



Waldorf Science

Explorations in Phenomenology as Practiced in Waldorf Schools

A Science News Roundletter

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NOTE FROM THE EDITORS

Last year research was published on science teaching in the Waldorf schools by Professors David Jelinek and Li-Ling Sun of California State University in Sacramento. Many of us participated in the study, took a survey, or engaged in a conversation with the researcher. The results of the student testing were especially positive, however the researchers judged that Waldorf science was “pseudo science.” Basically, they condemned the use of Steiner as a source of accurate scientific concepts and measured our teaching of phenomenology by main-stream views. Their view seems to be that there is only one correct approach to science and anything different is pseudoscience. Conversations with the researcher brought about retractions of some statements, but those of us studying his paper had to acknowledge that there were several valid criticisms and that Waldorf science teaching in many schools was not always up to the high standard we expect.

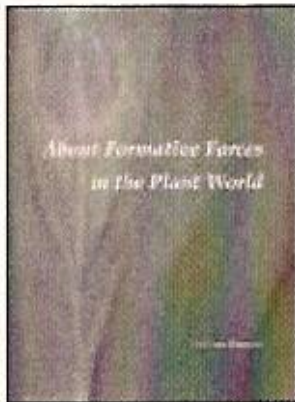
At the AWSNA annual meeting in Chicago, David Mitchell and Douglas Gerwin reported on the research and

challenged the Delegates to come up with their perception of the problem and how it might be remedied. A survey was handed out and the results were tabulated. In January at the AWSNA Delegates meeting in New York, David and Douglas will share the steps that have been taken, draw forth new insights, and encourage the faculties of each Waldorf school to do the following:

1. Hand out descriptions of phenomenological/ Goethean science for each fifth grade teacher (as well as any new teacher in 6-8) [two essays found in this issue].
2. Have a faculty library with relevant science books available [a preliminary recommended list is in this issue].
3. Request that teachers entering the middle school to attend one of the WHSRP sponsored workshops on science teaching in your area [details will be provided].

(Continued on page 36)

Books of Note



About Formative Forces

by Dick van Romunde, ISBN 0-9675056-1-5, 2003
Hardcover, 163 pages, published by Jannebeth Röell,
available from AWSNA Publications

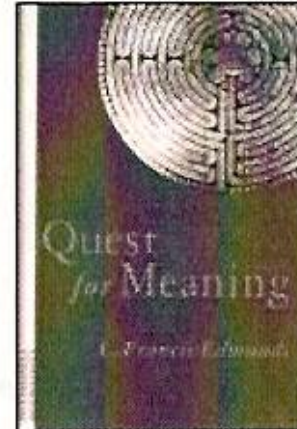
This book offers the reader an intimate approach to understanding and observing plants. Drawing from the insights first introduced by Johann Wolfgang von Goethe and further developed by Rudolf Steiner, the author demonstrates a phenomenological approach to Botany.

The "Goethean" approach used by the author engages the reader to use astute powers of observation, rigorous penetration of thinking, and the full activity of all the senses before stilling oneself to allow the plant to speak to your intuition to approach an intimate yet lucid awareness of the full nature of the plant.

This contemplative approach has distinctive stages which the author guides the reader..

In nine chapters with titles such as "Petal Structures," "Bilateral Symmetry in Flowers," "Parallel Veined Leaf Structures," and so forth, he describes many individual plants such as the Wild Tulip, the Garden Hyacinth, the Chive, the White Water Lilly, the Crocus, to name but a few. These descriptions enable the reader to see plant life in a new way.

I consider this book to be an outstanding source for all adults unafraid to see the world in a new way and eager to unfold a heretofore hidden capacity within their own thinking.



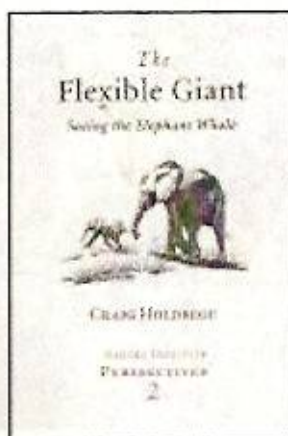
Quest for Meaning

by L. Francis Edmunds, ISBN 0-8264-1070-7, 1997
Hardcover, 372 pages, published by The Continuum
Publishing Company

Those readers interested in a rich background in the evolution of scientific thinking as a foundation for understanding modern life will find this book to be a treat.

The book is a selective survey of history and the development of science in which Francis Edmonds illustrates how the quest for meaning of Galileo, Copernicus, Newton, Harvey, Darwin, and Einstein, led to discoveries which now shape our existence and dominate our consciousness.

Edmunds also reveals how Goethe, Chardin, and Steiner introduced innovative concepts which lead us towards a new spiritualized understanding of science which contains inner perspicacity, moral integrity, and environmental wholeness. He guides the reader to an understanding of how consciousness can transform science from a cold, computerized, mechanistic, and materialistic discipline to a knowledge which recognizes the spiritual significance of humankind and our earth.



The Flexible Giant

Seeing the Elephant Whole

by Craig Holdrege

ISBN 0-9675056-1-5, 2003

Softcover, 163 pages, published by The Nature Institute, available from AWSNA Publications

Craig Holdrege traveled to Africa to observe animals in the wild. Upon his return he wrote this remarkable little book about elephants that is a “must read” for Waldorf teachers at all levels. You should not only use it as a source book for describing elephants in your zoology or “man and animal” blocks, however. When you read it pay keen attention to “how” Craig brings this wonderful animal to life in the pages of his book and then your own creative powers will be enhanced as you describe any animal, insect, plant, or even mineral that you teach. The “wholeness” of the elephant is portrayed and through this portrayal you learn about yourself.

Below is summarized a description of his journey in Craig’s words:

“A large herd of elephants we counted sixty-three individuals—crossed the sandy track along which we were driving. We stopped and observed. As they walked, the elephants enwrapped tufts of grass with their trunks and shook them back and forth, removing the soil; then they curled their trunks inward and brought the grass into their mouths and began their to and fro grinding. This was a mixed herd with all age groups. Anne helped us to distinguish males and females by the shape of the head -- females have a sharper angle between forehead and the more horizontal, rear part of the head, while males have a more gradually rounded forehead.

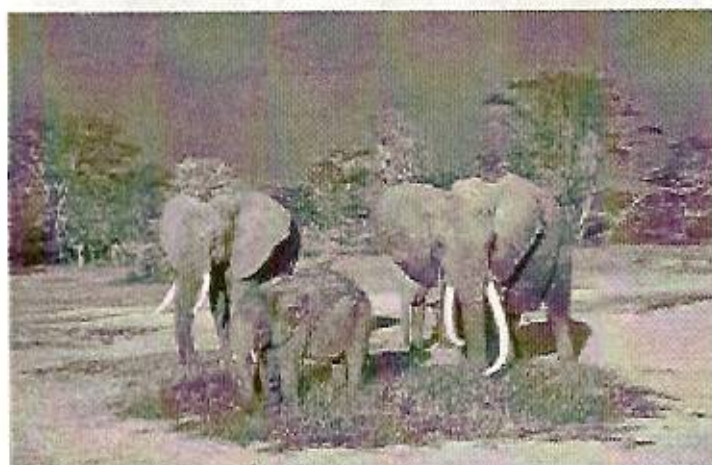


Young African elephant running

“There was one tiny baby, almost newborn, with its trunk flailing about. The end portion of the trunk always seems a bit limp in very young elephants—it lacks the muscular dexterity apparent in the trunks of older animals. Because of this it is always humorous to look at these little (comparatively speaking!) animals walking quickly about with this swaying appendage they do not yet fully command.

“At one point we heard trumpeting coming from the woods as more elephants emerged into the open and scrubby area. As the elephants walked, they continually flapped their large ears. Although their ears and trunks always seem active, the huge bulk of the animals with their smooth and flowing gait (no bobbing up and down) radiates calm and inwardness.

“These elephants took little note of us. None put up its trunk to catch our scent more accurately, as others have done on previous occasions. Elephants are not, in contrast to giraffes, visual animals. They do not look at you unless you are close enough to smell and hear. This herd moved off to a watering hole. There they drank and sprayed themselves with mud. . . .”



Family of African elephants



The Beaver

Castor canadensis

Kingdom:	Phylum:	Class:	Order:	Family:
Animalia	Chordata	Mammalia	Rodentia	Castoridae
Animals	Vertebrates	Mammals	Rodents	Beaver

by
Jeff Minton

Professor of Biology
University of Colorado
(printed with permission of the author)

The beaver has several morphological adaptations that allow it to live in the water and restructure its environment. This natural engineer builds dams to grow more food and provide protection from its predators.

The beaver is the largest rodent in North America. Their fur is a rich, lustrous reddish brown, except for the belly, which is buff or gray.



Among its morphological features are: Webbed hind feet for swimming; closable nostrils to exclude water, thick warm fur for insulation in cold water, and a long, flat tail that serves as a rudder.

The tail also serves as a prop for standing upright and as a lever when dragging logs. A loud slap of the tail on the water warns other beavers of impending danger.



Beavers have physiological adaptations as well, for they can stay underwater as long as 20 minutes when avoiding predators.

