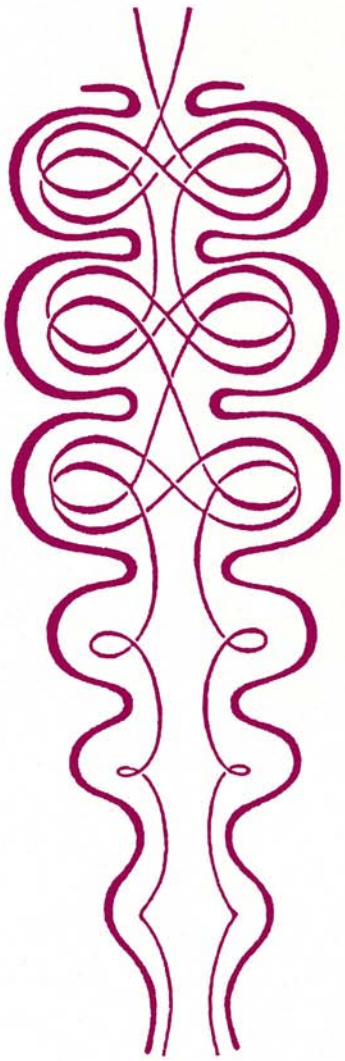


Volume 14, #24
Spring 2008



WALDORF SCIENCE NEWSLETTER

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Waldorf Science

Explorations in Phenomenology as Practiced in Waldorf Schools

A Science News Roundletter

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Printed with the Support of the Waldorf Curriculum Fund

VOL. 14, #24

Spring 2008

FROM THE EDITORS

We are pleased that the first west coast session of “Sensible Science” workshops led by Michael D’Aleo and his team are now underway. Sponsored by the Research Institute for Waldorf Education and AWSNA, these training sessions for teachers have been extremely helpful in forwarding the phenomenological approach to science teaching in Waldorf schools. It is hoped that every Waldorf school in North America will send at least one faculty member to participate in and share with colleagues the impulses emanating from this effort. For more information, contact Michael D’Aleo at spalight@verizon.net.

We also want to acknowledge the passing of Seyhan Ege, Professor Emerita of Chemistry at the University of Michigan. A long time anthroposophist and supporter of Waldorf education, Professor Ege helped to form the Rudolf Steiner High School of Ann Arbor. For many years she taught the 11th grade Atomic Chemistry block, developing a phenomenological approach to the subject. Professor Ege was the first tenured woman and the first female full professor on the faculty of the Chemistry

Department at the University of Michigan. She was widely regarded for her contributions to the modernization of the teaching of organic chemistry at the college level, and authored a much-used textbook on the subject. A true pioneer in her field, and an advocate for women everywhere, Professor Ege died on September 13, 2007.

This edition of the *Waldorf Science Newsletter* includes the following articles: Robotics; a Seventh Grade Fresco Project; a Pinhole Camera Project for the Seventh Grade; Other Projects for Elementary Physics Classes; the Aurora Borealis; Phenomenological Science Equipment; The Karma of Calculus—Involving Isaac Newton and Gottfried Leibniz; Award Winning Photos of Nature and Animals; and Science Workshops for the Summer of 2008.

The *Waldorf Science Newsletter* is intended to be a participatory newsletter. We welcome your comments, articles, experiments and requests. We hope you will find this issue useful.

Books of Interest

Functional Morphology

The Dynamic Wholeness of the Human Organism

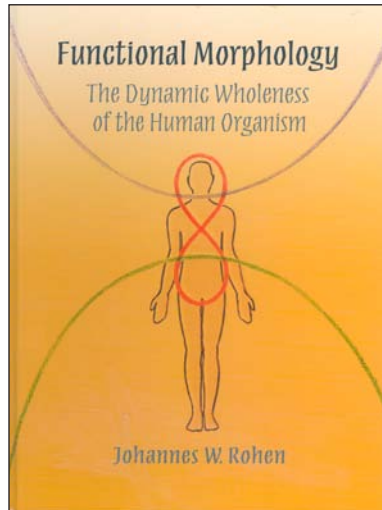
by Johannes W. Rohen

Too infrequently one picks up a book and discovers it to be a rare masterpiece, in this case a book presenting a comprehensive picture of the human being. Such was my delight when I opened *Functional Morphology* a new title by Johannes Rohen, MD, one of the founders of functional anatomy. Many thanks are extended to John Barnes and Adonis Press for translating and making this book available to the English-speaking world.

A large book with exquisite color diagrams this book is a “must have” for every Waldorf high school life-science teacher and every school with a 7th and 8th grade should have at least one copy in the faculty library.

The main headings are:

- General Principles of Form
- Pylogenetic Processes
- The Musculoskeletal System
- The Metabolic System and Digestive Organs
- The Immune System, Lymphatic Organs, and Spleen
- The Urogenital System
- Blood and the Organs of Circulation
- The Respiratory System
- The Functional Threefoldness of the Nervous System
- The Major Sensorimotor Systems
- The Sensory Systems
- The Autonomic or Vegative Nervous System
- The Nervous System and Consciousness
- The Endocrine System (Hormonal Glands)
- Head Development and the Integration Principle
- Organ Metamorphoses
- Head Development and the Disintegration Principle
- The Respiratory System of the Head
- The Pituitary/Pineal System
- The Physiological Foundations of Freedom
- Evolutionary Principles and the Genesis of the Modern Human Form
- The Future of Human Evolution and the Problem of the Resurrection Body



There is not space enough to further extoll the wonders of this book. Unequivocally, I urge you to purchase a copy.

ISBN 978-0932776365

429 pages 8.75 x 11.25 hardcover

Richly illustrated in color

Price: \$75.00

Adonis Science Books

Available from AWSNA Publications

Research Bulletin

Autumn 2007

Volume XIII, 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:

- Human Development and Moral Force: An Anthropology of Moral Education
- The Moral Reasoning of High School Seniors from Diverse Educational Settings
- Can Moral Principles be Taught?
- Transformative Education and the Right to an Inviolable Childhood
- The Riddle of Teacher Authority
- Religious and Moral Education in the Light of Spiritual Science—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 available from:

researchinstitute@earthlink.net

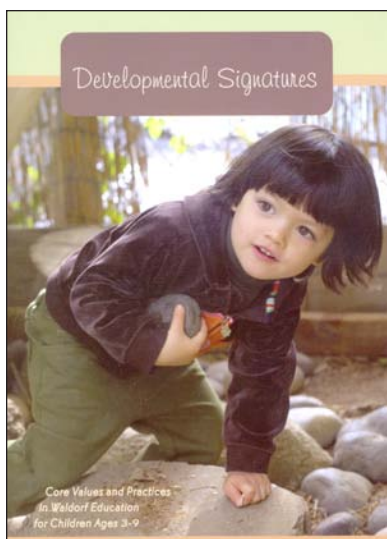


71 pages

7.5 x 11 inches \$12.00

Available from

AWSNA Publications



Developmental Signatures

*Core Values and Practices in Waldorf Education
for Children Ages 3–9*

Commissioned by the the German Association of Waldorf Schools (Bund), a team of teachers, doctors, parents, and scholars describe the developmental stages of Waldorf education as related to State educational requirements in Germany. These first two parts of a three-part study are concerned with children from three to nine years old and the conditions required for successful schooling. The results of this working group's study in Germany are a great resource for reflection for deepening and renewing Waldorf and non-Waldorf educational practices, both within the European community and throughout the world.

ISBN 978-888365-81-8

158 pages 6.5 x 9 softcover

Illustrated

Price: \$20.00

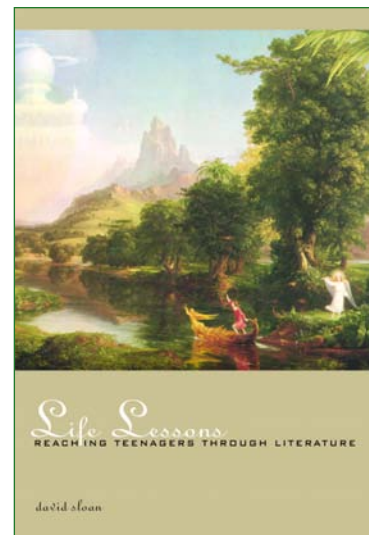
Available from AWSNA Publications

Life Lessons

Reaching Teenagers through Literature

by David Sloan

A teacher's love for literature is apparent as he reaches out to inspire the adolescents he teaches through the written word. Each class of the high school is explored, their universal developmental uniqueness examined, and rich examples of literature are illuminated. This jewel of a book will delight high school teachers everywhere.



ISBN 978-888365-90-0

135 pages 6.5 x 8.5 softcover

Illustrated

Price: \$16.00

Available from AWSNA Publications

Education, Teaching, and Practical Life

by Rudolf Steiner

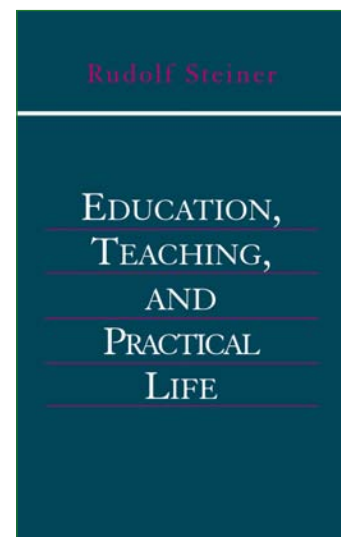
Available in English for the first time, these lectures by Rudolf Steiner describe a way of educating and teaching children and youth that aims toward educating the whole person according to body, soul, and spirit in a balanced way. Such an education can be carried out only if the educator is aware of how in evolution the physical is formed out of the soul and spirit, for one can participate in the education of a being only if one understands the laws of this education. This book is filled with gems to be mined by teachers, parents, students of spiritual science, and scholars.

