and economy
 - c) Grade level of students taking the course: 9th
 - d) Is the course required or an elective? required
 - e) How often and for how long does the course meet? one semester, 2 to 3 one-hour sessions per week
 - f) Has the course been successful? In what way? This was the first year. It convinced me to revise it but definitely offer it again.
 - g) Is the instructor of the course a full-time teacher? yes
 - a) Name of course: **Information Technology**
 - b) Theme and topics of the course: Wiring logic gates, memory, how a microprocessor works
 - c) Grade level of students taking the course: 10th
 - d) Is the course required or an elective? required main lesson block
 - e) How often and for how long does the course meet? 1.5 hours five days a week for three or four weeks
 - f) Has the course been successful? In what way? Yes, though it is very challenging for some students
 - g) Is the instructor of the course a full-time teacher? yes
 - a) Name of course: **Modern Math & Logic**
 - b) Theme and topics of the course: 20th century math, with an emphasis on mathematical logic and fractal geometry/chaos theory

- c) Grade level of students taking the course: 12th
 - d) Is the course required or an elective? required
 - e) How often and for how long does the course meet? 1.5 hours five days a week for three or four weeks
 - f) Has the course been successful? In what way? Yes, though I do it differently every year to meet the specific senior class. Includes historical origins of the computer as an idea.
 - g) Is the instructor of the course a full-time teacher? yes
-
- a) Name of course: **Research Science & Engineering**
 - b) Theme and topics of the course: Experimental lab science and technology engineering projects designed and built by students (many projects—not all—involve use of computers)
 - c) Grade level of students taking the course: 11th and 12th
 - d) Is the course required or an elective? elective
 - e) How often and for how long does the course meet? 2 to 3 one- or two-hour sessions per week. Can be taken for a semester or a year
 - f) Has the course been successful? In what way? This specific course is new this year, but we offer similar courses every year
 - g) Is the instructor of the course a full-time teacher? yes
-
- a) Name of course: **Filmmaking (beginner and advanced levels)**
 - b) Theme and topics of the course: Scriptwriting, production and editing of digital films
 - c) Grade level of students taking the course: 9th through 12th
 - d) Is the course required or an elective? elective
 - e) How often and for how long does the course meet? 2 to 3 one- or two-hour sessions per week. Can be taken for a semester or a year
 - f) Has the course been successful? In what way? Yes. This extremely popular course deepens many skills, especially the sense of timing.
 - g) Is the instructor of the course a full-time teacher? yes
-
- a) Name of course: **Graphics (beginner and advanced levels)**
 - b) Theme and topics of the course: Digital photography, graphics design, animation, some graphics programming
 - c) Grade level of students taking the course: 9th through 12th
 - d) Is the course required or an elective? elective
 - e) How often and for how long does the course meet? 2 to 3 one- or two-hour sessions per week. Can be taken for a semester or a year
 - f) Has the course been successful? In what way? Yes. This very popular course is tailored to the group and individual developmental needs
 - g) Is the instructor of the course a full-time teacher? yes
5. Does your school have a dedicated computer lab? We have a block-sized classroom also equipped with 13 networked workstations and audiovisual equipment
 6. Other comments about your computer curriculum: We intentionally don't have a "computer curriculum" other than the one Information Technology block. We do have a strong media and communications curriculum that is integrated with our traditional arts programs. For example, we teach traditional black-and-white chemical photography and also digital photography. We teach both stage acting and film acting (sometimes together in one course, sometimes separately). Computers are also used quite heavily in our science & engineering tracks and senior math block, though the point of these classes isn't to teach "computers" but to learn about subjects where information technology is necessary or helpful.
-

1. Name of school: **Santa Fe Waldorf High School**
2. Name of person filling out survey: Greg Shultz
3. Does your school offer any computer courses? Yes.
4. If yes to #3, then for each course please give the following information:
 - a) Name of course: **Keyboarding**
 - b) Theme and topics of the course: By the beginning of 10th grade students should be able to touch-type a computer keyboard. A good program for this is the Mavis Beacon typing course that operates right on the computer. Use of this program can begin in 9th grade or during the summer between 9th and 10th grades.
 - c) Grade level of students taking the course: 9
 - d) Is the course required or an elective? Required by the English Department.
 - e) How often and for how long does the course meet? Students use the Mavis Beacon typing application during the summer between 9th and 10th grades.
 - f) Has the course been successful? In what way? Yes. All students have learned to touch-type on the keyboard.
 - g) Is the instructor of the course a full-time teacher? Yes. She's a full-time English teacher.
- a) Name of course: **Using the Personal Computer**
- b) Theme and topics of the course: Most students either have their own personal computer or have access to their parents' PC or one at the school. Windows XP and Apple OSX are now quite similar in many of their basic desktop and file organizing features; students can learn to use either environment and acquire similar skills. The most commonly used application on the computer is a word processing application, and of these, Microsoft Word is the most widely used. Microsoft Word is available for both the Windows and Apple operating systems. The current versions of Word, when run on the current Windows or Apple operating system, do not require translation from one operating system to another. This means the current version of Word for Windows functions nearly identically to the current version of Word for the Mac, and students may use either version with equal results. This particular course shows students how to manage their desktop and filing system, name and save files, send and receive e-mails with attachments, save files to media (hard drives, Zip discs, floppy disks, CDs, etc.), print documents, and use Microsoft Word for their word processing needs. Students will also learn how to care for their equipment (laptop, media, printer, etc.) and protect their computer from malware (viruses, adware, etc.), bugs, spam, and disk problems, and other maladies.
- c) Grade level of students taking the course: 10
- d) Is the course required or an elective? It has not yet been offered, but when it is it will be required.
- e) How often and for how long does the course meet? We haven't worked this out yet.
- f) Has the course been successful? In what way? N/A
- g) Is the instructor of the course a full-time teacher? We don't know yet who will teach this course, but we have several candidates.
- a) Name of course: **Logic Gates and Computing**
- b) Theme and topics of the course: Students are now fairly familiar with the use of their PC's desktop and operating system, saving to removable media, using a word processing application, e-mailing attachments, and printing documents. Now the students learn about the binary logic behind their computer. Students examine the properties of logic and its application in performing calculations, particularly those involving the use of binary numbers. If...then... propositions using not, and, or, and other operands are explored mathematically and by using physical devices to carry out operations using these logical expressions. Among these are water flows, electrical relays, and transistors (integrated circuits). Truth tables and circuit diagrams are used to develop logic gates using integrated circuits to perform simple binary operations. From this a half adder is constructed, and then an adder. The course ends with an overview of how these principles and materials are used to create computers.
- c) Grade level of students taking the course: 11
- d) Is the course required or an elective? Elective
- e) How often and for how long does the course meet? Four 90-minute periods per week (afternoons) for three weeks.
- f) Has the course been successful? In what way? Yes, it was. The students were amazed that in the end they

had constructed a simple computational device, and yet this represented but a minute fraction of what takes place in the CPU of a personal computer. They could compare a half adder built from electrical relays—large and clumsy but very visual with enjoyable clicking sounds—to one built from transistors—now much smaller and elegant but devoid of any sensory content—to one built from integrated circuits, which showed the progression away from sense-experience to purely conceptual experience. We also made a binary adder using running water to help us see that electricity is not the only thing one can use to construct logic gates. With more time, we could have built logic gates from Lego's, as well, showing a mechanical perspective.

g) Is the instructor of the course a full-time teacher? Yes. I taught this course, and am a full-time math and science teacher.

a) Name of course: **Computer Languages**

b) Theme and topics of the course: Building on the students' knowledge of computer use and binary computing, they begin to learn about computer programming languages. After an overview, students begin to learn Java, which is the language currently recommended and in use by most high schools. Students examine the properties of the codified languages employed to program a computer at the level of the operating system and in the writing and compiling of applications. The interrelationships between hardware and software are explored. A computer programming language (Java) is studied and applied to the development of one or more applications; students learn to use debugging techniques.

c) Grade level of students taking the course: 12

d) Is the course required or an elective? Elective

e) This course has not yet been offered, nor have we identified anyone to teach it.