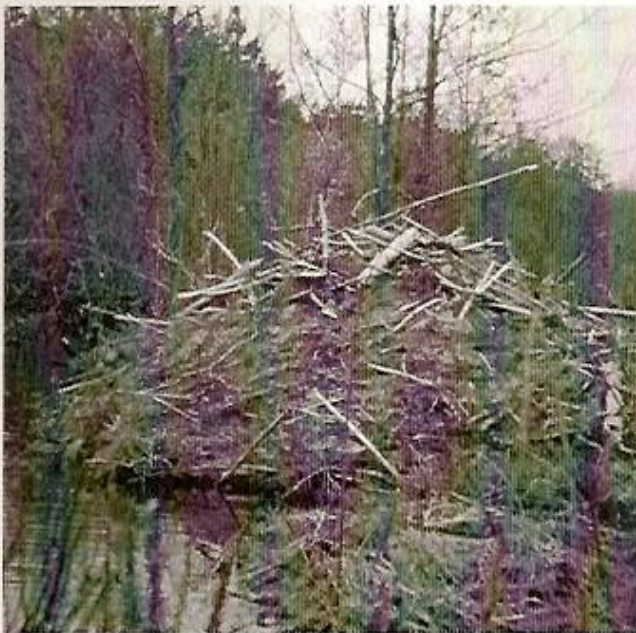
With their powerful jaws and sharp teeth, beavers gnaw I trees off at the base, then drag them to the water, where they are either stored as winter food or incorporated into the dam.

A single beaver can fen as many as 200 trees per year. Beavers find it difficult to drag trees over the ground, so they may dig a canal from the pond to a grove of trees, then float the trees back to the safety of the pond



Beavers build dams that block streams and create ponds. The ponds and associated marshes provide more habitat for the aquatic plants that they eat, and the ponds provide a safe haven from wolves, coyote, fox, mountain lion, and lynx. Dams, which can be as large as 5 feet high and 10 feet wide at the base, are constructed of sticks and logs, and are sealed with brush, mud and stones.

Beavers build a lodge in the pond, away from shore. The lodge is commonly constructed of willow branches and mud, and has an underwater entrance that leads to an internal platform above the water.



Some beavers live in rivers too large to be dammed, and too deep and swift for lodges. Beavers living in the Colorado River near Moab simply dig burrows—some as deep as 50 feet—into the bank. Two common expressions trace back to beavers. Historically, we credit the beaver with ingenuity and persistent industry, and by extension we refer to an avid worker as an “eager beaver.”

In the early 1800s, the best top hats and stovepipe hats were made from beaver fur. Hatters brushed the pelt with a solution of a mercurous nitrate to roughen the hairs so that they would mat into the finest felt, then steamed the felt into the appropriate shapes. Hatters who absorbed too much mercury developed mad hatter syndrome, characterized by tremors and irrational behavior. Today, we say that someone is “mad as a hatter.”



SPECIES DESCRIPTION

- Adult Total Length: 900-1,200 mm (36-60 in.)
- Tail: 225-300 mm (9-12 in.)
- Hind Foot: 150-163 mm (6-6 1/2 in.)
- Weight: 13.5-22 g (29-49 lbs.)

• Physical Characteristics: Beavers are the largest rodents native to North America. Some may occasionally weigh 50 pounds (22.5 kg) or more. The broad, flat, scaly tail is a key identification feature.

Beavers are brown to blackish-brown with slightly paler underparts. The dense pelage consists of fine, short underfur overlaid with long, coarse, shiny guard hairs. The ears are small and are set far back on the broad, rounded head. The flattened tail and webbed hind feet are black. Both the ears and the nose are equipped with valves that shut when the animal is underwater. The heavy, broad incisor teeth are dark orange-chestnut on their anterior surfaces.

Interesting Features Culled from Current Science Publications

The Physics Teacher—Vol. 41, November 2003, “A Triple Rainbow?” by Archibald W. Hendry,

Description from the viewpoint of optical path (line)-tracing of the location of a 3rd order rainbow close to the sun.

(See also Raimo Rask’s website on a Phenomenological Approach to Rainbows, with an observer-centric approach to similar questions: [http://www.clarinet.fi/~raimrask/](http://www.clarinet.fi/~raimrask/Rainbows.htm)

Rainbows.htm)

“A Demonstration Apparatus for the Cartesian Diver” by J. Güémez, C. Fiolhais, and M. Fiolhais pp. 495-496

American Journal of Physics—November 2003 Vol. 71, Issue 11

“How to hit home runs: Optimum baseball bat swing parameters for maximum range trajectories” by Gregory S. Sawicki, Mont Hubbard and William J. Stronge, pp. 1152-1162

Where you find that a well-hit curve ball will travel farther than a fastball or knuckleball.

Journal Chemical Education—August 2003 Vol. 80 p. 879.

“Oliver Sacks in Mendeleev’s Garden” letter from James L. Marshall

Describes his personal experiences with the wonder shown by Sacks as he explored the direct observation of elemental substances in Dr. Marshall’s collection.

Journal Chemical Education—September 2003 Vol. 80 No. 9

“Lithium Batteries: A Practical Application of Chemical Principles” by Richard S. Treptow

Practical discussion of the chemistry of lithium as related to the increasingly common lithium battery cell.

The Physics Teacher—December 2003—Volume 41, Issue 9, pp 537–541, “A Simple Apparatus for Optical Polarization Experiments,” by Kelly Kriebel and Joseph L. Powlette

An interesting simple apparatus that will serve for several more sophisticated demonstrations of polarization phenomena.

Journal Chemical Education—January 2004, Vol 81, No. 1, p 45, “Chemistry Perfumes Your Daily Life” by Anne-Dominique Fortineau

A fascinating overview of the natural products, and organic chemistry relating to perfumes an “highlights of fragrance chemistry” are given. (This is especially relevant for ninth grade chemistry of esters.)

NATURE IN THE HUMAN BEING

The Human Being in Nature in Support of an Ecology Main-Lesson in Class Nine

by

Walter Liebendorfer

Translated by William Forward

Paideia #12

When we study the human skeleton with our fourteen year-olds in Class Eight, there is often a surprising quietness among them. The very boys who were not exactly gentle with each other in the break now observe the fine structure of foot and leg with a certain reverence. We hold up drawings beside them which show the delicate curved course of the trajectories (directions taken by the osseous structure) within the joints. There are structures here which go beyond the individual parts of the skeleton. This is a source of wonder if one begins one's studies by focusing on details, perhaps even modelling a hip joint. It seems appropriate during the time of puberty to start with details which can be apprehended as sober facts and only then to discover for oneself the comprehensive structures that unite them. The bony structure referred to above, which is found in the spongiosa (tissue on the inside of the bone) makes it possible for us throughout the long period of growth of the skeleton and, indeed, throughout our lives, to overcome ever and again the dully perceived burden of gravity. The skeleton hardens, but despite this, never becomes too heavy. It is truly astonishing: matter, hard bony substance, is given lasting form by the activity of our will. Thus while jumping or climbing in the mountains, we can experience, now somewhat more consciously, something of this power which can overcome gravity something of the liberating levity which carries us through life. The power of uprightness, which forms us from early childhood on, right into the details of our bones and vertebrae, and thus sculpts the human form, both functionally and beautifully, has a certain mystery about it. In conventional physics we do not recognize the term levity, and Newton showed interest in the phenomenon of the falling apple, without, as far as we know, concerning himself unduly with the question of how it got up into the tree in the first place. Nevertheless the activity of this power which overcomes gravity may be clearly felt, particularly when from time to time, it is missing or weaker, or if, for one reason or another, we are downcast. Does not our fundamental experience of reality have something to do with a dull perception of the activity of our own will? That is to say, with effectiveness. How different, on the other hand, is the formation and structure of the skull. Particularly in the upper part of the skull, the bones are formed differently and even earlier than the bones of our arms and legs.

This so called skull casing develops like a shell around the brain as it forms itself. The structures that form it harden quickly, grow together, and then form the dome that we so much admire. There seems to be no will activity involved here and once this form has been completed it is difficult to alter it. Despite the completely opposite principles by which this is formed, the whole nevertheless contributes to the

uniform human being. We thus also discover the middle, the chest area, which is composed of both types of ossification. The plate forms typical of the skull and the spare bones typical of the extremities, which are developed in the course of one's youth.

During what is a turbulent time for all young people today, the time of puberty, which Steinel characterized with the more comprehensive expression, "ripeness for the earth", our pupils' attention is directed much more intensely than at first appears to the world of the adult. How often do they encounter prejudice, rules for the sake of rules; and how often, even resignation and indifference! All the while they carry within them a secret, scarcely formed question: What image of the human being does the adult carry within him? Is it a static image; or is there room in it for dynamic developments which might even bring about changes in the world of the adults?

The theme that we have sketched above, which naturally encompasses a great deal more (among other things it is important to deal with major sense organs in this connection), is to present to the Eighth Class as clearly and concretely as possible, a situation of the human being in the world. The central issue here is that they perceive the meaning of uprightness, which makes it possible for us to liberate ourselves from the ties of instinct and nature. This makes it possible for us to become conscious that we stand opposite things in the world. We can develop objective consciousness and can learn to know the world in increasing freedom.