ISBN 978-888365-71-9

150 pages 5.5 x 8.5 softcover

Price: \$22.00

Available from AWSNA Publications



Long Haul Record

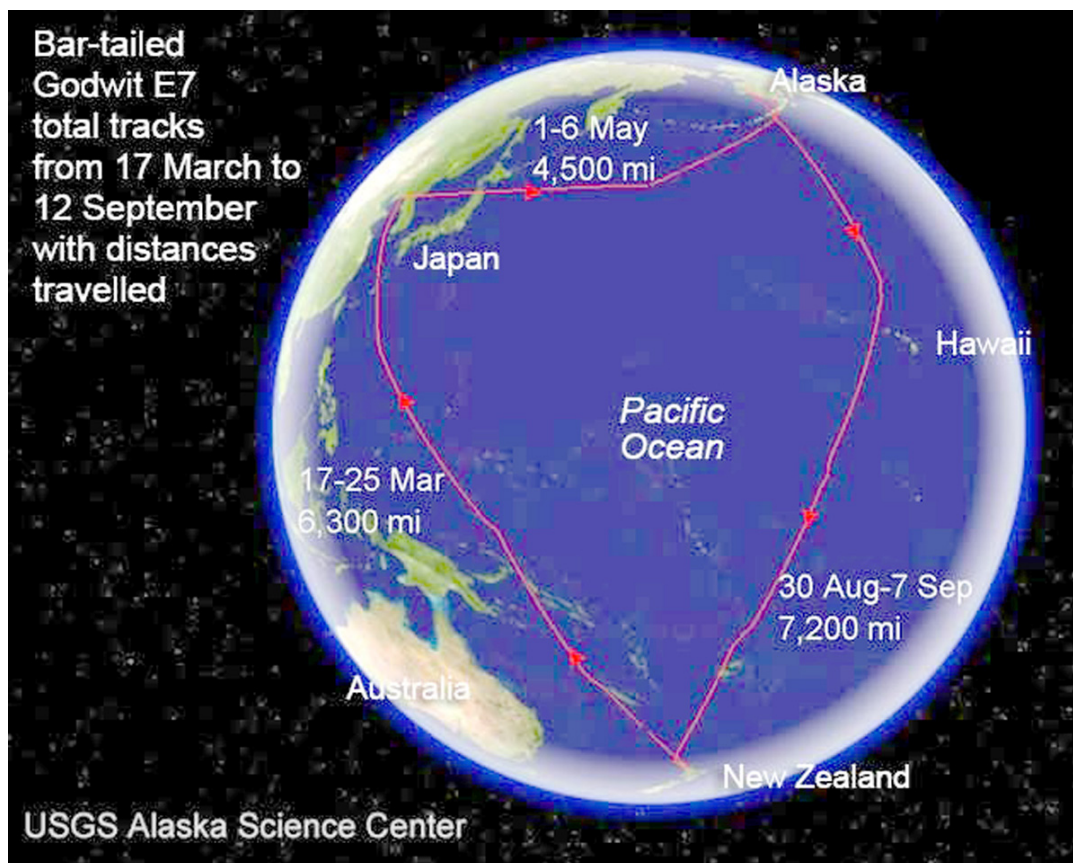


The godwits are a group of large, long-billed, long-legged and strongly migratory wading birds of the genus *Limosa*. They form large flocks on coasts and estuaries in winter.

They can be distinguished from the curlews by their straight or slightly upturned bills, and from the dowitchers by their longer legs. The winter plumage is fairly drab, but three species have reddish underparts when breeding. The females are appreciably larger than the males. U.S. scientists tracked a shorebird as it made a record 7,145-mile flight from Alaska to New Zealand without stopping for food or water. The U.S. Geological Survey's Alaska Sci-

ence Center says its observations confirm the godwit made the longest nonstop flight ever recorded for a land bird.

The bird, dubbed "E7," was one of 16 godwits captured by researchers in early February in New Zealand. All were fitted with GPS and a small battery powered satellite transmitter to track their migration. E7 left northern New Zealand on March 17, flying 6,300 miles nonstop to China. After resting for five weeks, it then traveled on to a summer nesting area in western Alaska. The bird began its record-setting flight back to New Zealand on August 29, flying past Hawaii, Fiji and other remote islands of the Pacific before arriving on September 7, just east of where she had been captured seven months earlier. During those nine days, the bird "slept" by shutting down one side of her brain at a time, researchers said.



ROBOTICS AT THE GREEN MEADOW WALDORF SCHOOL

by

Winslow Elliot

They're called The Poly-Gnomes. They are a group of eight Waldorf students in grades nine through twelve who design and create robots.

And these students made up half of the championship alliance that won the Snow Day Showdown tournament in Hightstown, N.J. on December 15— an event that is part of FIRST, an international program designed “to inspire and recognize excellence in science and technology through robotics co-opertitions.”

Green Meadow Waldorf School's robotics team includes Alexander Evans, Nicolas Frei, Noah Kaplan, Gavin Langdon, Aidan Nelson, Charles Rudish, Sung-Pil Moon, and Sung-Ryul Moon. The team gathers together after school every week under the guidance of GMWS's robotics coach and high school physics and math teacher, James Madsen. Together they strategize, plan, program, and build.

“FIRST calls them ‘co-opertitions’ because you have to cooperate as well as compete,” says Madsen. “Sometimes during the competition someone from another team will help nudge a stuck robot, or we'll share software. The point is to help everyone do their best, as well as to win.”

The FIRST Robotics Competition challenges teams to design a robot that will win against a robotics game designed by FIRST founder Dean Kamen and a committee of engineers and other professionals.

Students are rewarded for excellence in design, demonstrated team spirit, gracious professionalism and maturity, and the ability to overcome obstacles. Scoring the most points is a secondary goal.

Winning means building partnerships that last.

All these goals are inherent in every aspect of the Waldorf curriculum, which may be one of the reasons for the Green Meadow students' success.

The game rules are different every year. This year's game was called Quad Quandary. “On the playing field there are bunch of three-inch rings and different types of goals,” Madsen describes it. “The teams are trying to gather rings and score them on the goals. The goals move. It gets pretty fast and serious.”

You can check out the game on the FIRST web site: http://www2.usfirst.org/FTC/2007GameAnimation/FTC_Animation_07_640x480.wmv

The Poly-Gnomes spent a couple of months thinking about how they could create a robot that would win the game. “The students have to constantly apply all the physics and math they've been learning, weighing cost and benefits of using one design over another,” says Madsen, “and without a lot of money to invest in research, you have to be more creative. There's a maximum of ten students on any team, which means that everyone needs to be active and participate.

“This is a terrific place for these students to be successful at something they are good at. It takes a lot of physics and programming to get the robots to do what they want them to do. They’re computer whizzes; they are great at playing computer games, but with the program that FIRST offers, now they can get really creative.

“During the first twenty seconds of each match, the robots must operate completely on their own by following programming instructions written and pre-loaded by the team. After that, the controls can be taken over by the students for two more minutes. Team alliances are selected randomly, chosen two on two, in a mini-arena. In any given match another team could be an opponent or a partner. After numerous qualifying matches, the teams with the best scores choose an alliance partner, and one of the rules is that the top teams can’t choose other top teams. The Poly-Gnomes team was selected by the winning team to be their partner because of their design and their collaborative efforts, as well as their software.”

And so the Poly-Gnomes combined with Team Overdrive from Bridgewater, N.J. to win the scrimmage. They’ll next be heading to NJ Tech Challenge in February, and then hopefully to the Javits Center in New York City in April.

FIRST emerged from a strong personality, a New Hampshire entrepreneur named Dean Kamen, who had several scientific patents to his credit. In the late nineteen-eighties, he saw something occurring in the United States that troubled him: science and math heroes were simply not valued by young people in the same way that were rock stars, athletics champions, and movie idols.

Kamen set out to create a venue that would inspire young kids to be scientifically and technologically challenged – something so exciting that it would be as exciting as performing at a rock concert.

In 1989, he founded FIRST, an acronym meaning: “For Inspiration and Recognition of Science and Technology.” By 2007, 37 competitions were held in places across the world such as Israel, Brazil, Canada, and the U.S.A. Kamen remains the driving force behind the organization, and continues to gain support and publicity from major corporations, universities, and colleges.

“The way these events occur is very exciting,” says Madsen. “There’s loud techno music, it’s all highly animated, and it’s very exciting for the kids. It’s nothing like a spelling bee or a science fair; instead there’s intense animation, excitement, yelling, screaming. And what’s really great is that gracious professionalism imbues everything we do in all the competitions. Dean Kamen’s ideal of helping your competitors permeates every aspect. Being a monopoly and destroying everyone else doesn’t help anyone. Helping each other helps everyone, and you see that in the competitions. The students are all helping each other, sharing software, helping with spare parts.”

What is robotics? Simply put, robotics is the science and technology of robots, their design, manufacture, and application. Robotics requires a working knowledge of electronics, mechanics, and software, and needs to be accompanied by a large working knowledge of many subjects.

Although the appearance and capabilities of robots varies, all robots share features of a mechanical, movable structure that is under an autonomous control. The structure of a robot is mostly mechanical; its functionality is similar to the human body, formed of links (bones), actuators (muscles), and joints.

The first program developed through FIRST was the FIRST Robotics Competition (FRC), which was designed to inspire high school students to

become serious engineers by giving them real world experience working with professional engineers to develop a robot. The competition challenge changes each year, and the teams cannot reuse components created for previous robots. The robots weigh around 120 pounds, depending on the current year's rules.

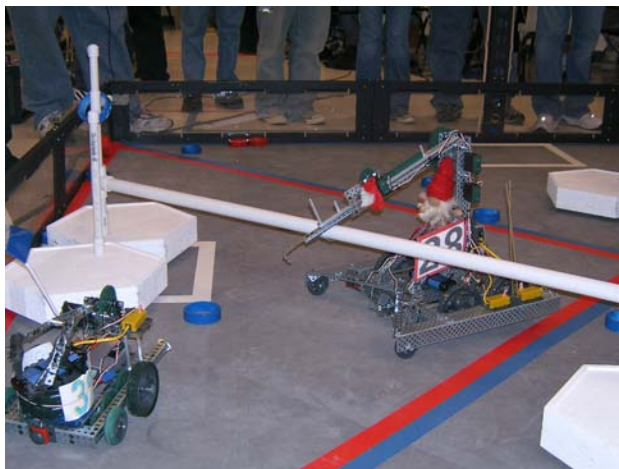
"Competition on a stage brings as much excitement and an adrenaline rush to the participants as do conventional varsity tournaments that are sports or performance-based," says Madsen.