5. Does your school have a dedicated computer lab? No. Every time we get ready to plan one, the technology progresses, especially with wireless and broadband connectivity, CPU development (Apple's plan to use Intel chips), OS development (Windows' new OS that we haven't seen yet), and security, both with students as well as with the Internet. We think one more year of development will bring out the new systems, which will, of course, continue to progress, but we will set up anyway.

6. Other comments about your computer curriculum: The 9th and 10th grade courses are practical courses for how to properly use the personal computer. Many students have problems using their computers: losing files in the chaos of their desktop; not attaching files in e-mails; having no idea how to back-up data or burn it to a disk; etc. The whole question of students using computers to compose and print assignments and the parallel problem of plagiarism off the Internet remain as living questions with the faculty.

The 11th and 12th grade courses are computer technology courses. The grade 11 course on logic gates and computing develops the topics from the ground up, so to speak, by working from logic itself, then to truth tables and logic gates, and from there to the wedding of logic gates to binary math to create computational devices. This process leads the students through the phenomenology and concepts to the paradigm or gestalt of computing with logic gates. The intention of the grade 12 course is to introduce students to computer languages as the software equivalent of how we examined the hardware equivalent in grade 11.

1. Name of school: **Austin Waldorf School**

2. Name of person filling out survey: John Kirkilis

3. Does your school offer any computer courses? Yes

4. If yes to #3, then for each course please give the following information: see Additional Pages

5. Does your school have a dedicated computer lab? Yes

6. Other comments about your computer curriculum:

- When our high school began in the Fall of 2000, our fledgling computer curriculum was taught by our very capable math teacher. As we started to fill each grade, it became clear that his math teaching load would not allow him to deliver the computer classes. The high school chair convened a meeting at a local restaurant with school parents in the high-tech community and asked what it would take to create a "state-of-the-art" computing curriculum that resonated both with Waldorf pedagogy as well as Austin's high-tech demographic. One of the parents just so happened to be a VP at Dell and put down the money

to start the process including a part-time salary for a computer teacher for 2 years, new computers, and an endowment to keep up with ongoing expenses. If the high school chair hadn't called that restaurant meeting and laid out a bold challenge, we would most likely be nowhere near where we are today.

- The first two teachers we hired were total disasters. I was in the midst of taking a year off to consider what I wanted to do with the second half of my professional life, after having worked for 20 years in the software industry. The same high school chair found a way to bring me in as a full-time employee by having me serve as the school's systems administrator as well. We've since outsourced that role now that I have a full-time teaching load. The school absorbed the teacher's salary into the operating budget after the first two years.
- Our Eurythmy instructors work with a maximum of 15 high school students in any one period, which also happens to be the current capacity of the computer lab (825 sq ft). While half a class is taking Eurythmy, the other half is in computer class twice a week for 45 minutes. It can be difficult to maintain momentum when meeting only twice a week for a single period, which is why I'm experimenting with web-based collaboration software so I can maintain an ongoing dialogue with my students between classes. This year, we also started to require that our 10th graders install our Java IDE on their home computer so that they can practice their programming skills through homework outside of class. I also have a hope that it will supplant some of their mindlessly recreational uses of their home computers, not the least of which is MySpace.
- Another important step in creating room in the daily schedule for computer classes was to jettison all study halls except for 9th grade. We found that a very small percentage of students actually used them productively. No other pedagogical program had to suffer to make room for the computer curriculum. The final scheduling piece fell into place when we started offering electives, one in the fall and one in the spring, which allowed for special topics to be offered and which met for 90-minute periods instead of 45.
- Although I've been teaching now for five years and sent my daughter to AWS for twelve, I am not a trained high school Waldorf teacher with certification. I've attended study groups and done some of my own reading, but I cannot yet wax esoteric about my subject area, which somehow reassures some of the nervous parents who work in engineering fields. I spent 20 years in the corporate high-tech arena, so I tend to speak their language.
- To determine which topics belonged in which grade, I relied upon the general themes of each high school grade. Ninth grade focuses on polarity, so information theory and digital circuits were a natural fit. Tenth grade's theme is process & relationships - how things work, so computer architecture and programming were a great fit. Identity is the theme of 11th grade, so digital self-portraits provided a surprisingly introspective way for students to present themselves. I've had to put constraints on the portrait project to keep the boys from avoiding the honest introspection. You can view some of these portraits at <http://www.awslab.org/coppermine>. Twelfth grade's theme is World Consciousness, so taking on an issue in the community and publishing a study through a variety of media seemed relevant. Conversely, we also explore how mass media tries to target the students' demographic.
- In the Austin area at least, there's a misconception that a Waldorf school is a "hippie art school". Having a comprehensive computer curriculum and a dedicated up-to-date computer lab and science lab helps offset that myth in an easily discernible manner. There's also the issue of retaining top students interested in technical fields. We have magnet schools in Austin that can be very attractive to students and parents who think that specialization even at the high school level is what they need. A tangibly strong computer, math and science curriculum can help mollify that knee-jerk desire. We all know that it's not about the gear. The ability to inspire and enlighten in a heart-warming manner doesn't have anything to do with hardware, but it doesn't hurt from a pure marketing perspective. (Is my corporate slip showing?)
- Integrating a comprehensive computer curriculum into a Waldorf High School is not a straightforward matter. The Waldorf pedagogy and the established courses of study are the clear priority. In the allotment of class time that's been devoted to the computer curriculum, we've tried to provide the students with a wide variety of learning experiences in the use of digital technologies and which also reinforce the pedagogical themes of each grade. The goal is to help students marshal their ability to think creatively, critically, and mindfully and we see that it's the task of our Digital Arts & Sciences curriculum to help students create a healthy working relationship with digital technologies that can support them

in their noble pursuits; in other words... the application of good taste, good judgment and appropriate technology in the fulfillment of good deeds.