From the Eighth to the Ninth Class: A Transition to the Active Human Being

If we now step into Class Nine as a subject teacher to introduce a natural science main-lesson, we find faces that have changed. The looks we get are questioning and challenging, and we may find that the classic formula 'anthropology is continued' which is to be found in the generally used and valued curriculum of the Waldorf schools (compiled by Caroline von Heydebrand) presents certain problems. Is it possible simply to continue anything at this time of general and necessary upheaval? Must not steps be taken, in the first place by teachers themselves, to awaken a new consciousness? Is it not our task to be versatile precisely in nurturing this new consciousness? This alone would enable us to introduce new developments. Questions like these led to an arrangement which has been tried in the classroom for a number of years, in a variety of different ways.

While, on the one hand, in Class Eight we pursued the question of the position of the human being in nature, i.e., a study in which the human being appears as an image, in the Ninth Class, on the other hand, we can look at the human being as an agent, as a creator of culture. We had seen how the human being became emancipated from the ties of nature in the whole composition of his bodily form. Can one now take the opposite route? If we succeed in finding such a path then this may have the consequence that the human being, whilst retaining the qualities that are in many ways emancipated from nature, can freely resolve and energetically strive with now considerably extended insight and knowledge, to re-integrate into nature as a whole. Still further: a human being might thus bestow new impulses for development on nature.

The Ecology Main-lesson—An Example From the Tropics

Taking this theme and searching for an answer to a question, it is worthwhile to take a particular, perhaps even a limited, geographical area, perhaps also with a

particular climate and vegetation, and study it in detail, such as the tropical rainforest and the savannah on its borders. What are the natural conditions here? How does plant life adapt to the soil conditions? Which animals live there? And not least, how have human beings lived in this area so far? What is the situation today? How will it be tomorrow? Scientific research now shows that there are alternative solutions for particular areas. As a basis for forming our own judgement we would do well to look at these alternatives. Thus in many tropical areas the significant growth in population is a completely new factor in relation to past history. This factor will have a considerable influence on natural events in one direction or another. Can our own research, even if it is initially carried out in the classroom, contribute anything of significance to the situation? If it is to do so we should give it the opportunity to develop over a certain number of years and achieve a certain maturity.

In our work in this main-lesson, we do not set ourselves the task of cataloguing the various organisms and natural influences, of studying them independently, and of giving them names. Far rather, we try to discover how one thing is linked with another. It very soon becomes apparent that these relationships are not those of cause and effect, in the way we so often expect. In the living world, different laws obtain. A concrete example will make this clear. In the African savannah, there is an harmonious equilibrium of grasses and trees which is maintained by the working together of a great variety of organisms. Thus, for instance, one may observe that a group of giraffes, which begins to graze at an acacia, moves on after a short while to start on another acacia. In the crown of the tree there are delicate feathery leaves which are skillfully nipped off by the giraffe using its long and subtle tongue. Among the leaves are long, pointed thorns some of which are swollen at their base. These are the home of ants, which had previously irritated the acacia, so that the swellings came about (as a result of the acacia's own activity), and could then provide homes for the ants. Now when the giraffes come along and begin to feed on the leaves, the ants are disturbed, and begin to irritate the giraffes. These then move on, but for this very reason are able later to return, which would not be possible if the acacia had lost too many of its leaves since it grows to the limits of its own potential. In the end, even we human beings derive pleasure from this process, for the deserted dwellings of the ants make a wonderful music in the wind. The Africans call this tree the flute acacia. We can see here one of the many networks of different life processes, some of which have not yet been researched scientifically. Each life form owes its existence to the other. Insights of this kind form a significant part of the new science of this century: ecology.

One of the classic researchers in this area, August Thienemann, points out that the concept ecology was first used by Ernst Haeckel. He used the word *oikos* in the sense of household and living relationships. However, ecology is not simply a matter of living relationships. We have to be capable of crossing boundaries in our thinking if we want to carry these relationships in our consciousness as a whole system. Comparable boundaries have already been crossed in this century in the realm of physics, and the renowned quantum physicist Arthur Zajonc even goes as far as to refer to an ecological consciousness. This means that we have to extend the boundaries of natural science, which has become excessively focused on individual objects, and look more at the relationships between organisms, and at the relationships between organisms and their environment. The important Finnish philosopher, Georg Henrik von Wright, agrees with the Anglo-American physicist Freeman Dyson that it is possible to develop a cosmic ecology. This does not mean that

the individual organism becomes meaningless, but rather that we can only understand it as an organism in the context of a multifarious living nexus within which we also have to take account of hierarchical differences within the kingdoms of nature.

The Human Being and Nature: Co-Operation or Destruction?

How does the human being relate to these complex living networks? There was a time in which it was thought one could distinguish in principle between people living in civilization and others entirely in natural surroundings. A closer look reveals, however, that all human being: bear the stamp of civilization to a greater or lesser extent; there is, of course, a considerable difference between peoples whose whole way of life revolves around nature, and the inhabitants of a big city such as, say, London. A number of detailed anthropological surveys are now available on the life of peoples or groups of tribes who were previously considered primitive races, for example, the Makuna Indians in the north western part of the Amazon.: Surveys have shown that this community, consisting of small villages of between 15 and 2 inhabitants, has developed a perfect integration within the local ecology with no sign of wastage. The Makunas live by hunting and by gathering widely dispersed fruits and seeds. They also cultivate areas left bare by fire which they desert after about three years, and which regenerate in the form of secondary forest within fifteen to twenty years. Their agrarian culture is diverse and there is no sign of want or malnutrition in any of their villages. The people have an extensive knowledge of the plants and animals, which they need for their nourishment and a complicated system of eating taboos and other rules that ensures moderation. Compared with the economy of the immigrant white settlers we find one significant difference: the consumption of the Makunas is based on needs, whereas the white settlers strive for the greatest possible production in the Shortest possible time. The latter results in the pillaging of both forests and rivers. Similar foods of highly developed ecological cultivation may be found in other places, for instance, among the Kayapo on the border of the Amazon forest with the savannah lands around it. There, too, husbandry is based on skilful use of slash and burn techniques. Gradually a picture emerges of tropical landscapes that have been cultivated for ages. At the same time nature was not left the poorer for it, but rather benefited in the form of greater differentiation in the various landscapes (as may be seen from the richer composition of formerly cultivated areas). Thus it is possible, in principle, that groups of human beings, sometimes even whole peoples, can integrate themselves harmoniously within an ecological network and, at the same time, enrich nature by means of new developments. Natural ecosystems are in any case subject to climatic change, volcanic eruptions or fire catastrophes, and generally show remarkable resilience. Sometimes indeed, a whole system is given a new direction. Thus, too, nature constantly takes up the cultural impulses of the human being and after a while brings them into a state of equilibrium. At least into the middle of this century our own European cultivated areas bore witness to this type of cooperation between nature and the human being.

Where the situation becomes problematical is when there is a combination of industrial thinking which is one-sidedly geared to production with massive use of scientifically oriented technology, and a strong increase in the population. There is a great need now in view of the widespread pessimism, even among the younger generation, to contemplate ways in which a positive development can be brought about, even by modern human beings who have lost touch with nature and are geared to urban life. They do exist, and could be brought about with some effort. What is certain is that we have no alternative but to bring about a change in our attitude to

nature. For this to come about our thinking needs to change in quality. It seems to me that the time of "ripeness for the earth" in the life of the human being is a particularly apt one for such a change to come about. It should perhaps begin with an acquired understanding of anthropology. In contrast to the animals, who have been wisely embedded in their various ecological niches-which is reflected in specialization right into anatomical detail and the instinctive behavior that goes with it - the human being is adapted for freedom by the form of his brain, his face, teeth, speech organs and, not least, by his hands, which have been preserved from any form of specialization.

However, freedom means not only emancipation but also the possibility of cooperation and communication. It may be seen as our task to show this by means of individual, well-chosen examples worked through thoroughly with the pupils. We may feel it is a great cultural task that we have to carry out in the field of pedagogy. Thus in my opinion a newly conceived anthropology of the senses, in which the senses are seen as intentional sense activity, is an area which could be very fruitful combined with the description of various animals and their peculiar sense organizations. Our whole civilization endows us for life with the view that our senses are receptive systems and thus makes the chasm between subject and object appear unalterable. It may, however, be demonstrated, that it is precisely our senses which have the capacity to unite us intimately with the world if they are cultivated appropriately. At a time in which multi-media culture is developing rapidly and expanding vigorously, this question is not merely a philosophical one. Other areas of research also seem to me to be very topical today: for example, research into the anthropology of speech and its application in contemporary pedagogy. The first beginnings of such research and the new perspectives it offers are already available. Once this has been discovered we can see rich fields of research opening up in social anthropology and also social ecology. What is essentially new in this research, is, as I have shown above, its whole approach. It is no longer a question of determining individual phenomena, perceived and treated as objects but rather a matter of seeing connections, and being willing and able to act out of an imaginative consciousness. If, in Class Eight, we can see with astonishment how individual bones develop within an overall network and are able to carry out their allotted task effectively within this, we can also develop, step by step, the corresponding concept of an ecological whole in Class Nine. This concept also includes our own existence to the extent that we are willing to take the leap from an anthropocentric to an ecocentric consciousness.