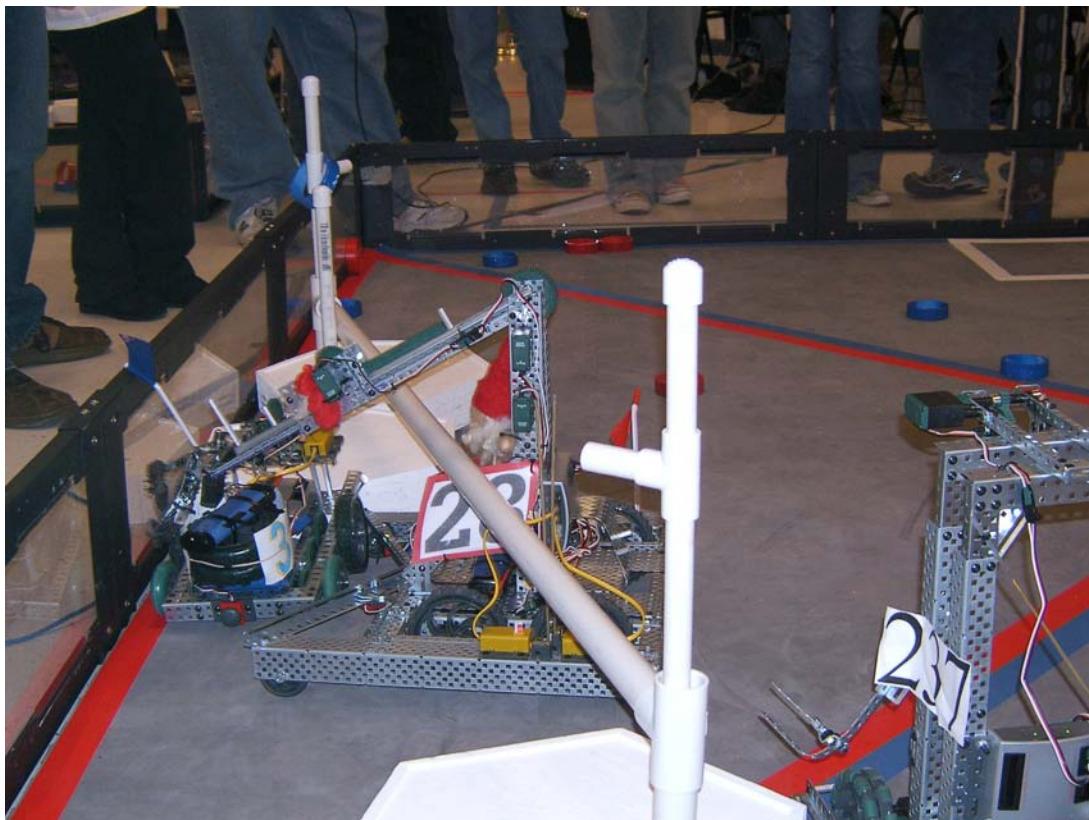
Mr. Madsen's children attended the Monadnock Waldorf School through eighth grade, but since there was no high school there at the time they attended public high school. "At the public high school there was this fantastic robotics team the students could join. When I got the job as physics and math teacher at Green Meadow Waldorf School, I wanted to offer the possibility for students to take part in the FIRST competition."

An interesting aspect of the Green Meadow Waldorf students doing so well with robotics is that in the Waldorf curriculum computer science is taught only after the students are adept in algebra and physics, typically not till high school. This is because, in the Waldorf curriculum, children learn conceptually only what they can actually do in practice, they learn first how a computer is made and how programming works, ideally before they use it to play games or conduct research. In this way they become masters of the tool, not the reverse.

An educational environment in which students typically make most things themselves throughout the elementary grades, including their own individual text books, might ultimately be the best place to achieve real expertise in technology, and to experience all its creative, imaginative possibilities.

Additionally, Waldorf interfaces particularly well with FIRST's ideal of collaboration, team spirit, graciousness, and perseverance. Any Waldorf school interested in getting involved in FIRST can go to <http://www.usfirst.org/contact.aspx?id=2878> to find a FIRST contact person near them that will help.





SEVENTH GRADE FRESCO PROJECT

by

Elan Leibner

Waldorf teachers are always looking for ways to integrate subjects across disciplines. The following project integrates chemistry, math, history and art into one age-appropriate, multi-sensory, unforgettable experience. I have now done it with two seventh grades, and can recommend it highly. It requires a fair amount of preparation and practice, but done well it is the kind of project that makes you happy to be a teacher.

I planned the entire first term of seventh grade around this project, so the block sequence allowed me to introduce the topics in a logical order. The sequence was: chemistry, math, and history (and with the first seventh grade class, astronomy, which gave the content of the frescos). The project itself includes one full day (or at least half a day) for the actual painting of the frescos, and several other good chunks of time, so it should be planned and thought out logistically well in advance. It is not likely to be satisfying without the needed preparations.

A little primer on frescos

Fresco is a painting done on fresh, wet plaster, usually on a wall. It is done so that the paint goes into, rather than onto the wall. Earth minerals are ground, mixed with water or limewater, brushed onto the plaster, and then soak into the wall as the plaster dries. The pattern for the painting is transferred onto the wall through a perforated paper called a cartoon (Yes, this is the original meaning of the word. Who would have thought that Waldorf teachers would ask their students to draw cartoons?). There are reasons for every one of the steps involved, which I will leave out for brevity's sake. The most thorough, and highly recommended resource I have been able to find is: www.muralist.org. Though the website specifies a process that is too cumbersome for our purposes, it is unsurpassed in its explanations of, and details about the whole endeavor.

[For a moving description of Michelangelo's painting of the Sistine Chapel, see Alex Ross's *Michelangelo and the Pope's Ceiling*. It was this book, read right after David Mitchell's *The Wonders of Waldorf Chemistry* that first gave me the idea of making frescos with my students.]

Though I have not done this project with high school students, it strikes me as something that could be done on a large scale in a high school. I would be thrilled to advise and encourage anyone who would be so bold as to try it out.

The Process:

I began the year with a chemistry block, and made sure to build John Hoffman's lime kiln (described in Mitchell's book). We saved some of the hydrated lime for use in the first layer of the frescos.

Next I taught math and made sure to cover ratios thoroughly, so that when I told the students to prepare plaster in different ratios of lime paste to sand, they had a clear understanding of what it meant.

History of the Renaissance came next, including Michelangelo's biography.

During this block, the students chose their themes for an 18"x18" fresco. They practiced drawing them with pencils, then with watercolor on stretched paper. The main difference between the usual watercolor painting done in Waldorf schools and this practice was that they were painting into an outline. The outline was done on a paper of similar size and then transferred onto the watercolor paper through perforations. Any fine black pigment can be used for this transference, though the historical pigment (crushed charcoal) is fun to prepare and works well if it is crushed into fine enough powder.

Also during the history block, I had parents come in for a morning to help prepare the frames, and had the students prepare the buckets of lime paste, and later on, the plaster. By the time the actual fresco day arrived, the students had already drawn their individual motifs at least twice, built a frame around the tile they were using in lieu of a wall, plastered that tile with the first layer of plaster, and learned how to crush and mix the pigments they would need. Thus there had been a lot of preparation and excitement building up, and the day itself felt like a celebration. With both classes, I had commandeered the entire day for the project, and after we were done (around 1PM both times) we took it easy outside. [It would be a bit cruel to ask another teacher to teach the class after such an event, and perhaps unreasonable to expect the students to cooperate.]

The Steps

There are basically three aspects to this project in terms of preparation: the frames, the plaster, and the artistic practice (including making the cartoon). The latter can occur as schedule permits, but the students should have practiced using the cartoon at least once before fresco day. The cartoon is the same size as the fresco, with a perforated outline of the theme.

1. The frame:

I bought 18"x18" ceramic tiles at Home Depot, and enough 1"x2" lumber to make frames for all of them. You need about 120" of lumber for each frame, basically in 20" units. Since the lumber is sold in 8' units, there is some waste involved (16" left over from each unit), but those pieces are often useful for some other needs around the campus. (They make excellent kindling for a camping trip, if nothing else.)

The tiles are used bottom side up. They have a porous surface and square ridges on the bottom for helping with gluing, and those same pores and ridges will help the plaster to set and bond to the tile firmly. The lumber is cut at 45°, with the 18" opening at the interior. Note that the lumber is cut so that it is the thickness, not the width that has the angled cut. (You want the width of the lumber to be the depth of the frame: about 1½".) Two 20" pieces are cut at right angles to serve as slats on the bottom (to prevent the tile from falling through the frame). Pre-drill and screw two 1½" wood screws at each corner of the frame. I screwed them in opposing directions in order to minimize the twisting of the lumber. The slats on the bottom are also pre-drilled and screwed. Once the tile rests in the completed frame, you can (and should, in my view) seal it to the frame with caulk or clay/beeswax. The corners of the frame can likewise be sealed.

[The whole process of making the frames requires some understanding of carpentry. With my first group, I tried to have the students do most of the work without help from other adults. That was a mistake, and I paid for it by having to make the frames essentially by myself. The second time, I invited parents, and

the additional expertise, miter saws, cordless drills and helping hands were a huge benefit for everyone.]

2. The Plaster

The plaster is made with hydrated mason's lime (found in masonry or outdoor gardening centers) and sand. (Do not use any materials or tools with cement on them, since that will damage the plaster in the long run.) The sand can be coarser in the first layer. I used play sand from Home Depot, sifted with a medium sifter to remove only the larger stones. For the second layer, the one that is painted, I sifted that same sand with a fine sifter, and mixed it 50/50 with Caribbean white sand, also from Home Depot. The white sand gives the plaster a wonderful whiter color, but by itself it makes plaster that tends to crack more easily. The mason's lime is mixed with water to a whipped-cream consistency, and allowed to settle for at least a couple of days. (Historically, and in the website mentioned above, the mixture has to settle for two years or more. I went to our fifth grade and made the mixture with them so they will have it properly aged by seventh grade, but since these frescos are made horizontally and not vertically, they have maintained structural integrity quite well, so far.)