Computer Lab Infrastructure

Shared

- Color Laser Printer, Photo Quality Inkjet (up to 13x19" prints), Scanner, LCD Projector
- File Server with accounts for each student
- Gigabit Ethernet & Wireless Access in the lab, fiber-optic between buildings
- 2 TB Digital Video Storage
- Lab Management Software to clone drives over the network, blank screens, disable keyboards, disable Internet access, broadcast teacher or any workstation display to all other workstations

15 student workstations

- 2.6 - 3.0 GHz IBM Think Centre Towers (donated by a parent working at IBM)
 - 17" to 19" flat panels and 20" CRT Displays (most donated by a parent)
- Over this coming summer, the uBuntu Linux distribution will be installed on all workstations in a dual-boot configuration. A migration to open source software will take place over the coming year so students aren't raised in a monoculture of one vendor's products.
 - The high school sponsored a computer/electronics recycling drive and collected over 3 tons of equipment. This provided an opportunity for the students to become aware of the full life-cycle of manufactured products and the toxic substances that are commonly used in CRTs, plastic cases, and PCBs.
 - The lab now has its own hosted web presence to keep it separate from the school's web hosting service. The open source online learning platform, Moodle, has been deployed on this site to support online collaboration between teacher and student outside of the classroom for all Digital Arts & Sciences blocks.
 - One full-time faculty member is devoted solely to delivering the Digital Arts & Sciences program.
 - Typing Instruction is provided by the school using a web-hosted service from TypingMaster.com. After an initial 45 minute orientation, students are expected to attain a minimum level of proficiency (25 accurate words per minute) on their own time as a graduation requirement. The service can be accessed from the students' homes or any Internet-connected computer. We used to offer it as a class, but found that there was little that Waldorf pedagogy could bring to the skill of typing and that we should better leverage our time. We also made a conscious decision to stay away from videogame-like typing software such as Mavis Beacon and most others.

a) Name of course: **Foundations of Digital Communication and Computation**

b) Theme and topics of the course: Theme: Polarity, Question: WHAT?

Part One: Study the basics of Claude Shannon's Information Theory and learn why the polarity of the binary number system emerged as the foundation of digital communication and computation, and why the encoding and decoding of information can be viewed as the basis for all communication from prehistoric times to the present. We studied encoding schemes, checksums, lossy vs. lossless compression, and encryption.

Part Two: Explore the difference between reality, an analog representation of that reality, and finally a digitized representation by using the phenomenon of sound as the focus. The entire analog to digital process is covered including quantization, sample rate, resolution and channelization.

Part Three: Boolean Algebra, logical vs. physical circuit diagrams. Review basic logic operations taught in 9th grade math class (AND, OR, NOT) and add XOR, BUFFER, NAND, NOR, and XNOR operations. The students design, build and test digital circuits to compare and add numbers using digital logic lab kits.

c) Grade level of students taking the course: 9th Grade

d) Is the course required or an elective? Required

e) How often and for how long does the course meet? Taught as a skills class (not main lesson), one semester (16 weeks), two 45-minute periods per week

f) Has the course been successful? In what way? Yes

- g) Is the instructor of the course a full-time teacher? Yes
- a) Name of course: **Computer Programming**
- b) Theme and topics of the course: Process, Parts, Relationships
 Robotic role-play group exercise to discover the need for and benefit of variables, functions, parameters, conditional statements and looping constructs. Object-oriented Programming with Java. Modeling classes of objects by analyzing their attributes and actions. Initial foray revolves around graphics programming while the majority of the semester uses robotics as the programming focus.
- c) Grade level of students taking the course: 10th Grade
- d) Is the course required or an elective? Required
- e) How often and for how long does the course meet? Taught as a skills class (not main lesson), one semester (16 weeks); two 45-minute periods per week
- f) Has the course been successful? In what way? Yes
- g) Is the instructor of the course a full-time teacher? Yes
- a) Name of course: **Computer Architecture**
- b) Theme and topics of the course: Process, Parts, Relationships, Question: HOW?
 Part One: Disassemble a PC and all of its constituent components providing opportunities to understand the speed vs. cost vs. capacity trade-offs amongst various storage media and how step-down transformers, optics, motors and electromagnetism are harnessed to produce a machine which is capable of carrying out a wide variety of tasks
 Part Two: Write simple assembly language programs using a computer simulator with a pedagogically-driven instruction set. Students learn how to use conditional branching and repetitive loops. Students learn how the arithmetic logic unit, program counter, instruction register, accumulator, mux, decoder and RAM are conparticipate in the orchestrated fetch-increment-decode-execute cycle of a CPU. We've received permission from the authors to take their Java source and enhance the CPU simulator to fit our needs.
- c) Grade level of students taking the course: 10th Grade
- d) Is the course required or an elective? Required
- e) How often and for how long does the course meet? Taught as a skills class (not main lesson), one semester (16 weeks); two 45-minute periods per week
- f) Has the course been successful? In what way? Yes
- g) Is the instructor of the course a full-time teacher? Yes
- a) Name of course: **Digital Imagery**
- b) Theme and topics of the course: Identity: Questions: WHO?
 During the digital imagery topic, students are introduced to the foundations of bitmap images and learn how visual images are represented using various color models ultimately encoded in binary numbers. Students learn how resolution, bit depth, and image size influence the final image. Once the key concepts were studied, the lab portion of the block focused on learning how to use Adobe Photoshop to alter existing images and finally how to create an original composition. For the final project, each student is asked to leverage their artistic sensibilities to create an introspective digital self-portrait.
- c) Grade level of students taking the course: 11th Grade
- d) Is the course required or an elective? Required
- e) How often and for how long does the course meet? Taught as a skills class (not main lesson), one semester (16 weeks); two 45-minute periods per week
- f) Has the course been successful? In what way? Yes
- g) Is the instructor of the course a full-time teacher? Yes
- a) Name of course: **Digital Networks and Applications**
- b) Theme and topics of the course: Research everything that happens from the time a link is pressed on a web page until the page appears on their display, including the role of switches, routers, protocols such as HTTP, TCP, IP, and finally to the physical layer where the rubber hits the road in the form of electronic, fiber-optic, or wireless pathways. Geographical Trace Routes are employed to plot the path of a web request across the Internet. Backbone bandwidth capacities of major providers are plotted and analyzed.

Students use vector-based drawing software to create block diagrams of computer networks. In contrast to bit-mapped images, students learn how to work with object-oriented graphics programs to create images and study the pros and cons of each type of image representation. Students learn how to use bezier curves, layering, transparency, scaling, duplication, and rotation to create images for a variety of purposes. Their work is presented using presentation software, web-site tools, advanced word processing, page-layout and animation software.

The data model behind presentations, slides and topics, are quickly learned and students understand 80% of the useful capabilities of computer-assisted presentations within an hour. Students are asked to read several articles and transcripts of Internet-based discussions on the pros and cons of computer-assisted presentations. We studied why some companies and events have banned the use of such tools since they tend to change the nature of discourse in several arenas from conversation to presentation.