Walter Liebendorfer was the course leader at the Rudolf-Steiner-Seminariet in Jarna, Sweden. He taught for many years at the Kristoffersskolen in Stockholm.

ASTRONOMY FOR THE MIDDLE SCHOOL

Written by John Trevillion, class teacher at the Chicago Waldorf School, these wonderful verses help orient the children to space as well as provide them with vocabulary for understanding Astronomy.

Orienting to Heaven and Earth

[Teacher speaks-children respond with gestures]

Here I stand under the sky.	[Remember to face North]
The center of the world am I.	
My right hand points to the rising sun;	[Extend right hand]
My left hand shows where the day is done.	[Extend left hand]
My nose points to the cold North Star;	[Extend right arm forward]
My back is turned to where the warm lands are.	[Extend right arm backwards]
North. South, East, West.	[Repeat all 4 motions]
Where I stand I am at rest.	[Fold hands across chest]

[Class recitation]

In course of time Man's dwellings change;
My ancestors would find ours strange;
But overhead the sights I see
Are those that awed my ancestry.
We have a name for this our home:
We call it the celestial dome.

By day 'tis lit by one close star,
And o'er the Earth I can see far;
The sky is charged with azure through;
No other stars may pierce its blue.
When sky is blanketed with night,
Sun's distant cousins twinkle bright;
Like fleets superb and orderly
They sail across the celestial sea.

[Slowly raise extended left hand and
trace arc from East to West]

Of all this motion to make sense
I need some lines of referencel-
Lines which seem straight from where I gaze,
Yet circles are from other place.
Such lines which tharry curved and straight
Great Circles we do designate.

[Trace straight horizontal line]
[Trace large circle]

Extend your arm and point straight out
And slowly rotate once about;
With this motion I define
The Ideal Horizon in a line.

[As directed]

A straight line through my trunk I see
Extending to infinity.
At the point it locates in the sky
The Zenith I identify.
Below my feet another point
The Nadir I do thus anoint.

[Point straight up]

[Point straight down]

One star alone stays in one place,
And to it I direct my gaze.
Polaris this one star I name
And thus true North I can now claim.
A straight line from this star I draw
Through zenith and nadir without flaw;

[Point towards Pole Star]

[Slowly trace the great circle that
pass the 3 points indicated]

And tracing thus this circle round
The Meridian I have now found.

Point to Polaris straight and true
And imagine an axis running through.
Now point the other arm with care
To make with the first an angle square;
With one arm pointed at the Pole
Let the other around it roll.
This great circle which is the third
As Celestial Equator is referred.

[With right arm]

[Indicate extension briefly with left
arm then bring left arm to horizontal to
make a right angle-the right arm does not move]

[A very difficult challenge-
must be visualized carefully]

With circles three we thus can scan
With confidence the celestial plan.

EXTENSIONS:

As the course continues, other aspects of astronomy could also be internalized by means of poetry and motion, i.e., following a suitable introduction to the phenomena. The poem that follows was, in fact, the outcome of this author's introduction of a sixth grade class to astronomy. It was similarly broken down into parts which groups of students were asked to memorize and recite to their classmates. It was eventually presented to the entire school and parent body.

The order of the poem reflects the order in which astronomical phenomena were introduced. Again, look for opportunities to highlight the words and concepts with movement.

Stars

All stars from greatest to the least
Begin ascending in the East;
Unto the Meridian they rise,
Then sink into the western skies,
In groups called constellations we
Recall the patterns that we see.

A Dipper round the Pole revolves-
Thus, one great problem it resolves:
Two stars afore this celestial pot
To Pole Star point and help us spot.

The Dipper we can always see
Along with royal company:
A queen, shaped like a double-u,
Her husband and her daughter, too;
A winged horse and hero bold
Complete this circumpolar fold.

When to the South we turn our search,
Orion holds the central perch;
With faithful dogs he hunts the hare
Till weather foul gives way to fair.

Twelve constellations form a bow,
In winter high, in summer low;
The Zodiac we call this band;
It forms a background proud and grand-
For through this stellar company
Revolve Sun, Moon, and planetry.

The line on which these bodies move
Does yet one more great circle prove.
From time to time Moon hides the Sun,
Or Earth casts shadow on the Moon;
And for this solar shadow game,
This line the Ecliptic we do name.

The paths of stars, when they are viewed,
Depend upon your latitude.
Throughout the long, dark polar night
The stars in horizontal flight
Parade. But o'er the Equator
The star from out the East do soar.

And arcing semi-circularly,
They plunge into the western sea.
It's not surprising, you'll conclude,
That in our own mid-latitude
The stars do rise and set oblique
To th' horizon o'er which they streak.

Sun

What is the Sun? This much is right:
The source 'tis of all warmth and light.
All life is blessed by its warm rays;
Full worthy 'tis of all our praise.
From East to West it sails each day
Illumining all upon its way.

Near March and September twenty-first
Day equals night o'er all the Earth;
The Equinox of Spring and Fall
These two momentous days we call.

When day is longest, night most short,
June twenty-first we'll like report;
With Summer Solstice we rejoice.
Sing Summer's praises with one voice.

Moon

The Sun commands all in the day
But in the night the Moon holds sway,
Casting light in less degree,
Yet with enchanting majesty;
Though if the truth be known in full,
The Moon reflects the light of Sol.

Now like the Earth the Moon's a sphere-
At any time one half is clear
With light of day, while th' other side
In gloomy darkness must abide.
Throughout the course of twenty-nine
days
The Moon appears in varying phase
As round the Earth it makes its route
Twelve times a year or thereabout.

Each month the Moon will disappear-
The New Moon we do call it here.
Then from an evening Crescent fine
It waxes Full in two weeks' time,
Then wanes unto the New Moon when
The Lunar Cycle starts again.

Planets

Among the stars that cross the sky
The order fixed some do defy;
These wand'ers five are planets named
And by the ancients were much famed.

Two planets neighbor our bright Sun
And sighted are when day is done,
Or when the dawn breaks, then we see
Bright Venus and faint Mercury.

The other three swing to and fro
Along the Ecliptic as they go:
Mars, warlike and with fire singed,
High Jupiter and Saturn ringed.

Three other planets we can hope
To see with aid of telescope:
Uranus, Neptune, Pluto far
Belong with Earth unto one star;
The Solar System we define
The Father Sun and planets nine.
And having named this family
We end this course in astronomy.

REFERENCES:

Mirbt, C.A. *An Introduction to a Study of the Stars*, Fair Oaks, CA: AWSNA Publications, 1994.
Baravalle, Dr. Hermann von. *Astronomy*, [out of print, obtain from the Rudolf Steiner Library].

Child Development and the Teaching of Science

Stimulation of the Senses → Astute Observation → Rigorous Training in Thinking → Phenomenological Thinking

by

David Mitchell

Waldorf education works with the developmental stages of growth in children. The harmonious unfolding of the personality depends on the healthy maturation of each developmental stage, and each progression builds upon the one before it. Strengthening a child's later cognition in science begins with the building of a strong foundation in the early years, initially by parents and family and later by teachers.

Preschool children are informed about the world through their bodily or sense impressions. The wonder in the world passes directly into their physical, sensory organization through every experience they encounter. Impressions are stored as cellular memory as the organs of the body are being sculpted. Young children have a feeling of "oneness" with the world, and the world is their teacher. These sensory engravings later become the basis upon which scientific cognition is founded.

What can parents do to help their children? Parents have the opportunity to enrich this time of development by surrounding their children with beauty, rhythm, and activities that appropriately stimulate the senses. The nourishment the parent provides for the child builds security in the world and allows for the gradual awakening of the individuality or self. In the early years everything coming toward the child from the environment requires adult attention and discretion; sounds, tastes, light sources, and all outer impressions which could possibly over-stimulate the child's sense life and throw it into imbalance need to be monitored.

To constructively aid development, adults could arrange activities so the children are consciously exposed to different smells (acrid, sweet, pungent), tastes (salty, sweet, sour), surfaces (smooth, rough, soft, and so on). However, parents should be cautious that their efforts do not over-stimulate the child through too much structured activity. Additionally, too much conversation with the child regarding conclusions or ideas relating to the sensory impressions should also be avoided. They could be encouraged to practice balancing on logs and stones; they could jump rope and be introduced to other games requiring rhythmic movement and spatial awareness. Warm, cool, hot, and tepid should become living experiences, and lightness, heaviness, bigness and smallness should be understood through wakeful activity. All of the primary senses need to be set to work. A good place to do this is the kitchen where science underlies every activity.

The children can experience the smell of yeast as the bread rises (fermentation) as well as the transformation of the bread as it is being baked; they could on special occasions experience the old traditional kitchen tasks of boiling fruit and jelling jams with pectin, the caramelizing of sugar, the separation of whey from milk, and the aroma of eggs being fried or custard being baked with nutmeg. In the kitchen, the mother and father become resident chemists, and if they ensoul their activity with love, they will fill the child's soul with warmth, and the child will help develop a loving relationship for learning and experimenting as he observes and imitates the parents. These participatory activities become the foundation stones for a later acquired scientific thinking.