Mix the lime paste with the coarse sand at about a 1:4 ratio (by volume) and allow it to settle overnight in a sealed bucket (We made two 5-gallon buckets). Wet the (framed) tiles well with a sponge, then trowel the plaster evenly at about 3/8" thick. Once the layer is even, score it with a wallpaper glue spreader or with the side of the trowel and let it dry for about one week, or until thoroughly dry. The scoring will help the second layer bond with the first one better. While the first layer is drying, the second layer is prepared. Mix the lime paste with the finer sand at about a 1:2½ ratio, and let it rest overnight in the sealed buckets.

[I estimate that I used about 1.5 bags of hydrated lime, four bags of play sand and one bag of white sand for 22 frescos, but can't swear that these are the accurate amounts. It is better to buy more than you think you'll need. The materials are not expensive, and unused bags can usually be returned. You do not want to run out in the middle of the lesson.]

Now that you have the tiles framed, the first layer dry on them, the second layer ready, the cartoons prepared and the students bursting at the seams to get going, all that is left before painting is to prepare the pigments. Use earth minerals only, since the alkalinity of the lime will bleach ordinary pigments over time. Earth minerals are also used in lazuring, so you may have some around your school, or you can order them from an art supply store. The website mentioned above has an excellent list of pigments. Make sure to order them well in advance. The pigments are ground with a mortar and pestle then mixed with water or limewater. A small amount goes a long way, so though they tend to be a bit pricy, the school will be able to use them for a number of years.

[A word about setting up the room: I placed two large folding tables in the center of the room. One was for plastering, and the other for grinding pigments. The rest of the room was arranged in working stations around the periphery, each consisting of three desks for the individual students, stationed around a fourth desk on which pigments, brushes and water were placed. This minimized the likelihood that a student walking to get more pigments or to put the finished fresco away would bump into another. We had no such accidents in either class,

so I would recommend the arrangement. See also the comment at the end about preparing the floor and about cleanup time]

On the morning of fresco day, spread the second layer over a thoroughly wet first layer, smooth it over about ¼" thick, let it set for about 30 minutes while the students are grinding pigments, and then, finally, they can paint.

They place the cartoon over the wet plaster, and using black pigment or crushed charcoal, spread the pigment with a brush or, as in olden times, tap a cheesecloth bag filled with the pigment over the perforations in the cartoon. Once the cartoon is lifted, they have an outline of the motif, and they can set to work. There are several hours during which the plaster is receptive to the paint, and the more the students can be patient while layering thin veils of paint, the more interesting and luminous the outcome will be. Practicing with watercolors in advance is thus a great help, since veil painting uses a similar technique (albeit hair driers should not be used here!). It is important to remind them not to use dark colors early in the process, but to get darker slowly. Frescos cannot be fixed easily; once a layer is on, it stays on. It can only be chipped after it is dry, then replaced with a new layer of fresh plaster and painted again. Since you are not likely to have a lot of extra time after the painting day, the students should treat their work as a final product that cannot be repaired. Patience is truly a virtue here! It is also a good idea to have a good artist present, especially if you (like me) are not entirely certain of your ability to guide a student towards a Michelangelo rather than a Michael Imperioli. (I do work in New Jersey...)

Note: Once painting is done, there will be a fine mess to clean up. I put construction paper over the whole floor (the second time...), and assigned specific cleaning crews. The frescos can be piled in one corner of the room, and left to dry. (The frames allow easy stacking.) The plaster and pigments will take time to clean up, and you don't want the children who are still working to be disturbed by the cleanup, so have someone ready to take those who are finished outside while you stay with the ones who are still at work. Once everyone is finished, cleanup can begin.

As the pictures here show, one of my classes painted pictures of the constellations, linking this project with the astronomy block as well. The second class painted Renaissance themes.



Examples of Student Fresco Projects

Things You Did Not Know About Perspiration

by

Madeleine Marr

McClatchy Newspapers

Two types of sweat glands exist. Eccrine (sudoriferous) glands, used for body temperature regulation, are seen mostly on the palms, soles, and the forehead. Apocrine (odoriferous) glands are mostly present in the armpits and scalp. The yellowish sweat they excrete contains proteins and fatty acids, causing stains. The odor is caused by bacteria fermenting in a hot environment, such as an armpit.

Antiperspirants (classified as drugs by the FDA) are basically astringents. Their main active ingredient is an aluminum-based compound that forms a temporary plug within the sweat duct. Rumors have circulated that aluminum causes breast cancer and Alzheimer's, but the medical community denies this. Another alternative, deodorants—classified as over-the-counter cosmetics by the FDA—are different from anti-perspirants. They are usually alcohol based and work by killing the bacteria that cause odor. If you aren't crazy about applying foreign substances to your skin, think about plain old talcum powder and showering as often as you can.

Pinhole Camera for 7th Grade Physics

developed by

Hans van Riel

transcribed by Bob Amis

As middle school science teachers, we are constantly on the lookout for ways to connect the phenomena that we study to the larger world. This can be accomplished in class discussions, for example, by asking the students, “Where have you seen this in your everyday life?” but a much more powerful method is to give the students the opportunity to create something of their own, using the principles that they have studied. This is not always possible due to constraints of time, budget, or expertise, but when we can provide these opportunities for the children, we are giving them a wonderful gift that will stay with them for years to come.

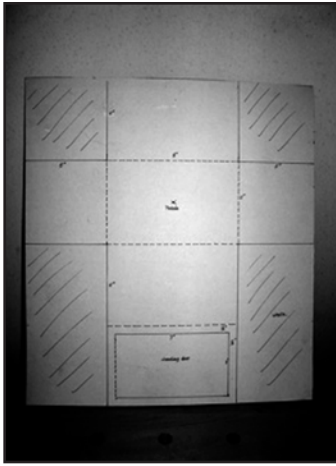
Hans van Riel, woodworking teacher and guest science teacher at Monadnock Waldorf School in Keene, New Hampshire, embodies the synthesis of creativity and practical knowledge to which we all aspire. He has developed and refined several activities that provide students with a memorable hands-on experience tied to the middle school Physics curriculum. The pinhole camera project is a perfect adjunct to the 7th grade Physics block.

Hans designed this “block within a block” to last ten school days. During the course of these two weeks, the students will build their own pinhole camera, shoot and develop their own pictures, maintain a journal, learn about the history of photography, and organize their work into a main lesson book along with a couple of essays.

“In this block the students study the ‘art of writing with light,’ ” says Hans. “They experience light as a wonderful ally, but also as a formidable enemy. The students learn how to use the gifts of light while controlling its destructive powers.”

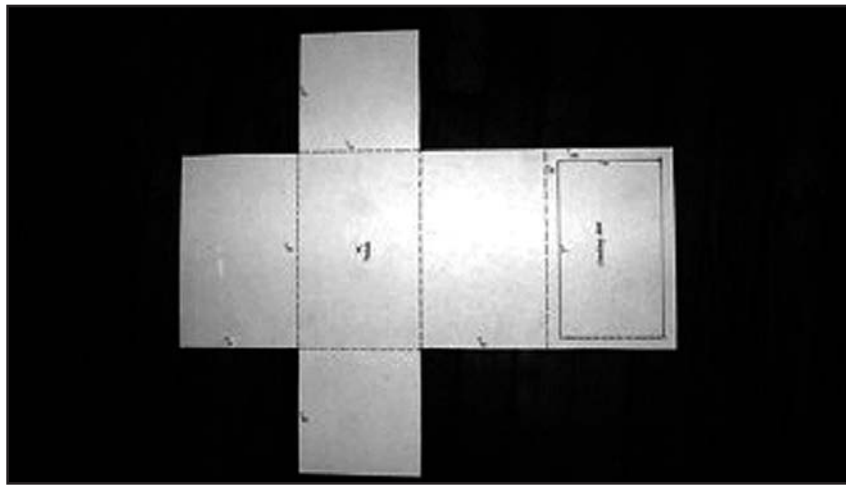
The block begins with the classic 7th grade Physics experiment, the Camera Obscura. Hans summarizes the experience by saying, “Through a small hole in the black plastic, a beam of light enters the space, reflecting an upside down image of the outdoors on the ceiling and the walls of the classroom. Everyone gets very excited seeing this phenomenon take place, and realizes that they find themselves inside a gigantic camera.” Having had the experience of being inside a pinhole camera, the students are now given the challenge of building their own.

“The students each construct a pinhole camera using mat board that is mat black on the inside and white on the outside. An 18" x 20" piece makes a shoebox shaped camera with a focal length of 5 inches,” explains Hans. The camera that Hans’s students build is actually a rectangular prism with final dimensions of 5" x 8" x 5". The four 8" x 5" sides of the camera are laid out on the white side of the mat board in a column, so that each side shares at least one common 8" edge with another side. The two 5" x 5" sides are drawn so that they share opposite 5" edges with the same 8" x 5" panel. The overall shape is that of a cross. The outside edges are cut out of the mat board, and then each common edge is scored so that the six sides can be folded into the desired prism shape and, eventually, taped together with black electrician’s tape. It is important that the black side of the mat board is on the inside of the camera. Before the box is taped together, a



$\frac{1}{2}$ " x $\frac{1}{2}$ " hole is cut out of the center of one of the 8" x 5" sides. This side will be the front of the camera. A 1" x 1" square is then cut out of a piece of brass or copper shim stock (available from an automotive supply store). A tiny hole is "drilled" into this very thin piece of metal, using a #20 darning needle stuck into the eraser end of a pencil. This is the pinhole for the camera. The drilled shim stock is then taped over the $\frac{1}{2}$ " hole in the mat board. In the panel opposite the pinhole, a door is fashioned by cutting out 3 sides of a 7" x 4" opening, and scoring the fourth side so that it acts as a hinge for the door. This door can then be opened and the photographic paper can be temporarily taped to its inside wall. You will have to experiment with a taping system for sealing out the light from around the door when the camera

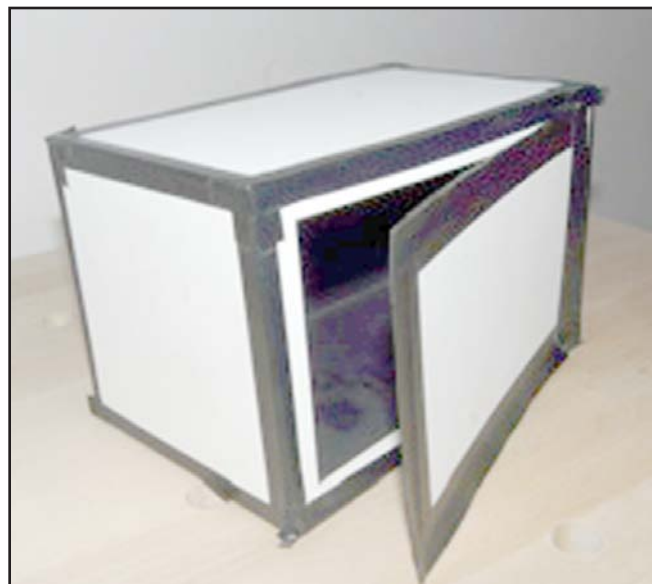
is loaded with paper. Another piece of electricians tape is temporarily placed over the pinhole and acts as the camera's shutter. In place of film, Hans uses glossy, black and white photo paper (RC). A box of 100 sheets of 8" x 10" paper is enough for a class of 16 students.