- c) Grade level of students taking the course: 11th Grade
 - d) Is the course required or an elective? Required
 - e) How often and for how long does the course meet? Taught as a skills class (not mainlesson), (6 weeks) two 45-minute periods per week
 - f) Has the course been successful? In what way? Yes
 - g) Is the instructor of the course a full-time teacher? Yes
-
- a) Name of course: **Computer Aided Design**
 - b) Theme and topics of the course: The students use a Computer-Aided Design software package to design living spaces or mechanical objects. Students work with both two-dimensional and three-dimensional tools. Students survey and measure actual structures and landscape on campus, at home, or elsewhere in Austin and produce 3D models. Students may also build miniature models from their designs developed on the computer.
 - c) Grade level of students taking the course: 9 to 12
 - d) Is the course required or an elective? Elective
 - e) How often and for how long does the course meet? Fifteen 90-minute periods over a 6- to 8-week time-frame
 - f) Has the course been successful? In what way? Yes
 - g) Is the instructor of the course a full-time teacher? Yes
-
- a) Name of course: **Digital Media Studies**
 - b) Theme and topics of the course: The purpose of this new block is to empower the students to communicate responsibly and powerfully through a variety of digital media including web-site design, print, digital audio, and digital video. Our goal is for each student, or perhaps groups of students, to select a non-profit organization or humanitarian subject and develop a treatment for print, web, radio, and video. In addition to learning how to use media, the students engage in a study of how the media of our popular culture influences their view of themselves and the world.
The inventions of the printing press, telegraph, radio, television, and the Internet are studied to understand the impact of each medium on the structure of human discourse. Students read and write critical essays that explore the impact of the Internet on a wide range of human virtues and vices. Last year students offered essays on Plagiarism, Free Speech, Family Relationships, Identity Theft, Privacy, Internet Addiction, and Copyright Issues.
The theme of the twelfth grade is World Consciousness, so it is fitting that we ask them to study an issue in the world today and to prepare powerful treatments of that subject through a variety of media. We also hope to deepen their understanding of the technology behind the art of saying something that is compelling, thought-provoking, and moving through digital media.
 - c) Grade level of students taking the course: 12th Grade
 - d) Is the course required or an elective? Required
 - e) How often and for how long does the course meet? Taught as a skills class (not main lesson), one semester (16 weeks); two 45-minute periods per week
 - f) Has the course been successful? In what way? Yes
 - g) Is the instructor of the course a full-time teacher? Yes

- a) Name of course: **Digital Music Composition**
 - b) Theme and topics of the course: Students leverage their knowledge of music to produce original works on the computer using MIDI (Musical Instrument Digital Interface) instruments, synthesized audio, and sampled audio. Music sequencing software is used to arrange multiple tracks of audio. Students use MIDI keyboards to record, arrange, and produce music. This block has been offered as an elective in conjunction with the Music department.
 - c) Grade level of students taking the course: 9 to 12
 - d) Is the course required or an elective? Elective
 - e) How often and for how long does the course meet? Fifteen 90-minute periods over a 6 to 8 week time-frame
 - f) Has the course been successful? In what way? Yes
 - g) Is the instructor of the course a full-time teacher? Yes
-
- a) Name of course: **Information Management: Data Modeling, Storage, and Retrieval**
 - b) Theme and topics of the course: The block begins by polling the students for their current understanding of the word “database” and asking them to offer examples of where they believe information on themselves and their family is kept. We study drivers licenses, doctor bills, phone bills, and other artifacts to reverse-engineer the data model institutions such as the Department of Motor Vehicles, the Auto Insurance Company, the Social Security Administration, and the Bank use to capture and track information. Students learn how to design their own databases by coalescing units of information into entities and attributes through an informal approach to third-normal form. Once the concepts of data partitioning are established, the students examine and build several small databases and learn how to manage, sort and filter information in a relational database.
 - c) Grade level of students taking the course: 11th Grade
 - d) Is the course required or an elective? Required
 - e) How often and for how long does the course meet? Taught as a skills class (not main lesson), (6 weeks); two 45-minute periods per week
 - f) Has the course been successful? In what way? Yes
 - g) Is the instructor of the course a full-time teacher? Yes
-
- a) Name of course: **Word Processing & Page Layout**
 - b) Theme and topics of the course: By the time a student reaches high school, they’ve already used word processing software. Our focus in the high school is to learn how to create well-structured word-processing for a variety of applications. Rather than learn by rote the location of menu and toolbar items, the students probe the data model behind the word processing software. Once the concepts of characters, words, paragraphs, pages, and sections are understood, the students then study the commands that operate on those constructs. This is consistent with the object-oriented paradigm that is taught in the Computer Programming blocks. The students create different types of documents that utilize character and paragraph formatting, page breaks, headers/footers, images, margins, tabs, and tables.
 - c) Grade level of students taking the course: 11th Grade
 - d) Is the course required or an elective? Required
 - e) How often and for how long does the course meet? Taught as a skills class (not main lesson), (8 weeks); two 45-minute periods per week
 - f) Has the course been successful? In what way? Yes
 - g) Is the instructor of the course a full-time teacher? Yes
-
- a) Name of course: **Numerical Analysis**
 - b) Theme and topics of the course: Using Rainwater Collection as our study, students measured the square footage of the high school buildings, developed usage models, incorporated monthly rainfall statistics, and conducted what-if scenarios to better understand how rainfall amounts, collection area, storage capacity, and usage models contribute to the entire system. This experience solidified our plans to base as much of our instruction on real applications versus canned lesson plans based on hypothetical examples. At first it seemed odd for students in a computer class to be measuring the dimensions of the roof area of

the buildings on campus, but it grounded them in the discipline of leveraging information technology to solve real problems.

To support the students in deepening their ability to apply numerical analysis, the students were asked to choose a topic for which they felt a personal interest or connection, and to analyze it by harvesting and analyzing numerical data. Examples included analyses on The Spread of AIDS, Weather Patterns, Collegiate Graduation Rates and Athletics, Endangered Species, and Elective Cosmetic Surgery in the United States.

- c) Grade level of students taking the course: 11th and 12th Grades
 - d) Is the course required or an elective? Required
 - e) How often and for how long does the course meet? Taught as a skills class (not main lesson). (8 weeks) two 45-minute periods per week
 - f) Has the course been successful? In what way? Yes
 - g) Is the instructor of the course a full-time teacher? Yes
-
- a) Name of course: **Web Site Design & Programming**
 - b) Theme and topics of the course: Students design and build both static and database-driven websites using HTML, CSS, JavaScript, Ajax, PHP and SQL. Three teams of four students each focus on a separate area of expertise. One group specializes in digital photography, graphics and video. The second group focuses on CSS-based web design and the third group learns server and client-side programming and database access.
 - c) Grade level of students taking the course: 9 to 12
 - d) Is the course required or an elective? Elective
 - e) How often and for how long does the course meet? Fifteen 90-minute periods over a 6- to 8-week time-frame
 - f) Has the course been successful? In what way? It is being offered in this form for the first time this semester.
 - g) Is the instructor of the course a full-time teacher? Yes
-

1. Name of school: **Rudolf Steiner School** (New York City)
2. Name of person filling out survey: Marisha Plotnik
3. Does your school offer any computer courses? Yes
4. If yes to #3, then for each course please give the following information:

7th & 8th Grade: Keyboarding

- Students use the program Mavis Beacon Teaches Typing to learn keyboarding skills.
- The class takes place in a 6- or 8-week block, one block per year, twice per week for about 30-40 minutes per class.
- It is required of all students.
- It is taught by full-time faculty and staff.

9th Grade: Introduction to our network

- The first two weeks of math track class in 9th grade includes having the students, in small groups, introduced to our computer network: usernames, passwords, saving files, printing, folders, available programs, etc. Required, taught by full-time faculty and staff.

10th Grade: Main lesson – “Computation”

- This is a main lesson that has been evolving. When taught by our chemistry teacher, Rich Turner, it was primarily a main lesson in the development of computing devices, mostly from a “how does the hardware work” point of view: from Napier’s Bones through vacuum tubes machines to the modern computer. Now it is taught by our math teacher, Dan Marsch, and it primarily focuses on the thoughts of those machines: logarithms, number bases, binary addition, etc.