The ages between three and five is the time when the children are learning to comprehend weight (mass)—but understanding it directly through their limbs and senses. Once, at a birthday party for one of our four children, I made the mistake of cutting the birthday cake disproportionately. My four-year-old daughter complained to me that her older sister had received a larger piece. Quietly, I reached over and cut hers in half and said, "There, now you have two," and she was satisfied. This would not work with a child past the age of seven.

Try never to answer a child's scientific questions with dead or fixed concepts. A young child does not have the ability to fully comprehend scientific abstraction. Children need living pictures that fill their souls with wonder and surprise, not dead abstract reasoning. Their inner imaging becomes vitalized when an observation awakens a feeling of reverence. Reverence and a sense of wonder are the groundwork that Waldorf education uses to build its science curriculum.

It is interesting to consider the derivation of the word "science." It evolved from the Latin word *scientia* which means "knowledge." In science knowledge is acquired through observation. The task for teachers and parents of young children is to create the conditions to experience wonder and love from they meet in the world. Most every Sunday, when our for children were small, my wife and I would take them for a walk around the neighborhood "ring road" in wooded southern New Hampshire. On every stroll the children darted from side to side noticing new growth, patterns in the flow of the small stream, the sound of our feet shuffling through snow at different temperatures, the shape of seed pods, and the crunchy quality of dead plants in January. We said very little but acknowledged their treasures. This type of activity in early childhood opens capacities needed for science when they reach puberty.

How does one observe? The word "observation" has the roots of two words within it—"serve" and "object." This is the key to the activity of looking at something; we ask the children "to serve the object." In other words, we ask them to put aside their feelings, their sympathies and antipathies, their preconceived notions and to ultimately allow the phenomena itself to speak directly to them, to fill their soul.

Some of the activities which help lay a healthy foundation for scientific thinking in the elementary school child involve activities in nature—walks where the child's observation is stimulated to notice the seeds in the swaying grasses, the pattern of the bark on different trees, the glitter within a rock, the geometry of a particular leaf or flower, the reflection in a puddle, and so on. The important thing at this stage is not to allow judgments or concepts to become fixed. Rather, let the observations stand, expand upon them, and provide opportunities for experimentation and comparison. The children do not require overt adult direction; they need merely to live into the world of nature freely, allowing their own experiences to build. Friedrich Schiller referred to the thinking capacity thus developed as the foundation of what in later life is called "*spieltrieb*" (playful thinking).

Some years ago I presented a lecture on patterns in water movement and "Vibrella Flowforms" to the *Philomorphs* at Harvard University. Attending my lecture was Professor Philip Morrison, chair of the physics department at M.I.T. Dr. Morrison was the former group leader of the Manhattan Project at the University of Chicago and is a columnist for *Scientific American* magazine. After my talk he lingered and we entered into conversation. He mentioned to me in encouragement, "Many of the most important scientific discoveries had been made by scientist at play." I am certain he was referring to this quality of uninhibited "playful thinking."

In the Waldorf first grade the children meet the metamorphosis of the butterfly and the wisdom imbedded in the various fairy tales. Minerals are available in the classroom as

are a terrarium and plants that require human care and consciousness. Academically, the teacher refrains from dry facts or platitudes and strives to build up inner pictures of living organisms. The children's minds are allowed flexibility and expansiveness. The "wholeness" and "security in the world" is emphasized.

In the second grade the class meets the fables. In a fable, such as "The Wolf and the Lamb" by Aesop, the teacher can ask questions which the class can answer out of their own collective observations. How do the wolf and the lamb walk? Both walk on four feet. What are their skins like? The lamb has soft, white, fluffy wool, and the wolf has rough, matted, shaggy fur. What are their teeth like? The lamb has small chisel-shaped front teeth (incisors) which it uses for cutting grass. The wolf has predominantly sharp pointed teeth (canines) which it uses for ripping meat. Both have flat strong back teeth (molars) for grinding and chewing. How do they live? The lambs live in groups or herds and are dependent on each other for safety. The wolf is a loner and hunts independently for his daily meal but can also travel in packs to overwhelm prey. In such a way the second grade teacher can build up objective and accurate pictures from within the animal kingdom that will return in future zoology classes.

The third grade is involved in farming, gardening, house building, measuring, weighing, analyzing soils, identifying grains and other practical activities which develop and solidify their scientific knowledge. This particular year finds the children going through physical changes. Their heartbeat slows down to a 4 : 1 ratio with their breathing. This is the ratio of the adult.

Also at this age the psychology changes; the children are able to discern a separation between the self and the world. The special tree no longer has a name—it is now objectively a tree! The children begin to lose the complete trust in the world that they had in the early years of childhood. They undergo a transformation from the imaginative, moral treatment of the kingdoms of nature to one in which they stand opposite natural objects in a more objective way—and they now need to understand them. This is developmentally the right time for a more objective science to be taught.

The fourth grade meets this need through the main lesson on zoology that continues into the fifth grade when botany is also added. The question for the teacher is, "What is expressing itself in the plant?" The plant should be examined as an integral part of its environment, but again pictures should be the vehicle for this knowledge, not dry, dead facts.

While teaching botany to my fifth grade, I asked the class one day what a seed was. One of my more imaginative students replied, "A seed is a little box with its lunch inside." The image contained in this response is greater than the fact it conveys. It is an example of metaphorical thinking and is another building block for the scientific reasoning that will blossom in the teenage years.

In the sixth grade mineralogy is introduced by way of the qualitative character of particular landscapes. Limestone landscapes such as the Mammoth Cave area in Kentucky are compared with granite landscapes such as the White Mountains of New England. What are the distinctive plants of each? How does each landscape react to acid rain? What are the different qualities of granite and limestone? Physics—including acoustics, optics, heat, magnetism, and static electricity—is introduced in the sixth grade as well. Optics is evolved from their experiences with watercolor painting and acoustics from their experiences in music. The children are now asked to accurately describe the phenomena from the demonstrations. These observations then lead to the discovery of the laws which underlie the phenomena.

Precise, accurate observations (free of attempts to figure out "what is causing it" behind the senses) are the activities which are reinforced for the next two years in the sev-

enth and eighth grades as chemistry is introduced, physics is deepened, astronomy is explored, and human physiology is studied.

The Waldorf approach to these subjects is different from what you yourself might have encountered in your public or traditional private school education. Historically, the scientific method is taught by the teacher or the textbook, wherein a hypothesis is presented and the students are told to prove it. This method is linear, has predicted results, and does not stimulate everyone. Physicist Victor Weisskopf objected to this sterile approach when he said, "Science is not flat knowledge, formulae, names. It is curiosity, discovering things, and asking why. . . . We must always begin by asking questions, not by giving answers." And he adds, "You can teach only by creating interest in what is around you, by creating an urge to know." The German poet/scientist Goethe said even more strongly, "Hypotheses are lullabies for teachers to sing their students to sleep!"

Therein is the reason that Waldorf schools use a totally different approach. Waldorf teachers begin with a phenomenon that the students observe. They then take their observations inward and later accurately write what they saw. The class discusses the observations, thinks about them, wrestles with them, perhaps repeats the experiment, and then strives to arrive at a conclusion. Why did such and such happen? In this process the students' thinking is active. They arrive at the concepts through their own inner thought activity and worked-at judgment. They re-discover what a Cavendish or Priestley is credited with discovering, but they own the experience of finding it themselves, they own the concept they have derived. Later the acquired activity of thinking will be of use to them in life when encountering problems requiring discrimination, whether they continue to study science or not.

In the ninth and tenth grades of a Waldorf high school, rigor is applied to the thinking. Now the students must do more than just observe. They must bring discipline to their thinking. There must be logic in their statements. They must understand the working of the internal combustion engine. They must know the glands of the endocrine system and how they function. They must comprehend the properties of metals and understand chemical reactions. Their thinking must become vital, and they must appreciate that it is a thinking that takes the laws of nature and imagines their applications in new ways not found in nature which has created our modern world. They must learn to value their own thoughts.

When a foundation of observation and disciplined thinking is established, the high school science teacher now introduces a new type of thinking, while still strengthening and building upon the first two. This "new" thinking is called phenomenological thinking. Quite simply it can be explained as follows: first, the phenomena is carefully observed; second, the rigors and the laws of thinking as well as previously gained concepts in science are considered and the phenomena is contemplated; third, everything up to now is laid to rest, the mind is cleared, and the phenomena themselves are allowed to speak. The student quietly observes what comes forward while keeping the mind from straying. Finally, the student will write what the phenomenon revealed in his life of thought. This activity opens one up to new possibilities.

This type of thinking is freed from the senses and allows the universe to speak through to the individual. It is a type of thinking that is truly moral and can be the fertile ground for the "new" science of the twenty-first century.

The aim of much conventional education is to lead the child into particular fields of knowledge. Waldorf education has the opposite aim—it strives to transform fields of knowledge into "education" in a way that encourages the child's healthy development.