Cardboard Template



Construction



Access Door

While the students are building their cameras, they also learn about the history of photography. They begin with the development of the Camera Obscura and pinhole camera, and then study the various optical and chemical discoveries that make modern photography possible.

Meanwhile, the classroom is being turned into a dark room. Hans has developed a system whereby he can roll a black plastic curtain over the classroom windows to seal out any light, and then roll it back up at the end of the morning lesson. The room is also set up with a double entry, covered in black plastic, so students can come and go. The alternative to this is to not allow any entry or exit while students are developing. The room is also equipped with darkroom lights, chemical trays and tongs, and enlargers (Over the years, Hans has acquired 8 enlargers; my class got by with one enlarger for 12 students. More would have been better).

The next step is for students to load their camera with film, take it outside, keep the shutter closed, and then bring it back to the dark room and develop the paper. If their camera is light proof, then the photo paper should remain white. If the paper shows signs of light exposure, then they have light leaks that must be plugged, usually with more electricians' tape. Once their cameras are ready to go, students are given several specific photo assignments. Exposure times vary from 60 to 120 seconds, depending on light conditions, and must be experimented with. Because of the long exposure times, the camera should not be held by the student, but must be set down in a stable position while the shutter is open. Hans's first few photo assignments involve taking pictures of stationary objects. These include changes in point of view, such as taking a picture from a bird's eye view, and then from a mouse's viewpoint. Hans also gets the students to take advantage of the pinhole camera's infinite depth of field. Compositions that involve photographing a distant object through a chain-link fence, or setting the camera at one end of a picnic table and taking a picture of an old shoe sitting at the other end of the table, are examples of effective assignments. "The kids always want to make a self-portrait," says Hans. He recommends taking the self-portraits on a sunny day, so there is a lot of contrast and shadow, and having the student's face positioned just one foot from the pinhole. Hans also lets the students experiment with double exposures, which allows them to super-impose images. One popular assignment is for a student to take a 60 second exposure of himself/herself in one position, then change positions and take a second 60 second exposure. The effect is one of a photo of identical twins. Some students also experiment with two, or more, pinholes in their camera.

Hans usually stays in the darkroom to assist the students with the developing process while other adults take groups of students outside to take their pictures. "Developing the pictures is usually the most exciting part of the process, and requires a well-organized system," says Hans. "It is remarkable how well a group of 7 graders take responsibility for a smooth process and understand that 'fooling around' in these circumstances is out of the question."

In the first stage of the developing process, students take the exposed paper out of the back of their camera and run it through the various chemical developer baths to produce an image. Hans takes a special pleasure in the students' exclamations of amazement at this moment, "What a discovery that is for the students, that what they have created with their boxes is a "negative" image of the world, where light is dark and dark is light." Once they have developed a number of negatives, the students transform their negatives into positives through the process of contact printing. In the darkroom, the negative print is laid directly on top of a fresh sheet of photo paper, and the two sheets are set under the enlarger. This assembly is exposed to light from the enlarger and then the new photo paper is run through the chemical baths to produce a positive. The students will need to experiment with exposure times under the enlarger. Hans recommends starting with a 5-second exposure, and then increasing the time, in 5-second increments, until they obtain the desired result.

The last couple of days of the block are used to create photographic title pages. Black letters are cut forming the word PHOTOGRAPHY and placed on an 8 by 10 piece of photo paper. One or more negatives are then superimposed over the title. "The effect is always surprising and often leads to further experimentation, but usually by now time is running out, and the curtains have to be opened for lunchtime," says Hans.

During the block the students keep a daily journal in which they record accomplishments/failures, personal impressions, and data of the pictures (distance to the object, light conditions, exposure times), as well as drawings and notes on the historical development of photography. They also write a reflection on their experience during the block. This can be done in the form of a poem titled “Light my friend and/or Light my foe?”, or a short essay starting with the sentence: “I never realized that . . .”

Hans reports that the cost of this block in 2007 was about \$150, for mat board, tape, chemicals, and paper. Of course, having done this block many times, Hans has already acquired the other equipment that the block requires (black plastic curtain and double entry door system, enlargers, chemical trays and tongs, and darkroom lights). Another thing to consider is proper ventilation for the darkroom.

Obviously, this activity would be a wonderful addition to the 7th grade Physics block. It does, however, require preparation, special equipment, and some familiarity with the darkroom process. You also need to be willing to give it the time that it requires (one week minimum, two is better). As is so often the case, though, the extra effort that you invest in this activity will return to you in many enlivened class discussions by students who are truly excited by what they are learning.



Completed pinhole camera



Photo of Hans van riel using a pinhole camera

Equipment and Supplies Needed:

- Black plastic for light-proofing classroom
- 20"x18" pieces of black mat board for each student
- Electricians' tape
- Utility knives
- Brass or copper shim stock (available at an automotive supply store)
- #20 darning needles
- Pencils with erasers
- Glossy, black and white photo paper (RC), 100 sheets should be enough for 16 students
- Photographic chemicals
- Chemical trays and tongs
- Darkroom lights
- Enlargers

Hans and his wife, Hanneke, were among the pioneer families in the founding of the Monadnock Waldorf School in Keene, NH, where Hans has been the Woodwork and guest science block teacher for the past 22 years. Hans is originally from The Netherlands, where he taught high school and, during his required military service, Physics to young sailors. Over the years, Hans has developed several hands-on, project-based learning experiences for his students, including the production of a video news show. Hans and Hanneke live on a fifty-acre tree farm in Marlow, New Hampshire.

Other Projects for Elementary Physics Classes

by

Bob Amis

The article on the Pinhole Camera project is specifically intended for 7th grade, but what about the other middle school years? Here are a couple of possibilities for the 6th grade Physics block.

One popular activity for 6th grade Physics is to have the students build their own home-made musical instruments. These instruments could be of their own design, or following an idea from a how-to book on building simple folk instruments. This works well as an independent project, done at home, or could be done at school if you can find time for it.

Another activity that fits in nicely with the 6th grade study of acoustic phenomena, is easy to prepare, and can be done in one morning lesson class period, is to have your students build “string telephones” using a variety of materials. I experimented with this idea last fall and was happy with the results: my students enjoyed the activity, were engaged, and came up with some insightful connections between the medium through which the sound was traveling and the qualities of the sound that they experienced.

In the days prior to this activity, we conducted several experiments where the students listened to sounds through media other than air (water in an aquarium, solid and hollow walls, and spoons or metal rulers dangling from strings that are held to the students’ ears). We then discussed our experiences, looking for connections between the qualities of the sounds we heard and the media through which the sounds were passing.

The day of our activity, I set out a number of different materials on a table in the class-

room, and divided the class into groups of four students. First, I demonstrated the proper use of a string telephone, using the classic materials of cotton kite string and paper cups. Most of the students were already familiar with this type of contraption. Next, I instructed each group to select a “scribe” (someone to record their results), and told them to construct and test four to six telephones using different combinations of the materials on the table. They needed to record the materials used for each telephone, and then describe, as precisely as possible, the qualities (volume, pitch, timbre) of the sounds they heard through that set of materials. At the end of the session we had time for each group to demonstrate one of the phones that they had made. We conducted our usual review the next day, and I had the students write up this experiment and put it in their main lesson books.

The materials that I made available to the students included paper, plastic, and Styrofoam cups of different sizes, metal cans, thick and thin string, monofilament fishing line, copper and steel wire of different gauges, multi-strand picture-hanging wire, and yarn. I also had copper and steel rods, both solid and hollow, of different diameters, to try in place of the string. I’m sure that there are many other interesting possibilities.

In a block where the students are asked to sit quietly and observe during many of the demonstrations, it was nice to have an activity that allowed them to get out of their chairs, manipulate the materials, come up with their own creative combinations, and see what happens. I would do it again.

The Aurora Borealis

by

David Mitchell



In the late autumn on Hermit Island off of Bath, Maine, in the mountains of northern Norway, and from a houseboat in Price William Sound, Alaska, I have had the opportunity to observe in these northern night skies a phenomenon known as the aurora borealis (Greek for “dawn of the North”). Historically this phenomenon was beyond the grasp of thought because no one could explain how light and color could appear without the presence of the sun. Only in our modern times have explanations come forward. It was, for me, an experience so profound that I felt impelled to describe it to my 10th grade meteorology/earth science classes—while allowing them to remotely share the experience through a video available from the University of Alaska in Fairbanks. Each class wanted to learn why this phenomenon occurs.

First, the Observation—Flowing Light

Picture yourself outside on a clear dark night. Low on the horizon you notice a faint glow of greenish light which forms an arch, stretching lazily across the sky. As time passes, additional bands of light form and drift overhead, slowly brightening to form giant curtains in the sky that slowly wave as if a gentle breeze were blowing. Suddenly, the bottom of the curtains brighten with a green-yellow tint and it ripples faster. Blues and purples appear. As the curtains pass directly overhead, you see bright points of light that swirl like a pinwheel. The entire sky seems to be full of color and motion. Then, after several minutes, everything fades into a warm green glow.