11th Grade: Solid-state circuitry work

- Circuitry work on breadboards. From lighting an LED through transistors, logic circuits with transistors, then using IC’s to create a full binary adder. In great years, we connect the adders together to form a

multi-bit (12? 15?) adder. Much fun. Taught by me.

- Also, graphing calculators are introduced this year, during a different block in the track class (maybe 2–3 week block). Primarily the programming capabilities are explored, to investigate, for example, convergence of infinite series. This then sometimes moves into similar work with QBASIC.

12th Grade: Programming elective

- There has not been student demand for this year-long course in several years, but we have offered it.
- It has usually been staffed by a part-time teacher.

5. Does your school have a dedicated computer lab?

We have two mobile computer labs: locked carts each containing 12 laptops. This is an excellent solution to the hardware problem! We also have multi-media capabilities (overhead projector with dedicated computer) in several classrooms.

6. Other comments about your computer curriculum:

We have unusually rich resources at our school, primary among which are a full-time Technology Coordinator and a full-time Network Administrator

1. Name of school: Sacramento Waldorf School

2. Name of person filling out survey: Andrew Silvert

3. Does your school offer any computer courses? Yes.

4. If yes to #3, then for each course please give the following information:

a) Name of course: Computer Literacy

b) Theme and topics of the course: No set curriculum. Completely left up to the teacher to decide what to teach. Not integrated with the rest of the school (in my opinion). Current curriculum consists of keyboarding instruction, use of powerpoint to present a pro/con presentation on a technology related topic, and a software application presentation on a program of each student's choosing. I am also adding a financial literacy component to the course in which the students will learn to build financial spreadsheets.

c) Grade level of students taking the course: 11th grade.

d) Is the course required or an elective? Required. Our high school does not offer electives.

e) How often and for how long does the course meet? Twice a week for 50 minutes. Last year this course was taught as a trimester course. This year, it is a semester.

f) Has the course been successful? In what way? That is hard for me to gauge as I am in my first year. However, I would say that to move forward, the course curriculum needs to be explored and evaluated as a whole school effort and that computer skills needs to be offered in 9th-12th grade, not just as one class in 11th grade.

g) Is the instructor of the course a full-time teacher? No, I am not. The previous teacher was full-time until she gave up teaching this class. She had been teaching it for the past five years.

5. Does your school have a dedicated computer lab? Yes, up until just a few months ago, the lab consisted of 20 5-8 year old networked PCs that had become too slow or broken down to be of any value to the students. It got so bad this year that the Board quickly approved the purchase of new equipment. We currently have brand new DELLs and a dedicated server. Unfortunately, the school has so far declined to pay for professional networking setup and support, and there are serious problems with our Internet connection, so even though we have had the new hardware for almost two months now, the students are not yet able to fully utilize the new machines.

6. Other comments about your computer curriculum: Up until this year, the school also offered a "Keyboarding" course in 10th grade. The curriculum consisted of typing instruction, understanding the hardware and software components of a computer, and learning how to use standard software such as Microsoft Word, Excel, and Powerpoint. This course was replaced by a "Health" class this year.

It seems that there is a deep divide within the teacher community about the proper place of the computer lab in the life of the school. As a result, the issues of curriculum and lab maintenance have not been explored or addressed by the faculty or administration in any systematic way. Things have been left up to the individual

teacher/s and parent volunteers. I am hoping that the investment in the new lab will motivate such an exploration in the coming year. I am very interested in how other schools have dealt with similar issues and what other schools have come up with in terms of curriculum and integration.

1. Name of school: **Shining Mountain Waldorf School** (Boulder, CO)
 2. Name of person filling out survey: Jamie York (not the instructor)
 3. Does your school offer any computer courses? Yes
 4. a) Name of course: **Introduction to the Computers**
 - b) Theme and topics of the course: Various computer applications
 - c) Grade level of students taking the course: 9
 - d) Is the course required or an elective? Required
 - e) How often and for how long does the course meet? Two 90-min periods/week for half of the year
 - g) Is the instructor of the course a full-time teacher? No
 - a) Name of course: **Web Design**
 - b) Theme and topics of the course: Learning how to design your own web page, etc.
 - c) Grade level of students taking the course: 10, 11, or 12
 - d) Is the course required or an elective? Elective
 - e) How often and for how long does the course meet? Two 90-min periods/week for half of the year
 - g) Is the instructor of the course a full-time teacher? No
 - a) Name of course: **Digital Film**
 - b) Theme and topics of the course: Students make their own movies, etc.
 - c) Grade level of students taking the course: 10, 11, or 12
 - d) Is the course required or an elective? Elective
 - e) How often and for how long does the course meet? two 90-min periods/week for half of the year
 - g) Is the instructor of the course a full-time teacher? No
 5. Does your school have a dedicated computer lab? No, we recently bought 20 laptops and have wireless.
 6. Other comments about your computer curriculum: The College of Teachers is finding it challenging to evaluate the computer curriculum. We are trying to figure out what the real pedagogical value of the computer curriculum is and what would make it a true “Waldorf” curriculum. In the greater community, some think we should have far more with computers—others think it isn’t “Waldorf” or is a waste of time.
-

1. Name of school: **Kimberton Waldorf School**
2. Name of person filling out survey: Hezi Haut
3. Does your school offer any computer courses? Yes.
4. a) Name of course: **Keyboarding**
 - b) Theme and topics of the course: Learning to type
 - c) Grade level of students taking the course: 9th
 - d) Is the course required or an elective? Elective
 - e) How often and for how long does the course meet? ??
 - f) Has the course been successful? In what way? Mixed.
 - g) Is the instructor of the course a full-time teacher? Yes
- a) Name of course: **I-Search**
 - b) Theme and topics of the course: English course regarding how to gather info wisely through the Internet

- c) Grade level of students taking the course: 11th
 - d) Is the course required or an elective? Required
 - e) How often and for how long does the course meet? One semester, twice per week
 - f) Has the course been successful? In what way? Yes.
 - g) Is the instructor of the course a full-time teacher? Yes
 - 5. Does your school have a dedicated computer lab? Yes, with 14 Dell computers. Not well utilized.
 - 6. Other comments about your computer curriculum: Looking into making changes.
-

- 1. Name of school: **Washington Waldorf School**
 - 2. Name of person filling out survey: Hartmut Doebel
 - 3. Does your school offer any computer courses? Not at the moment
 - 6. Other comments about your computer curriculum: Things were tried in the past, but were not very successful. We are now thinking about what to do in the future.
-

- 1. Name of school: **Green Meadow Waldorf School**
 - 2. Name of person filling out survey: Harlan Gilbert
 - 3. Does your school offer any computer courses? Up until now, there have only been modules as parts of math courses. This year, however:
 - 4. a) Name of course: **The Information Revolution**
 - b) Theme and topics of the course: History and development of computers, nature of computing technology and information transfer, social implications.
 - c) Grade level of students taking the course: 12th grade
 - d) Is the course required or an elective? A main lesson for those who do not go on internship
 - e) How often and for how long does the course meet? 3 weeks, an hour and 40 minutes per day (main lesson time)
 - f) Has the course been successful? In what way? This will be the first year.
 - g) Is the instructor of the course a full-time teacher? Yes
 - 5. Does your school have a dedicated computer lab? 4 desktops in the library serve as a research space and are used intensively by the yearbook designers (students led by a graphic designer). In addition, 17 laptops travel to classrooms as needed.
 - 6. Other comments about your computer curriculum:

I have been trying to introduce programming in 10th grade with simple coding applications (to calculate square roots, etc.). We are also going to build logic circuits using DPDT switches with the 10th grade this year, for the first time.