Science teaching needs to utilize new techniques based on the old wisdom. This requires a combination of kindling the sparks of imagination, quieting the soul so the inspi-

ration can be heard, and presenting intellectual material so that intuitive truths can be experienced. When we do this we attend to both content and character. We help students move from apathy to wonder, from wonder to knowing, and from knowing to gratitude.

Revised and taken from *The Wonders of Waldorf Chemistry* by David Mitchell, Fair Oaks, CA: AWSNA Publications, 2001.

In summary:

Preschool	Tactile experiences with sand, mud, water, cooking, etc. Nature walks and free play. Experiencing adults joy in nature.
K-5	Stimulate the 12 senses as much as possible Nature observation Cooking Nature and animal stories with vivid descriptions
6-7	Cause and effect are introduced Observation of phenomena becoming more and more detailed Goethean approach from whole to the parts Expository writing introduced
8-10	More detailed observation Exact recall of phenomenon leading to discovery of underlying concept Morning recapitulation concise, detailed, and quick-moving Expository writing developed to higher level Rigor and discipline in thinking (mathematical accuracy, astute observation, ability to make connections with other disciplines)
11-12	Focus on concepts behind phenomena Phenomenology—astute observation, disciplined thinking, inner quietness which then allows the phenomena to speak directly to you through your thinking

BIBLIOGRAPHY For Middle School

Resource books are important, however, there are many poor science preparatory books on the market, including some written by anthroposophists. The brief list of titles below was compiled jointly by David Mitchell, Douglas Gerwin, and Michael D'Aleo. We recommend that as many as possible of the following books be available in your school's faculty library:

- Baravalle, Hermann. *Introduction to Physics in the Waldorf School*, Waldorf Curriculum Series, Rudolf Steiner College Publications, 1991.
- Böckemühl, Jochen ed. *Towards a Phenomenology of the Etheric*, Hudson, NY: Anthroposophic Press, 1985.
- Bortoft, Henri. *The Wholeness of Nature*, Hudson, NY: Lindisfarne Press, 1996.
- Cloos, Walther. *The Living Earth*, Lanthorn Press, 1977.
- D'Aleo, Michael and Edelglass, Stephen. *Sensible Physics Teaching*, Chestnut Ridge, NY: Parker Courtney Press, 1999.
- Davidson, Norman. *Sky Phenomena*, Hudson, NY: Lindesfarne Press, 1993.
- Edmunds, L. Francis. *Quest for Meaning*, New York City: Continuum Pub. Co., 1997.
- Faraday, Michael. *Faraday's Chemical History of a Candle*. Chicago: Chicago Review Press, 1988.
- Goethe, Wolfgang von. *The Metamorphosis of Plants*, San Francisco: Biodynamic Association.
- _____. *On Granite*, Fair Oaks, CA: AWSNA Publications.
- Grohmann, Gerbert Dr. *The Living World of Plants*, Fair Oaks, CA: AWSNA Publications, 2003.
- _____. *The Plant: Earth's Sense Organ for Light*, Rudolf Steiner Library.
- Harwood, A.C. *The Recovery of Man in Childhood*, Chapters 11 and 12, Great Barrington, MA: Myrin Institute, 2001.
- Hauschka, Rudolf. *The Nature of Substance*, London: Steiner Press, 1996.
- _____. *Nutrition*, London: Steiner Press, 1998.
- Heydebrand, Caroline von. *The Curriculum of the First Waldorf School*, Steiner Fellowship.
- Holdrege, Craig. *Genetics and the Manipulation of Life*, Hudson, NY: Lindisfarne Press, 1996.
- Julius, Frits. *Fundamentals for a Phenomenological Study of Chemistry*, Fair Oaks, CA: AWSNA Publications, 2000.
- _____. *The World of Matter and the Education of Man*. Forest Row, England: Steiner Schools Fellowship, 1987.
- Kolisko, Eugen. *Elementary Chemistry*, Fair Oaks, CA: St. George Books, Rudolf Steiner College Press, 1978.
- _____. *Geology*, Kolisko Archives.
- Lehrs, Ernst. *Man or Matter*, London: Rudolf Steiner Press, 1985.
- Mees, L. F. C. *Living Metals*, London: Regency Press, 1974.
- Miller, Douglas, ed. *Johann Wolfgang von Goethe: Scientific Studies*, New York: Suhrkamp Publishers, 1998.
- Mirbt, C. R. *Astronomy*, Fair Oaks, CA: AWSNA Publications, 1994.

- Mitchell, David. *The Wonders of Waldorf Chemistry*, Fair Oaks, CA: AWSNA Publications, 2001.
- _____. *Research Guide for Waldorf Teachers*, Fair Oaks, CA: AWSNA Publications, 1999.
- _____. *Waldorf Curriculum Chart*, Fair Oaks, CA: AWSNA Publications, 2003.
- _____. ed. Waldorf High School Research Project, *Chemistry Colloquium*. Fair Oaks, CA: AWSNA Publications, 2000.
- _____. and Petering, John. *Waldorf Science Newsletter*, (see *Waldorf Science Newsletter Index* for many relevant articles), Fair Oaks, CA: AWSNA Publications.
- Ott, Gerhard. *Fundamentals of Chemistry*. (Only available in manuscript from private libraries), 1972.
- Pelikan. *The Secret of Metals*, New York: Anthroposophic Press, 1973.
- Poppelbaum, Hermann. *Man and Animal*, New York: Anthroposophic Press.
- _____. *A New Zoology*, Dornach, Switzerland: Philosophic-Anthroposophic Press, 1961.
- _____. *The Battle for a New Consciousness*, Spring Valley, NY: Mercury Press, 1993.
- Schad, Wolfgang, et al. *Goethean Science in the Waldorf Curriculum*. Forest Row: Steiner Schools Fellowship, 1978.
- _____. *Man and Mammals: Toward a Biology of Form*, Garden City, NY: Waldorf Press, 1977.
- Schindler, Maria. *Goethe's Theory of Color*, New Knowledge Books, 1970.
- Schmidt, Gerhart. *Dynamics of Nutrition*, New York: Anthroposophic Press.
- _____. *Essentials of Nutrition*, New York: Anthroposophic Press.
- Schwenk, Theodore. *Sensitive Chaos*, London: Steiner Press, 1990.
- Stockmeyer, E.A. *Rudolf Steiner's Curriculum*, Forest Row, England: Steiner Schools Fellowship.
- Trostli, Roberto. *Physics Is Fun*, Octavo Editions, 1995.
- Twentyman, Ralph. *The Science and Art of Healing*, Edinburgh, Scotland: Floris Books, 1989.
- von Mackensen, Manfred. *A Phenomena-Based Physics*, (Vol. 1 for grade 6, Vol. 2 for grade 7, Vol. 3 for grade 8) Fair Oaks, CA: AWSNA Publications, 1997.
- Waller, Mary Désiré. *Chladni Figures*, New York: Harcourt, Brace & World, 1992.
- Wilson, Michael. *What is Colour?* Forest Row, England: Steiner Schools Fellowship, 1983.
- Zajonc, Arthur. *Catching the Light: the Entwined History of Light and Mind*, Bantam Books, 1993.

For Elementary Grade Level Listings of Additional Science Reference Books see

Mitchell, David. *Research Guide for Waldorf Teachers*, Fair Oaks: CA: AWSNA Publications, 1999.

Rudolf Steiner's Indications on Teaching Science

Steiner, Rudolf. *The Kingdom of Childhood*, lectures 3 and 7, GA 317, New York: Anthroposophic Press.

_____. *A Modern Art of Education*, lecture 10, GA 307, New York: Anthroposophic Press.

_____. *Discussions with Teachers*, Chapters 9, 10, and 11, GA 295, New York: Anthroposophic Press.

_____. *How the Spiritual Works in Man*, New York: Anthroposophic Press.

_____. *Practical Advice to Teachers*, lecture 8, GA 294, New York: Anthroposophic Press.

_____. *The Roots of Education*, Chapters 4 and 5, GA 309, New York: Anthroposophic Press.

_____. *The Renewal of Education*, lectures 8 and 10, Chapters 4 and 5, Anthroposophic Press.

_____. *The Second Scientific Lecture Course* GA 321, (published in English as the "Warmth Course"), New York: Anthroposophic Press.

_____. *Soul Economy and Waldorf Education*, lecture 11, GA 303, Anthroposophic Press.

_____. *Foundations of Human Experience*, (formerly *Study of Man*), Lectures 10, 11, 12, 13, GA 293, New York: Anthroposophic Press.

_____. *The Spiritual Ground of Education*, lecture 6, GA 305, New York: Anthroposophic Press.

_____. *Three Lectures to Teachers*, September 6, 1919, GA 295, Chapters 7 and 8, New York: Anthroposophic Press

_____. *Education for Adolescents*, lectures 1-4, and especially lecture 3, GA 302, New York: Anthroposophic Press.

_____. *The First Scientific Lecture Course*, GA 320, (published in English as the "Light Course"), New York: Anthroposophic Press.