No Two Auroras are Ever Alike

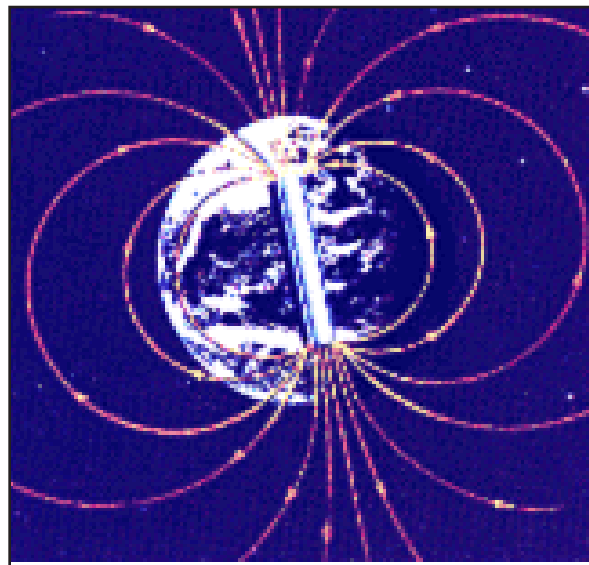
Each aurora has its own distinct characteristics.





The Earth's Magnetic Field

We are not able to see the magnetic field that surrounds the earth. When you experiment with a bar magnet and iron filings you have seen the curved patterns the filings form in the magnetic field. The next picture shows how the magnetic field around the earth's core is like the field of a bar magnet.



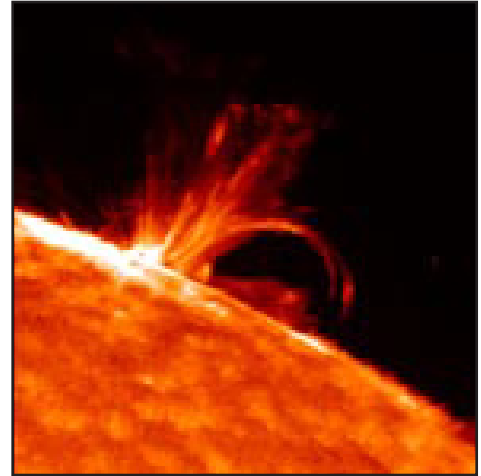
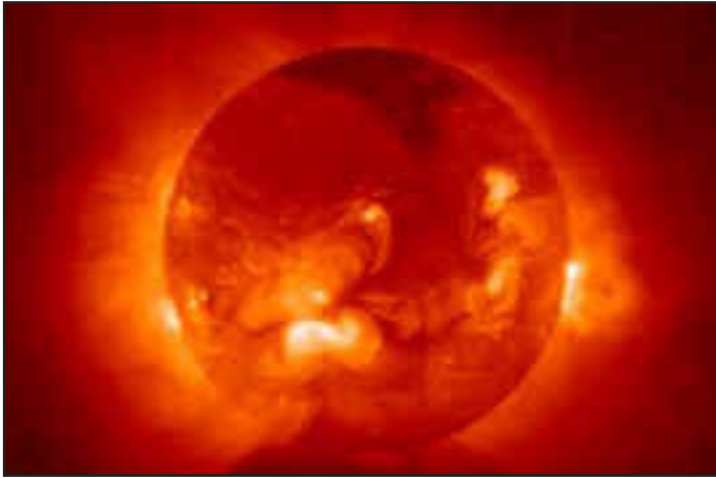
The earth's "magnet" is deep in the core. Since we can't see the magnetic field, we draw lines to represent it. The field lines go into and out of the earth around the earth's magnetic poles. Where the lines are closest together the field is strongest. Where they are furthest apart it is weakest.

So, What Creates the Aurora?

The short answer to how the aurora happens is that energetic, electrically charged particles accelerate along the magnetic field lines into the upper atmosphere, where they collide with atmospheric gas, causing the gas to give off light. But why does that happen? To find the answer, we must look further away, to the sun. The spectacular, "great" auroras are powered by what is called solar wind.

The sun also has an atmosphere and a magnetic field that extend into space. The sun's atmosphere is made of hydrogen and particles. These particles are constantly boiling off the sun

and streaming outward at very high speeds. Together, the Sun's magnetic field and particles are called the "solar wind."



Earth's magnetosphere in the solar wind

This wind is always pushing on the Earth's magnetic field, changing its shape. You change the shape of a soap bubble in a similar way when you blow on its surface. We call this compressed field around the earth the magnetosphere. The Earth's field is compressed on the day side, where the solar wind flows over it. It is also stretched into a long tail like the wake of a ship, which is called the magnetotail, and points away from the sun.

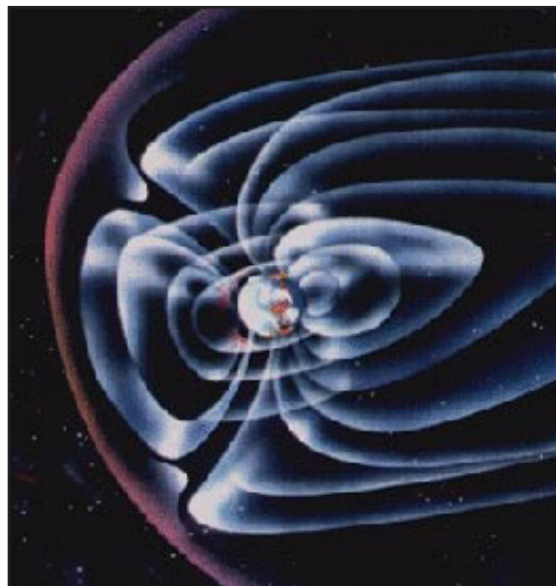
We know that the solar wind is the power source for auroras. It has also been known for a long time that there is a connection between activity on the sun and auroral activity on the earth.

A Cosmic Dance

The Sun and its wind are constantly changing. The flow of particles and the intensity of the solar wind's magnetic field increase when the sun is more active. Scientists now know that certain kinds of high-energy solar events can result in very large and unusual auroras.

It takes 2 to 4 days for solar wind and particles to reach Earth. When these events arrive, they strike the magnetosphere like a shock wave and inject huge amounts of energy into the magnetic field, often causing enormous and unusual auroras. We will also see that such intense "gusts" of solar wind can affect where auroras can be seen.

Below is an artist's conception of a solar shock wave acting on the magnetosphere.



Have you ever noticed the different colors in streetlights? Some are a dark yellow color while others have a blue or purplish light. How about neon signs? They have many different colors. Streetlights and neon signs are filled with gas. When they are turned on, an applied voltage energizes particles in the gas. These particles strike the gas molecules, which excites them to emit light. The color of the light you see depends on the type of gas.

Every gas shines with its own special colors of light. These colors are like a fingerprint because no two gases give off exactly the same colors. Streetlights filled with sodium gas give off a dark yellow light. Only sodium atoms give off that particular shade of yellow. Orange neon signs are filled with pure neon gas. Other colors of neon signs are actually neon mixed with other types of gases, like helium or argon, and these produce the colors blue, orange, and red.

Definition

In the simplest of terms, the aurora borealis are created when solar wind meets the earth's magnetic field. The movement that you see is created when the two forces meet and interact. The colors and glow are a result of the solar wind particles colliding with the gases of earth's atmosphere. The consequences are a magnificent technicolor light show that only nature can present. The aurora borealis is a visual gift for all who behold them.



Note: For a more detailed study of the Aurora borealis see the book *Aurora—The Northern Lights in Mythology, History, and Science* by Harald Falck-Ytter, ISBN 0-88010-123-7, New York: Anthroposophical Press, 1983. It is also available from Floris Books.

A Visit to Kassel, Germany

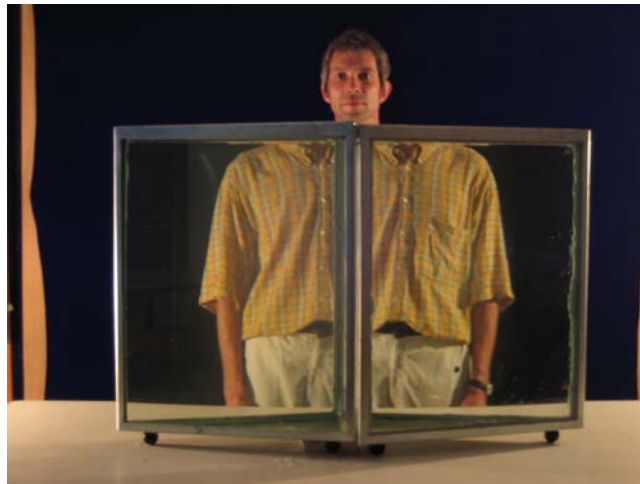
Phenomenological Science Equipment

David Mitchell

Recently, I had the opportunity to visit the Pädagogische Forschungsstelle in Kassel, Germany, where they specialize in research into phenomenological, or Goethean science. Several of the students from the teacher training presented demonstrations and then I was able to view the “teaching aids” that they had created for purchase by the European Waldorf schools. I was most fascinated by the new device to measure microwave transmissions, and the results they demonstrated to me coming from a cell phone.

Thinking that many Waldorf schools in North America might be interested in obtaining the equipment they have developed, I have included photographs of some of them below. I exclude electrical equipment because the European system is set for 220 volts, however when you see the pictures in their catalog you can substitute 110 volt motors. The catalog is available by writing to:

Bildungswerk Beruf und Umwelt
Lehrmittelabteilung
Brabanter Str. 45
34131 Kassel, Germany
Phone: 001-561 - 37206
Fax 001 561 - 3162189
Info@lehrerseminar-forschung.de
www.lehrerseminar-forschung.de



Optics—Large Water Prism

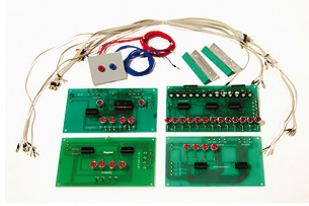




Physics—200 Toothed Disk For Measuring Frequencies



Physics—Static Electricity Generator



Computers—Mother Boards, etc.



Chemistry—Gas Burner



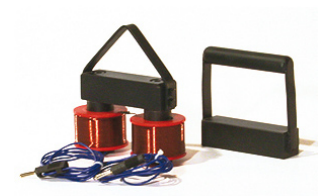
Physics—Motor Assembly Kit



Physics—Aluminum Conductors



Physics—Wooden Block & Tackle



Physics—Electromagnet



Physics—Ash Wave Lever



Geometry—Drawing Compass

HUMOR

fi yuo cna raed tihs, yuo hvae a sgtrane mnid too. Cna yuo raed tihs?