In 11th and/or 12th, we use Macromedia Flash to produce coding-driven applications with sophisticated user interfaces (e.g., an address book with lookup features). We hope to introduce next year's 11th grade to integrated circuits, as well.
-

- 1. Name of school: **Waldorf High School of Massachusetts Bay**
- 2. Name of person filling out survey: Dan Raizen
- 3. Does your school offer any computer courses? No (though I'll maybe offer a programming elective in the spring)
- 4. If yes to #3, then for each course please give the following information:
 - a) Name of course: ???

- b) Theme and topics of the course: Learning to program
 - c) Grade level of students taking the course: 9-12
 - d) Is the course required or an elective? Elective (all of these answers are tentative)
5. Does your school have a dedicated computer lab? Yes, 9 machines - 6 Windows, 2 Macs, 1 Linux
-

- 1. Name of school: **San Francisco Waldorf School**
 - 2. Name of person filling out survey: Paolo Carini
 - 3. Does your school offer any computer courses? Not this year
 - 6. Other comments about your computer curriculum: We had been taking time out of the math curriculum to teach computers, and we had to stop doing so. We had planned to incorporate computer stuff in our own math classes, but in the end it did not happen. So, this year the computer curriculum was on hold.
-

- 1. Name of school: **Chicago Waldorf School**
 - 2. Name of person filling out survey: Brian Gleichauf
 - 3. Does your school offer any computer courses? No
 - 5. Does your school have a dedicated computer lab? No
 - 6. Other comments about your computer curriculum: We do not really have a computer curriculum. We have only recently hired an IT person to manage the faculty computers. It's a area in which we have much growing to do.
-

Classroom Experiments

8th Grade Optics Demonstration or Puzzler

This is a simple, intriguing phenomenon that can be used to illustrate the principles of refraction or as a challenging puzzle for the students to tackle at the end of your study of optics. I saw this demonstration for the first time at the “Teaching Sensible Science” seminar in Saratoga Springs, NY.

Place a four-inch square ceramic tile in a clear 1000ml beaker and fill the beaker with water. The tile will stand on one of its edges and lean against the side of the beaker. Place the beaker roughly at eye level, and invite the students to walk around it, looking at the tile. As they do so, they should see the image of the tile change shape in some very interesting ways. This experience usually evokes some satisfying expressions of surprise and wonder.

This demonstration can be used to reinforce and deepen the principles and relationships already built up by the study of refraction, prisms, and lenses. You could also challenge the students to come up with their own explanation of the phenomenon, based on the work they have done thus far. The curving surface of the beaker provides a constantly changing prism angle, which creates the conditions for the image of the tile to bend and curve, the bending increasing as your viewing angle approaches the tangent of the surface of the beaker. This is explained further in von Mackenson’s *A Phenomena-Based Physics for Grade 8*, available from AWSNA Publications.

If you don’t have a four-inch tile and a 1000ml beaker, you can certainly experiment with other objects. Any opaque, thin, straight-sided, square or rectangular object that you can stand on edge inside a clear, cylindrical container could work. Good luck!

BA

Classroom Experiments

MAKING NYLON IN THE LABORATORY

Materials: 250ml beaker, sebacoyl chloride solution, hexamethylenediamine solution, long plastic tweezers, rubber gloves, safety glasses, apron or lab coat, paint roller (or large dowel or glass bottle), and a paper towel

NOTE: Wear safety glasses, rubber gloves, protective apron in a well-ventilated area and use extreme caution.

- Carefully pour the sebacoyl chloride solution on top of the hexamethylenediamine solution (both are available from chemical suppliers).
- Use tweezers to grab the layer between the two liquids and pull it up.
- The thread will appear as fast as you pull it from the mixture. You can collect it around anything that's convenient. Drape a paper towel over a paint roller and spin the thread on the roller, or wrap it around a large wooden dowel or a glass bottle.

In 1938 the E. I. Dupont de Nemours Company, known at the time mainly as a maker of explosives, announced what was arguably the single most important invention in the history of stockings: nylon.

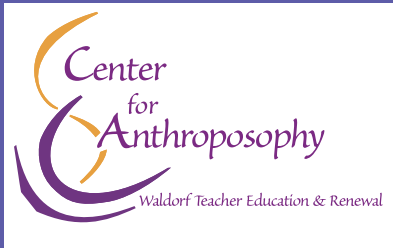
Nylon was not discovered by accident or extracted from a natural source. It was one of the first materials engineered from scratch, based on an understanding of polymer chemistry and a desire to plug what was, apparently, a serious hole in the hosiery department. The company promised that this magical product would finally free the modern woman from the yoke of expensive, run-prone silk stockings. And it worked!

Nylon is now abundant, and if you have a chemical catalog handy, it's not that difficult to make yourself. When molecules of hexamethylenediamine and sebacoyl chloride link together in an alternating pattern to create chains thousands of atoms long—which happens spontaneously anytime these chemicals come in contact with each other—you get nylon.

The recipe I used is based on two solutions with different densities layered in the same glass. The heavier, aqueous (water-based) hexamethylenediamine solution is on the bottom, and the lighter sebacoyl chloride is on top. A film of nylon appears instantly where the two layers meet. Gently pull the film with tweezers, and new nylon forms in its place, allowing you to produce from an average-size glassful a continuous thread dozens of yards long.

Commercial nylon is made with the same chemical bonds through a slightly different reaction, and the resulting product is purified and melted down before being pulled into fibers. This home-made thread, on the other hand, is too thick and brittle for knitting.

DSM



Teaching High School Physical & Life Sciences

with Michael D'Aleo (Physical Sciences), Dennis Klocek (Goethean Studies), Gary Banks (Life Sciences)

Three month-long summer sessions in Wilton, New Hampshire, plus two years of independent study, guided research, and an internship/practicum in Waldorf high school physical or life science classes. Program includes:

- | | |
|----------|---|
| Year I | <p>Summer Session</p> <ul style="list-style-type: none"> 1 Adolescent Development and High School Curriculum Overview 1 Living Thinking: The Practice of Phenomenology 1 Subject Seminar I: Life Sciences or Physical Sciences 1 Courses selected from drama, drawing, eurythmy, music, painting, sculpture, spatial dynamics, speech <p>Fall and Spring</p> <ul style="list-style-type: none"> 1 Independent study and research in physical or life sciences 1 Observation of high school science classes and labs 1 Artistic apprenticeship, including sketching of nature phenomena |
| Year II | <p>Summer Session</p> <ul style="list-style-type: none"> 1 Esoteric Science 1 Subject Seminar II: Life Sciences or Physical Sciences 1 Professional Seminar: Science and Art of High School Teaching 1 Further artistic courses <p>Fall and Spring</p> <ul style="list-style-type: none"> 1 Independent science research and thesis 1 Artistic apprenticeship, including laboratory drawing |
| Year III | <p>Summer Session</p> <ul style="list-style-type: none"> 1 Education for Adolescents / Foundations of Human Experience 1 Social Development of the Teenager 1 Subject Seminar III: Life Sciences or Physical Sciences 1 Further artistic courses |