WHAT IS PHENOMENOLOGY?

by

Michael J. D'Aleo

INTRODUCTION

A few years ago I recall standing in the checkout line of a large store. There were still a couple of people in front of me who were paying for their purchases when a woman came up behind me with her approximately three-year-old child. The woman first glanced at the long line and then noticed a simple child's puzzle near the checkout. The simple puzzle had three or four wooden cutout that would fit nicely into the flat piece of wood from which they had been cut. Each piece was cut in the shape of a barnyard animal and was painted appropriately. "Look," the woman said to the child, "this is a sheep!" With this exclamation she removed a particular piece of wood that was shaped and painted in the outline of a sheep.

Immediately, I saw a problem:

"That's not a sheep," I thought to myself. "That's only a cutout piece of wood painted to represent a sheep. A sheep is much larger, has a particular smell, makes a very characteristic sound, its body is covered with a very unusual material that feels soft, often oily and leaves a funny scent and taste on your hand. Have you ever helped someone try and catch some sheep or helped to shear them? Sheep are fast, skittish, they can jump. . . . These animals have many unusual ways of behaving . . . this is only a part of my experience of sheep. - Please, take the child somewhere where they can have an experience of sheep!"

I never said anything to the woman or her child but in this moment makes clear what the distinction between a concept that is given and one that arises out of actual sensational experiences.

Having a young child of my own, I sympathized with the plight of the woman and her child. The checkout lines in many stores are often deigned to overwhelm you as each item competes for your attention and interest. As an adult, we can develop the capacities to ignore or "tune out" the myriad impressions that bombard us in such an environment; a child cannot. However, without careful discrimination we as adults can just as easily begin to "tune-out" the many other sense impressions in our world. When this happens, we can begin to sense that our life has become a routine in which we are simply going through the motions, that we have lost our connection to not only the world but also ourselves.

A BRIEF HISTORICAL CONTEXT

Many teachers, parents and perhaps older students may have heard that Waldorf education encourages the use of a phenomenological approach to science. While even saying the word, "phenomenological" can be difficult for a person encountering it for the first

time, there is even less familiarity with the meaning of the word and its relation to the approach to science advocated by many Waldorf schools. In fact, phenomenology does not have its origin in Waldorf education but instead, the roots of phenomenology can be traced back to European Continental Philosophy of the late 17th and early 18th century. While many people familiar with Waldorf schools may know that Goethe (1749-1832) and Steiner (1861-1925) advocated for such an approach, there were parallel efforts by Alexander Gottlieb Baumgarten (1714-1762), Johannes Mueller (1801-1858) and Edmund Husserl (1859-1938). Additionally, in reading any of the writings of the great historical scientists, one finds repeated references to a process that can be described as seeing a "pattern or lawfulness" in observations, that had not been seen before, or simply been overlooked by others. Examples of this can be found in the notebooks of Leonardo da Vinci, the dialogues of Galileo Galilei and the notebooks of Johannes Kepler. In each of these cases, a deeper understanding of a given set of phenomena is reached not by accepting the work of their predecessors, but instead, by looking again at the phenomena described by others and then "seeing something new."

For example, in Galileo's time (early 1600's) the commonly accepted view of objects that fall "naturally" (simply dropped) was that a heavier object would fall faster than a lighter one. By carefully reviewing the argument that was made *to support* this view, Galileo noticed an inconsistency in the argument. Through a combination of intuitions, thought experiments and actual demonstrations he was able to conclude that all "heavy" objects (ignoring feathers, dust, etc.) would fall through the same distance in the same time, that each object's speed (velocity) would increase at the same rate and furthermore, that the rate of acceleration was constant. This example is often used in the 10th grade Waldorf Physics block in the study of Mechanics.

Another clear example advocating for an experiential approach can be found in da Vinci's notebook in which he describes the difficulties he had with the scholars of his day. In da Vinci's time (about 1500), much of the scholarly debate in universities focused on how to interpret the work left by the "Masters" rather than an individual inquiry into the phenomena of the world. This of course was at odds with da Vinci's own process of keen observation. In *The Notebooks of Leonardo da Vinci* as translated by Edward McCurdy (Reynal & Hitchcock, New York, 1938), the first entry reads:

If indeed I have no power to quote from authors as they (i.e. the scholars) have, it is a far bigger and more worthy thing to read by the light of experience, which is the instructress of their masters. They strut about puffed up and pompous, decked out and adorned not with their own labours but by those of others, and they will not even allow me my own. And if they despise me who am an inventor how much more should blame be given to themselves, who are not inventors but trumpeters and reciters of the work of others.

Consciously observing the phenomena of the world: this is the starting point for the middle school science curriculum.

A phenomenological approach to science *begins* with the premise that all empirical knowledge must start with sensory impressions. Every concept we form be it in science or everyday life must ultimately be based upon sense impressions or a combination of sense impressions and other concepts. Initially we can think of these sense impressions as the basic senses we use every day such as sight, sound, taste, touch and smell. In time we may become conscious of other sense impressions; for example our sense of motion, balance, thoughts, etc.

The foundations for such an approach to an understanding of the world was outlined in depth by Rudolf Steiner, the founder of Waldorf educational methods, in his book *The Philosophy of Freedom or Intuitive Thinking as a Spiritual Path*. One of the central themes in this book might be outlined in the following manner.

When we experience a new or unfamiliar environment for the first time, we choose specific observations to focus on and then mentally remove these details from the whole of the environment in which we are observing. There are myriad choices of possible observations but we can only focus on a finite number at any time. Having decided to focus on specific observations, we then find relationships or order within these observations. Relationships also appear between the observations that have been separated and the whole environment from which they were removed. Initially, one can think of the observations as sensed based perceptions and the relationships as thought based conceptions. Later on, when the capacity to distinguish between perceptions and conceptions is more clearly developed, one can also take thought as the basis of perceptions as well.

The fascinating part of the process outlined above is that the activity of looking for the relationships between the perceptions is not a linear one nor one that can be arrived at through logic. The process of finding the relationship for the "first time" is often referred to as intuition. Intuition is the process by which one first has an insight into a conceptual framework that can unite a given set of perceptions, or a set of perceptions with other concepts. This is the "aha" or "eureka" experience of the scientist, inventor, artist or investigator. In that moment a new relationship is seen and it is then *and only then* that logic can be rightly applied to determine if the relationship will hold true in the context of the other relationships that are known. *This process of looking for a relationship among phenomena is the true activity of thinking. Thinking is not simply the recollection of previously known facts.*

And herein lies the biggest distinction between a phenomenological educational approach to science and a more conventional educational approach. In a phenomenological approach, one strives to give the students an experience of the phenomena and then have them wrestle with finding relationships or order. This process actually cultivates the true powers and capacities necessary for thinking. Here thinking becomes an activity, a verb, something that is dynamic and living. In a more conventional approach, the laws or relationships are initially given and then the student is guided through a proof of why they hold true. In this second approach, the students do not need to utilize their own thinking capacities in the same manner since they simply need to follow a logical argument rather than

having an insight themselves as required in the phenomenological approach. In this second case, the thinking becomes a process of data acquisition and accessing.

What is interesting about these two approaches is that in fact almost every new idea and invention that has arisen in science has resulted from a person consciously or unconsciously using a phenomenological approach. Often this can unconsciously result when a scientist is working with an old concept, one that has often been passed down for years, and suddenly the scientist sees something new in the phenomena. In that moment, the scientist leaves the conventional view of looking at the problem using old fixed concepts and instead, becomes interested in some new detail and suddenly desires to "make sense" of this new situation. This is precisely the kind of thinking that we are ultimately trying to instill in the students in a Waldorf school. It does not necessarily matter whether they are going to become scientists. The sciences give us an opportunity to develop in every student the capacity to enter a situation, take stock of it (make observations) and then make sense (find relationships and form concepts) of the situation.

THE YOUNG CHILD

Now of course one cannot initially ask that a young child participate in such a process. To make observations, one needs to have senses that are well developed and have a rich background of experience with which to make comparisons. What is more, a young child needs to experience for herself how to separate out specific sense impressions from the rich world of experiences that are possible to be perceived. And finally, the world or sensory environment that a child does experience needs to be one in which none of the impressions are either overwhelming or too narrow in their context. To properly educate the very young child, it is not so much a question of "teaching" but rather one of ensuring that the proper environment, one that is rich in sensations and also deep in context, can occur.

Perhaps no environment can surpass nature in its richness of sensations or depth of context. Again, the key is not to teach the child to see the observations and then tell them the concept, but rather to allow this process to occur naturally while the senses of the child are developing. Recall the example given at the beginning of this essay concerning a sheep. Take a few moments to focus on the environment and sense impressions found on a small farm. — Now, compare those to the impressions found in a checkout line at a large store or, to focus on the sheep more specifically, consider the impressions given by an interactive computer program in which animated images of sheep move across a flat screen accompanied with corresponding digitized sounds. — Which of these environments will a young child be able to "take in" and which gives the child a richer, fuller context on which to know not only an individual sheep, but the full context of forces and activities that help define how sheep "are?"

It might now be even more apparent why the classrooms for the Waldorf Kindergarten students are organized in the way they are, and why the activities of the morning circle and "play" are such a central part of a child's "education."