Olnty 55 plepoe out of 100 can.

i cdnuolt blveiee taht I cluod aulacly uesdnatnrd waht I was rdanieg. The phaonmneal pweor of the hmuan mnid, aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it dseno't mtaetr in waht oerdr the ltteres in a wrod are, the olnty iproamtnt tihng is taht the frsit and lsat ltteer be in the rghit pclae. The rset can be a taotl mses and you can sitll raed it whotuit a pboerlm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe. Azanmig huh? yaeh and I awlyas tghuhot slpeling was ipmorantt!

The Karma of Calculus

Involving Isaac Newton and Gottfried Leibniz

Like most discoveries, calculus was the culmination of centuries of work rather than an instant epiphany. Mathematicians all over the world contributed to its development, but the two most recognized discoverers of calculus are Isaac Newton and Gottfried Wilhelm Leibniz, both of whom appear to have received enlightenment at relatively the same point in time. Although the credit is currently given to both men, there was a time when the debate over which of them truly deserved the recognition was both heated and widespread.

As the renowned author of *Principia* (1687) as well as a host of equally esteemed published works, it appears that Newton not only went much further in exploring the applications of calculus than Leibniz did, but he also ventured down a different road. Leibniz and Newton had very different views of calculus in that Newton's was based on limits and concrete reality, while Leibniz focused more on the infinite and the abstract (Struik, 1948). However, regardless of the divergent paths these two scholars chose to venture down, the question of who took the first step remained the primary issue of debate.

Unaware that Newton was reported to have discovered similar methods, Leibniz discovered "his" calculus in Paris between 1673 and 1676 (Ball, 1908). By 1676, Leibniz realized that he was onto something "big," he just didn't realize that Newton was on to the same big discovery because Newton was remaining somewhat tight lipped about his breakthroughs. In fact, it was actually the delayed publication of Newton's findings that caused the entire controversy. Leibniz published the first account of differential calculus in 1684 and then published the explanation of integral calculus in 1686 (Boyer, 1968).

Newton did not publish his findings until 1687. Yet evidence shows that Newton discovered his theories of fluxional calculus in 1665 and 1666, after having studied the work of other mathematicians such as Barrows and Wallis (Struik, 1948). Evidence also shows that Newton was the first to establish the general method called the "theory of fluxions," was the first to state the fundamental theorem of calculus, and was also the first to explore applications of both integration and differentiation in a single work (Struik, 1948). However, since Leibniz was the first to publish a dissertation on calculus, he was given the total credit for the discovery for a number of years. This later led, of course, to accusations of plagiarism being hurled relentlessly in the direction of Leibniz.

There was speculation that Leibniz may have gleaned some of his insights from two of Newton's manuscripts on fluxions, and this is what sparked his understanding of calculus. Many believed that Leibniz used Newton's unpublished ideas, created a new notation and then published it as his own, which would obviously constitute plagiarism. The rumor that Leibniz may have seen some of Newton's manuscripts left little doubt in most people's minds as to whether or not Leibniz arrived at his conclusions independently. The rumor was, after all, believable because Newton had admittedly bounced his ideas off a handful of colleagues, some of who were also in close contact with Leibniz (Boyer, 1968).

It is also known that Leibniz and Newton corresponded by letter quite regularly, and they most often discussed the subject of mathematics (Boyer, 1968). In fact, Newton first described his methods, formulas and concepts of calculus, including his binomial theorem, fluxions and tangents, in letters he wrote to Leibniz (Ball, 1908). However an examination of Leibniz' unpublished manuscripts provided evidence that despite his correspondence with Newton, he had come to his own conclusions about calculus already. The letters may then, have merely helped Leibniz to expand upon his own initial ideas.

The question of the date at which these extracts were made is therefore all important. It is known that a copy of Newton's manuscript had been sent to Tschirnhausen in May, 1675, and as in that year he and Leibniz were engaged together on a piece of work, it is not impossible that these extracts were made then. It is also possible that they may have been made in 1676, for Leibniz discussed the question of analysis by infinite series with Collins and Oldenburg in that year, and it is a priori probable that they would have then shown him the manuscript of Newton on that subject, a copy of which was possessed by one or both of them. On the other hand it may be supposed that Leibniz made the extracts from the printed copy in or after 1704. Leibniz shortly before his death admitted in a letter to Conti that in 1676 Collins had shown him some Newtonian papers, but implied that they were of little or no value,—presumably he referred to Newton's letters of June 13 and Oct. 24, 1676, and to the letter of Dec. 10, 1672, on the method of tangents, extracts from which accompanied the letter of June 13,—but it is remarkable that, on the receipt of these letters, Leibniz should have made no further inquiries, unless he was already aware from other sources of the method followed by Newton (Ball, 1908).

While Newton had many allies rallying in his favor, Leibniz had only one: John Bernoulli, who in a letter, tried to cast doubt upon Newton's credibility. When Bernoulli was later asked to comment on the letter, he denied ever writing it, which caused Newton to aver: I have never grasped at fame among foreign nations, but I am very desirous to preserve my character for honesty, which the author of that epistle, as if by the authority of a great judge, had endeavored to wrest from me. Now that I am old, I have little pleasure in mathematical studies, and I have never tried to propagate my opinions over the world, but I have rather taken care not to involve myself in disputes on account of them (Ball, 1908).

In 1715, just a year before Leibniz death, the Royal Society handed down their verdict crediting Sir Isaac Newton with the discovery of calculus. It was also stated that Leibniz was guilty of plagiarism because of certain letters he was supposed to have seen (Ball, 1908). It later became known that these accusations were false, and both men were then given credit, but not until after Leibniz had already died. In fact, the controversy over who really deserved the credit for discovering calculus continued to rage on long after Leibniz' death in 1716 (Struik, 1948). Newton and his associates even tried to get the ambassadors of the London diplomatic corps to review his old manuscripts and letters, in the hopes that they would endorse the finding of the Royal Society that Leibniz had plagiarized his findings regarding calculus. Another argument on the side promoting the idea of Leibniz as a plagiarist was the fact that he used an alternate set of symbols. Leibniz specifically set out to develop a more meticulous notation system than Newton's, and he developed the integral sign ($\int$) and the 'd' sign, which are still used today (O'Connor, 1996). However this action was argued by many to be merely a way for Leibniz to "cover his tracks" so as not to get accused of stealing Newton's material (Boyer, 1968). The fact that the method was more efficient was considered to be an ancillary benefit. The fact is that Leibniz sent letters to Newton outlining his own presentation of his own methods, and these letters focused quite stringently upon the subject of tangents and curves. Because Newton had been approaching calculus primarily in regards to its applications to physics, he purported curves to be the creation of the motion of points while perceiving velocity to be the primary derivative. Conversely, the calculus of Leibniz was applied more to discoveries in geometry made by scholars such as Descartes and Pascal. Since "Leibniz' approach was geometrical," the notation of the differential calculus and many of the general rules for calculating derivatives are still used today, while Newton's approach, which has in many aspects, fallen by the wayside, was "primarily cinemactical" (Struik, 1948).

Despite the ruling of the Royal Society, mathematics throughout the eighteenth century was typified by an elaboration of the differential and integral calculus in which mathematicians generally discarded Newton's fluxional calculus in favor of the new methods presented by Leibniz. Nevertheless, in England, the controversy was viewed as an attempt to pilfer Newton's glory simply because of international egotism. Consequently, as a matter of "national pride," England

refused to teach anything but Newton's discoveries of geometrical and fluxional methods for over a century. So while other countries were integrating various findings that occurred over time and were progressing in their discoveries, England remained essentially stagnant in the realm of mathematical discovery. In fact, it wasn't until 1820 that England finally agreed to recognize the work of mathematicians from any other countries (Ball, 1908).

With modern controversies covering such volatile topics as abortion and gun control, a debate over who discovered calculus may seem somewhat trivial by contemporary standards. However at the time, this was a serious issue that not only involved matters of mathematical discovery but also matters of national pride and allegiance. What is important to keep in perspective is that no matter who actually discovered calculus first, both Newton and Leibniz made great contributions to the advancement of mathematical processes, and for this both deserve credit.

—DSM

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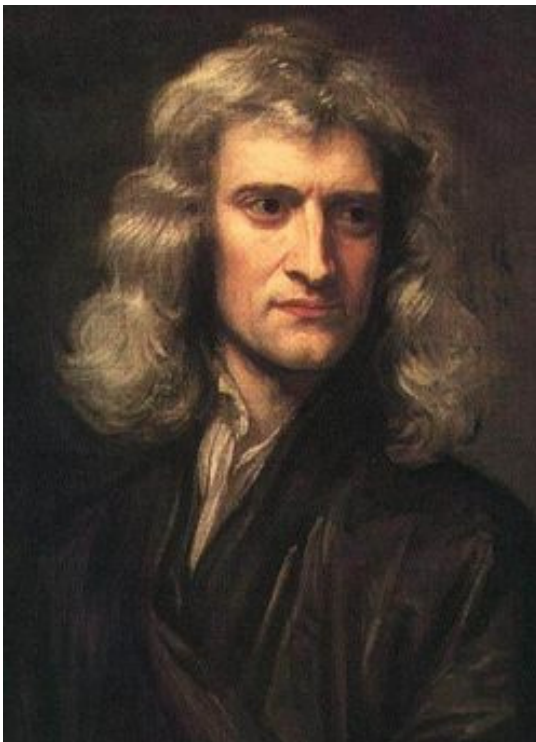
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O'Connor, John J. *The Rise of Calculus*, St Andrews, Scotland: 1996.

Struik, Dirk. *A Concise History of Mathematics*, New York, New York: Dover Publications, Inc., 1948.