For details contact: Douglas Gerwin, Ph.D., Director
Center for Anthroposophy
Box 545, Wilton, NH 03086

Renewal Courses 2007

Week 1: June 24-29

Healing the Earth: Do the Festivals Have a Future? with Eugene Schwartz

Exploring Artistic Speech and Gesture through Rudolf Steiner's Mystery Dramas with Linden Sturgis

Deepening the Waldorf Curriculum through Drawing, Painting, and Clay Modelling: Grades 6, 7, and 8 with Georg Locher

"To Love is to Hold the Wound Always Open": Unfolding a Sophianic-Michaelic Spiritual Path of Human Relationships with Christopher Bamford

Exploring the Sacred in Art: Finding a Modern, Meditative, Artistic Path with Laura Summer

Keep Them Moving! with Christopher Sblendorio

The Healing Art of Handwork: Awakening a Sense of Form and Color in Embroidery with Sandy Pearson

Transformational Cooking: Cooking from Within with Master Chef Hiroshi Hayashi and Barbara Sustick

Teaching Math in Grades 6, 7, and 8: From Survival to Inspiration with Jamie York

Living the Foreign Language: A Path From Imagination to Cognition with Lorey Johnson

Week 2: July 1-6

Money Can Heal with Siegfried Finser

The New Environmental Aesthetic: A New Way of Being on Earth with Michael D'Aleo

Practical Arts in Grades 1, 2, and 3: Bringing the Curriculum into the Hands of Children with Elizabeth Auer

Teaching Physics and Chemistry in the Upper Elementary Grades with Roberto Trostli

Organizational Integrity: How the Body Speaks in Families, Groups, and Organizations with Torin Finser and Nancy Mellon

The Contemporary Child and Adolescent with Kim John Payne

Nourishing the Soul's Imagination with Color and Light: The Alchemical Mystery of Stained Glass with Susan Brown

Transformation of Self through Intuitive Thinking and Artistic Perception with Georg Locher and Douglas Gerwin

Center for Anthroposophy
P. O. Box 545, Wilton, NH 03086
telephone 603.654.2566
fax 603.654.5258
info@centerforanthroposophy.org
www.centerforanthroposophy.org



*2007 Summer Course at The Nature Institute
Coming Alive to Nature: the Goethean Approach to Science and Nature Study
June 24 to June 30*

*“When we try to pick out anything by itself,
we find it hitched to everything else in the universe.” (John Muir)*

*In this year’s course, we will turn our attention to plant communities and habitats—how can we characterize
an upland or a streamside forest?*

Can we begin to see the wholeness and qualities of a place?

To help facilitate this process, we will begin the days with explorations of the qualities of earth, water, air, warmth, and light.

The course presupposes some familiarity with the Goethean, phenomenological approach to science and nature study.

*It will include presentations from
participants who have taken part in past courses.*

Morning seminars

Earth, Water, Air, Warmth and Light (Henrike Holdrege)

Plant Community and Habitat Study; Goethean Methodology (Craig Holdrege)

Afternoon activities

Field observations and project work in small groups;

Presentations by participants

The course begins on Sunday evening, June 24, at 7 pm and ends Saturday, June 30, at 12:30 pm.

Course fee: \$480, (\$455 when registering before May 1)

Contact us for a registration form or for a brochure at info@natureinstitute.org

Please register by June 1.

Information about this course you will also find on our website www.natureinstitute.org

For Sale Senior Architecture Slide Course



Eleven carousels plus one slide box
with hundreds of slides, including:

*Egyptian architecture
Peruvian architecture
Assarian architecture
Greek architecture
Roman architecture
Byzantine architecture
Renaissance architecture
Cathedrals
Colonial American architecture
Sir Joseph Paxton
Eric Mendelson
Antonio Guadi
Le Corbusier*

*Rudolf Steiner
Mies van der Rohe
Buckminster Fuller
Eero Saarinen
Frank Lloyd Wright
I. M. Pei
Skyscrapers
Modern Design
and more*

Contact David Mitchell
303/541-9244

d_mitchell@mindspring.com

Binary Being



Symposium, July 26-29, 2007
UC Berkeley Campus, California

STAYING HUMAN IN THE COMPUTER AGE

A three-day symposium organized around keynote presentations and group discussions, which explore the challenges of and opportunities for human identity in the computer age.

Inspired by our collective experiences as technology professionals, we offer this symposium as an opportunity to explore questions such as:

- Human thinking and artificial intelligence:
what is the difference?
- The impact of virtual reality on our experience of nature.
Are we losing our senses?
- Inner work, concentration, and picture consciousness in
the computer age.

Fun prepares the mind for new ideas.

The Symposium will offer a variety of artistic activities which anyone can enjoy. No prior experience is necessary.

Our Artistic and Discussion Group Leaders include: Christiaan Boele, Michael D'Aleo, Christopher Garvey, Chris Guilfoil, Michael Holdrege, Van James, Glenda Monasch, David-Michael Monasch, Dr. Valdemar Setzer

Register early and save!

For more information and to register visit
our website:

www.binarybeing.org

K
E
Y
N
O
T
E

S
P
E
A
K
E
R
S



Dr. David Levy



Dr. Ernst Schubert



Ms. Dorit Winter



sponsored by:

BAY AREA CENTER FOR
WALDORF TEACHER TRAINING

Index of Past Issues

Waldorf Science Newsletter edited by David Mitchell & Bob Amis, © AWSNA Publications

This newsletter is published once each year and is dedicated to developing science teaching in the Waldorf schools. Teachers are invited to pose questions, seek resource material, discuss experiments, write about their classes (successful and not very successful), and investigate phenomena. The editors also translate relevant science articles from Waldorf periodicals from around the world. The following past editions are available from:

AWSNA Publications	E-mail: awsna@awsna.org
3911 Bannister Road	fax: 916/ 961-0715
Fair Oaks, CA 95628	phone: 916/ 961-0927

Available from www.awsna.org on-line at: http://www.awsna.org/books_sciencenews.htm

Volume 1, #1

Partial contents – Acoustics in Grade 6; Teaching about Alcohol in Grade 8 Chemistry; The Chemistry Curriculum: The Debate over Teacher Demonstration vs. Student Experimentation; Spiritual Aspects of 20th Century Science; Overview of the Waldorf Science Curriculum; Water; Characteristics of the Major Sugars; Goethe's Meditation on Granite; Book Reviews; Humor; Poetry; Conferences; and Sample Experiments

Volume 1, #2

Partial contents – The Characteristics of Drugs; Eratosthenes Revived; The Golden Number; Educational Guidelines for a Chemical Formula Language; The Properties of Acids and Bases; Walter Lebedörfer on Chemistry; Biology in the 11th Grade; What Is Home?; The Waldorf Environmental Curriculum; Environmental Education; Women in Science; Book Reviews; Humor; Poetry; Conferences; and Sample Experiments

Volume 2, #3

Partial contents – Grade 12 Physics – Von Mackensen; Biology Teaching in the 11th Grade; Euclid's Algorithm; The Logos and Goethean Observation; Nature Education; Aristotle's Taste Spectrum; Book Reviews; Humor; Poetry; Conferences; and Sample Experiments

Volume 2, #4

Partial contents – Current Research; Strange Theories; Science Education and Wonder; The Human Earth; Steiner's Counterspace Examined; The Cow; Language and the Book of Nature; Book Reviews; Humor; Poetry; Conferences; and Sample Experiment

Volume 3, #5

Partial contents – Book Reviews; First Lessons in Astronomy; Steps in the Development of Thinking (Power of Judgment); Computer Science and Computers in the Waldorf School; Technology; Computers in Education; Some Characteristics of the Computer; Computers and Consciousness; Experiments

Volume 3, #6

Partial contents – Space and Counter Space; New Eyes for Plants; Experiments of Academia dell Cement; Physics and Chemistry in the Grades; Goethean Science Credits; Chemistry Workshop; Table of Important Salts; Goethe's Scientific Imagination; To Infinity and Back in Class 11; Π and Trigonometry; Science in the Waldorf Kindergarten; A Note on Pascal's Triangle; Experiments

Volume 4, #7

Partial contents – The Message of the Sphinx; Honey; Cell Cosmology; Einstein's Question; What Is Goethean Science?; Prototype Computer Program; River Watch as a Classroom Activity; Thoughts on Curriculum Standards; Comments on Building a Waldorf School; Experiments

Volume 4, #8

Partial contents – Towards Holistic Biology; How DNA Computers Work; Solar System Facts; What Is Goethean Science?; Human Movement and the Nervous System; What Is Science?; What Is Meant by “Teaching the Children to Breathe?”; Experiments

Volume 5, #9

Partial contents – The Globe Inside Our Planet; Music, Blood and Hemoglobin; Standards in Science; Cognitive Channels—the Learning Cycles and Middle School Students; 8th Grade Physics, From Dividing to Extracting Roots; What Is Lambda?; Waldorf Science Kits

Volume 5, #10

Partial contents – Reading the Rocks; Why the Arts Are Important to Science; The Three Groups of Rocks; Introduction to Geology; The Rock Cycle; Mineralogy for Grade 6; Metals and Minerals, Precious Stones—Their Meaning for Earth, the Human Being, and the Cosmos; Experiments

Volume 6, #11

Partial contents – A Chemistry of Process; Sponges and Sinks and Rags; How to Read Science; Experiences and Suggestions for Chemistry Teaching; Experimentation as an Art; Biographies—Dmitri Mendeleev, Joseph Priestley, Marie Curie; Destructive Distillation; Experiments

Volume 6, #12

Partial contents – Light and Darkness in 6th Grade Physics; The Relation of “Optical Elevation” to Binocular Vision; Description of Curves in Connection with Elevation Phenomena; Water Treatment at the Toronto Waldorf School; A Lime Kiln that Can Be Assembled and Disassembled; Experiments

Volume 7, #13

Partial contents – Thoughts on Returning to an “Education Towards Freedom”; Pedagogical Motives for the Third Seven-Year Period; Social Education through Mathematics Lessons; A Vision for Waldorf Education; Our Approach to Math Doesn’t Add Up; International Mathematics Curriculum

Volume 7, #14

Partial contents – Conferences; Physiology, Update on Taste; Pictorial Earthquake; Boiling with Snow; Towards a Waldorf High School Science Curriculum for the 21st Century; The Thermal Decomposition of Calcium Carbonate; Crystal Reveals Unexpected Beginnings; Cosmic Ray Studies on Skis; Experiments

Volume 8, #15

Partial contents – Book Reviews; Arabic Science; Arabic Mathematics: Forgotten Brilliance; Making Natural Dyes; Exploring the Qualities of Iron; Von Mackensen Chemistry Conference; Oxalic and Formic Acid; Hydraulic Rams; What the Water Spider Taught Me

Volume 8, #16

Partial contents – Waldorf High School Research Papers; Inside the Gulf of Maine; How Do Atomistic Models Act on the Understanding of Nature in the Young Person?; The House of Arithmetic; Origami Mathematics; Sixth Grade Acoustics; Sixth Grade Kaleidoscopes; Tricks with Mirrors; The Flour Mill and the Industrial Revolution; Web Gems; Understanding Parabolic Reflectors; The Capacitor; Oscillation and Waves; Crystal Radio; Qualifications for High School Mathematics Teaching

Volume 9, #17

Partial contents – Book Reviews; Acknowledgement from a Waldorf Parent; Raising Money for Science; The Twelve Year-Old Child and Orpheus; Towards a Sensible Kind of Chemistry, Part One; The Lightning Bug; The Ladybug; Exploratory Experimentation: Goethe, Land, and Faraday; Faraday’s Synthetic Investigation of Solenoids; Faraday’s Analytic Investigation of Induction; Geometric Addition Table: A Curious Configuration

Volume 9, #18

Partial contents – Book Reviews; Towards a Sensible Kind of Chemistry, Part Two; The Evolution of the Fast Brain; Professors Vie with Web for Class Attention; The Teenage Edge; Oscillator Coil Demonstration Using an Ultra-Low Frequency LC- “Tank” Circuit; Thermodynamic Experiments for the Middle School

Volume 10, #19

Partial contents – Book Reviews; The Beaver; Nature in the Human Being; Astronomy Verses for the Middle School; Child Development and the Teaching of Science; Bibliography for Middle School Teachers; What Is Phenomenology?; The Design of Human and Animal Bodies; The Brain and Finger Dexterity; Observations of a Neurophysiologist

Volume 10, #20

Partial contents – Book Reviews; A Number Story for the Sixth Grade; Novel Entries for a Trig Table; An Introduction to the Sine and Tangent; Toss Out the Toss-Up: Bias in Heads or Tails; Phlogistron Theory; Song of the Rain; Refrigeration in Physics; The Poetry of Astronomy; Build Your Own Sextant; Highlights from Recent Science-teaching Periodicals; Websites of Interest

Volume 11, #21

Partial contents – Books of Interest; A Sampling of Poems for Botany; How Does Sense-Nerve System Activity Relate to Conscious Experience?; Acoustics in Sixth Grade; Fun Facts of Physiology; About Formative Forces in Vertebrates and Human Beings; Global Perspective; Points to Consider in Science Teaching; Deconstructing Black Box Aspects of a Computerized Physics Lab

Volume 12, #22

Partial contents – Books of Interest; Preserving a Snowflake; Environment, Morphology, and Physical Principles for Waldorf High School Teachers and Students; Homemade Audio Speaker for Grade Eight; Mathematics and Natural Science: A Reflection from the Viewpoint of Pedagogy and the History of Ideas; Animal Sight; Kepler’s Model of the Universe; Teaching Sensible Science; Mug on a Glass: An Optics Demonstration for Grade Seven; Chemistry Challenge for Grade Eight; On Being an Insect; Surveying and Mapping: An Attempt to Integrate New and Emerging Technologies into the Class 10 Curriculum

Volume 13, #23

Partial contents – Books of Interest; Advice on Teaching 8th Grade Meteorology; An Explanation of the Phenomenological Approach for Parents of Middle School Children; Astronomy (Hubble Space Telescope Photographs); Environment, Morphology, and Physical Principles for Waldorf High School Teachers and Students; Sensible Science Workshop; How Parachute Spiders Invade a New Territory; Pluto Is No Longer a Planet; Computer Curricula in U.S. Waldorf Schools; Experiments