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<http://www.angelfire.com/md/byme/mathsample.html>

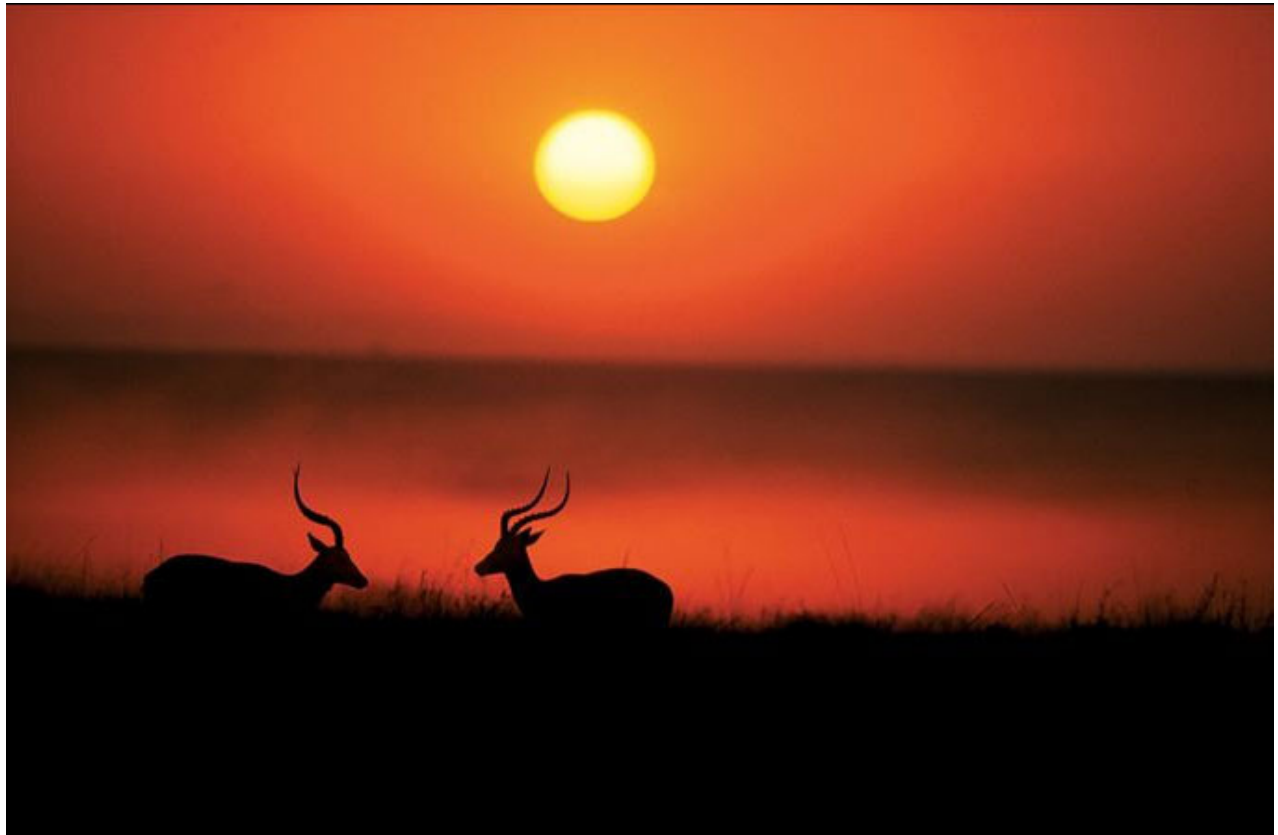


Sir Isaac Newton 1643–1727



Gottfried Wilhelm Leibniz 1646–1716

AWARD WINNING PHOTOS OF NATURE AND ANIMALS









If you would like an electronic file of any of these photographs for printing and hanging in your classroom please write to me identifying the picture and I will send you an electronic file.
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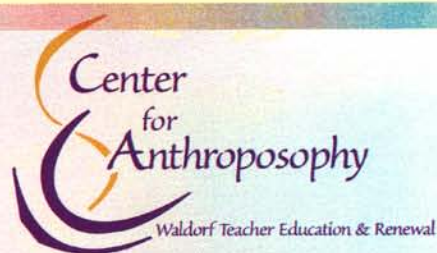
Teaching High School Physical & Life Sciences

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 Summer Session
- | Adolescent Development and High School Curriculum Overview
 - | Living Thinking: The Practice of Phenomenology
 - | Subject Seminar I: Life Sciences or Physical Sciences
 - | Courses selected from drama, drawing, eurythmy, music, painting, sculpture, spatial dynamics, speech
- Fall and Spring
- | Independent study and research in physical or life sciences
 - | Observation of high school science classes and labs
 - | Artistic apprenticeship, including sketching of nature phenomena
- Year II Summer Session
- | Esoteric Science
 - | Subject Seminar II: Life Sciences or Physical Sciences
 - | Professional Seminar: Science and Art of High School Teaching
 - | Further artistic courses
- Fall and Spring
- | Independent science research and thesis
 - | Artistic apprenticeship, including laboratory drawing
- Year III Summer Session
- | Education for Adolescents / Foundations of Human Experience
 - | Social Development of the Teenager
 - | Subject Seminar III: Life Sciences or Physical Sciences
 - | Further artistic courses

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



Renewal Courses 2008

Join us in the peaceful rolling hills of Southern New Hampshire for a 5-day retreat of reflection, artistic immersion, and social sharing. This year's course titles bring personal rejuvenation and social renewal through anthroposophical study, art, healthy food and good fun.

WEEK 1: JUNE 29-JULY 4

Turning Darkness into Light: How Can We Live a Spiritual Life in a Materialistic World?

with Marijo Rogers and Torin Finser

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Light, Darkness and Color: Veilpainting to Keep the Heart Warm with Karine Munk Finser

Deepening the Waldorf Curriculum through Painting, Drawing, and Clay Modelling in 6th, 7th & 8th Grade with Georg Locher

The Healing Art of Handwork: Creating a Stuffed Animal with Sandy Pearson and Teresita Gomez

Teaching the Sciences in Grades 5 & 6: Botany, Geology, Astronomy and Physics with Roberto Trostli

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

The Art of the Actor/ The Art of Living: Transformation and Renewal through Imagination, Movement, and Space with Glen Williamson

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

Yellow Sound: A Creativity Studio in Poetry and Visual Arts with Patrice Pinette and Susan Quaglia Brown, with guest presentation by Thomas Moore

Keep Them Moving! How to Enliven the Curriculum in the 6th, 7th & 8th Grades with Christopher Sblendorio

WEEK 2: JULY 6-11

Awakening to Nature: Biodynamic Gardening & Nature Observation as a Path of Spiritual Development with Chris Korrow

Teaching the World Languages: From Imagination to Cognition with Lori Johnson, Robert Sim and Julia Nunez

Projective Geometry with Jamie York

Personal and Organization Renewal: From Survival to Success with Leonore Russell and Torin Finser, with guest presentation by Siegfried Finser

Transformation of Self Through Intuitive Thinking and Artistic Perception with Georg Locher, Douglas Gerwin and Martha Rose Kelder

Teaching the Sciences in Grades 7 & 8: Anatomy, Physiology, Physics, Chemistry with Roberto Trostli

The Extra Lesson for the Whole Class: Helping Children and Adolescents Overcome Hindrances with Connie Helms and Hanneke van Riel

The Art of the Puppet: Archetypes Versus Stereotypes with Janene Ping

Preparing for the Sixth Epoch with Christopher Bamford



CONTACT: Karine Munk Finser, Coordinator

P. O. Box 545, Wilton, NH 03086

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info@centerforanthroposophy.org • www.centerforanthroposophy.org

Physics, Phenomena, and Personal Growth in Waldorf Education

What? Why? And What Else?

The Physics Curriculum in the Waldorf School

October 17—19, 2008

Rudolf Steiner College

Rudolf Steiner College in partnership with the Research Institute for Waldorf Education would like to offer a colloquium on the teaching of Physics to be held at the Rudolf Steiner College from October 17–19, 2008. We encourage each Waldorf high school to send a representative as well as Waldorf schools with grades 6–8. Our intention is to have discussions where we explore the depths of the Physics curriculum and anticipate the future. We welcome key questions in advance from the participants, will also discuss the particular nature of demonstration versus experimentation and how to find the correct balance.

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and more

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303/541-9244
d_mitchell@mindspring.com



June 22-28, 2008

The Plant as a Teacher of Living Thinking

a one week summer course at The Nature Institute

Our modern culture cultivates abstract thought that leads to fragmented modes of understanding and interacting with the world. But nature herself is whole and integrated. Can we learn from nature how to think and act in more living, whole ways? Imagine gaining such flexibility of thought that our ideas are no longer rigid, static and object-like, but grow, transform, and when necessary, die away. And as with plant forms, what if our thoughts and actions grew out of a context-sensitive relation to the world we inhabit? The Nature Institute, 20 May Hill Road, Ghent, NY 12075, 518-672-0116, info@natureinstitute.org, www.natureinstitute.org

July 6-12, 2008

Bringing Science to Life

a continuing education program for high school science teachers

Teaching science in high school is a challenge. And teaching it in a manner that allows students to experience and question the world is an even greater one. Too often their world is one in which receiving information takes precedence over active, self-directed exploration, a world in which nature unfolds its splendors in digitally enhanced magnificence on a flat screen, a world in which science is more a matter of answers than questions. How do we awaken in students a sense of wonder for direct experience? How can this grow into true interest that stimulates exploration and leads to deeper understanding and engagement in life?

Unfortunately, our modern culture and educational system do little to prepare us to guide students along this path of experience-based learning. To question what we take for granted and to engage in open-ended inquiry is as much a struggle for the teacher as it is for students. Too many explanations can cloud our vision, just as too little insight can leave us blind. How do I as a teacher learn to see with fresh eyes? Can I learn to practice the capacities that I hope the students will attain?

Bringing Science to Life is a course that wants to address these questions in relation to high school science education. It is for practicing teachers and will run over three summers with a one-week course each year. The summer sessions will be a mix of seminars, group project work, and dialogue. The seminars and projects will explore the concrete practice of phenomenological methodology, the living relation between experience and scientific concept formation, and the spiritual psychology of learning.

Collegial dialogue will be an important part of this course. Since peer exchange and active involvement in the learning process is an important and often neglected component of effective adult education, there will be opportunity to consider educational questions that the attending teachers feel to be most pressing in their day-to-day work. The Nature Institute, 20 May Hill Road, Ghent, NY 12075, 518-672-0116, info@natureinstitute.org, www.natureinstitute.org

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

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Volume 4, #8

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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

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