Skipping ahead now to the middle school students, we can see that they are definitely in a different place with respect to their individual relationships to the environment and their own self-awareness. By sixth grade the students become very observant of their surroundings. They begin to really notice all of the "odd things" about the adults in their lives and also can become self-conscious of his, or her, own outer appearance and inner feelings. It is at this time that a teacher can start working consciously with the students' own observations both those of the individual as well as those shared collectively by the class. The students can be shown a scene such as a sunrise and then later, the teacher can ask them to recall specific observations that were made, what the order was in which they occurred and if there are any relationships (concepts) that can be found between the observations (perceptions).

For example, in the 6th grade I took the class into a small, completely dark, room and using a high quality light dimmer, ever so slowly increased the level of illumination in the room from total darkness to incredible brilliance (we used a 500 watt bulb). This exercise was done with little talking but I was careful to increase the level of illumination in stages so that the students could really "take in" the phenomena. During the review period the next day, the students were overflowing with observations. It started with the obvious such as, *"At first, I couldn't see anything and then I saw someone's head!"* After trying to figure out whose head it was, another student offered, *"Initially everything was in black and white,"* while another said, *"and it was also kind of 'flat,' two dimensional like."*

As I slowly focused the conversation, the class began to order their perceptions and noticed that the "scene" started with little to see other than the very dim glow of the lamp. Slowly varying shades of darkness were perceived and out of this the students began to distinguish familiar forms (the classmates' head). The students then began to notice that some colors on their clothing were more easily discernible during the "darker phases" than other colors. White was seen early on, but it took a brighter level of illumination to distinguish white from yellow. Red was also seen fairly early, while a relatively bright level of illumination was needed to identify a blue stripe on a sweater that had a black appearance under lower levels of illumination. By the time the light bulb was at its maximum level of brightness, we were all "blind" again, as all we could see was white brilliance. One of the key points the students finally articulated was that the colors changed with the level of illumination. Less obvious but equally present was the role that color plays in our ability to take a two-dimensional image of color and form, and relate it to our everyday three-dimensional spatial orientation. This was just touched upon, as it would become clearer through their experiences in painting class and their study of Renaissance art in 7th grade.

The middle school years is also the time that the students can first make a basic distinction between the world as observed and the world as conceived. The students of this age are *not* ready for a philosophical exploration of the foundations of knowledge but it is appropriate to make a distinction between what one actually sees (smells, hears, and so forth) and the feelings and thoughts that arise from these sensations. Again, the teacher does not have to go into a deep philosophical discussion with the students but instead can

simply point out the distinction *within the context of comments made by students in the class*. The pedagogical importance of helping a young adolescent see the difference between sensations and feelings, or thoughts is probably apparent. Here the science lesson presents an opportunity to properly balance the strong feeling life of the early teenager, without resorting to any moralizing.

It is be important to be clear about how one might deliver a lesson using a phenomenological approach. First, with little to no introduction, the class is brought into an environment in which the phenomena that are to be discussed the following day are observed. There need be no elaborate scientific setup and in fact, by bringing the lesson out of regularly encountered environments the students can develop a sense for how the phenomena in question relate to the world at large. As the activity or process to be observed unfolds, the students should be encouraged to observe the phenomena as fully as possible with minimal prodding from the teacher to "look at this" or "did you hear that?" At the same time, the students should be discouraged from communicating in any manner or asking questions out loud. Finally, when the experience or experiment has been completed, and just before the class finishes, the students can be asked to recall or remember the sequence of events. The importance of having the students live with the process (sequencing is an important tool for clear thinking) they have just observed should not be overlooked. Sometimes a teacher can leave the students with a question to consider but the teacher should always be careful not to lead the students toward a conclusion.

On the following morning, the teacher has the students recall the demonstration from the previous day but without redoing the experiment or using the apparatus as a prop. The teacher's first request of the students should be to solicit observations *without conclusions, cause or relationships*. This process allows each of the students to carefully weigh and consider all of the observations without having a sense that they have to rush ahead and get "the answer" before their classmates. Additionally, the teacher needs to be careful not to have too strong a picture of what the students, "should have observed" and what the exact wording is of, "what they should conclude." If one has cultivated the right atmosphere in the class, the students will arrive at not only the observations and conclusions that were anticipated, but also, the students will often bring other observations and find additional relationships that were not intended. Again, the teacher needs to be very awake to allow for the possibility of new ways of seeing a relationship, or other means of expressing a given relationship. We want the students to experience that they are really involved in forming the concepts and not simply trying to say, "what the teacher wants me to say." Again, the relationships or concepts are only developed after all of the observations are in place. It is also important that the teacher not immediately judge a comment as "correct" or "incorrect," but instead, allow the class to try and form the judgement of whether or not a suggested relationship offered by one of the students holds true. In the end, the teacher must be the guide of the class but the process does not always have to move forward because the teacher is always the first to take "the next step." In fact, the best opportunity to introduce the next demonstration or experience can often arise when a student who has just understood the previous day's material, asks a question such as, "Well if that's true, then what about. . . ?" When this happens, it is usually a sign that things are going well.

During a specific lesson in the 8th grade, I recall how many of these elements came together for the first time. We had observed colored fringes (refraction phenomena) while looking through any kind of prism at objects that had light surfaces that bounded dark surfaces. In class, we developed the convention that one of the edges of the prism would always face upwards and we all held our prisms at eye level so that we would all see the same order of colors provided we all looked at the same boundary. Given this orientation of the prism, when the light surface was above the dark surface, the warm spectrum (red orange yellow) was observed and when the dark surface was above the light surface the cool spectrum (blue violet) was observed.

For homework that night, I gave each of the students a prism and asked them to draw a "scene" in their main lesson book of their own room at home. The following day I asked the students to show me their drawing and received the following unexpected response from one of the students that sounded something like this:

"It didn't work. I don't know what happened but I started to do the assignment and everything was going well and then it stopped working! Maybe something is wrong with my prism. I started to draw my wall with the window and at first there were the colors, just like yesterday. Then after awhile the colors started to get fainter and sort of disappeared, so I gave up. Then when I came back later to try and do it again the colors were back, only this time, the warm and cool colors were now switched from where they were before!"

I stood in the front of the class and pondered this statement for a few moments. I imagined her house, the time of year (December), and sensing what might have happened, proceeded with questions.

"What time of day did you begin?"

"Late afternoon," she replied.

"Specifically what time?"

"I started about four in the afternoon and worked for half an hour."

"Is that when the problem started?"

"Yes, so I stopped and then tried again after dinner. That's when the colors switched"

I then turned to the class and asked them what had changed during that time. Eventually, the students realized that the sun was setting at that time and that their classmate had been working in a room without a light on. Under these conditions, the light colored window (there was snow on the ground, her house was in an open field) and the relative darker coloration of the walls (in a room lit only from the sun outside) gave her one orientation of colors. As the sun set, everything in the room and the window began to appear dark so there were no longer any light/dark boundaries visible. When she returned from dinner it had become very dark. The class eventually realized their classmate had turned on her bedroom

light so that now, the window was dark and the walls were light. These were the opposite conditions that she had started with and the reason for all of the difficulties that night!

What had happened in the class was remarkable. The frustrated student had given her classmates a real opportunity to understand the conditions for color fringe phenomena because she had observed something that at first appearance made no sense. In time, *the class* sorted out the mystery and the teacher's task was to simply find the right questions that would help the students discover the relationship *out of the students' own effort*. Finally, the student who made the observation felt empowered by her discovery.

Using a conventional approach to science education, one usually begins with "the law" and then performs experiments or demonstrations to show its justification. In a class with a conventional approach to science, it would have been very easy to dismiss the experience above as something that did not fit "the law of refraction." This can send a student the message that the senses cannot be trusted. *Yet, it was because people used their senses, and carefully so, that the lawfulness was found in the first place!*

A BRIEF COMMENT ON BOOKWORK

Finally, it is important for all students to make the experience and the discovered relationships their own. In the middle school years, a lot of time can be spent developing clear and orderly descriptions of what took place and what were the relationships that were uncovered. While these descriptions can initially be completed as a class together, in time each individual child should begin to develop a responsibility for his or her own record of "what happened." In any case, the teacher should check and make suggestions on "first drafts" to ensure that each student is developing a clear relationship to observations, sequencing and finding appropriate relationships. For some experiences, a detailed illustration might capture all of the phenomena and relationships and a written essay would be redundant. In time, each teacher can develop a sense for the balance between written work and illustrations, rather than simply insisting that each demonstration must include both. By the end of the block, each student would ideally have a main lesson book that helps him or her to "remember" all of the experiences that were encountered and have a *feeling* (sense) for all of the relationships that were found.

WHERE DOES THIS LEAD? A BRIEF SKETCH OF SOME ELEMENTS OF THE HIGH SCHOOL PHYSICS CURRICULUM

Phenomena based methods can continue to be used in high school and from my experience, very successfully. If the students have a solid foundation in observation and stay attentive to the phenomena under consideration, then they can really delve into almost any topic in science and understand it in context. For example, in the 9th grade the students begin a study of thermal phenomena by performing a few experiments and then making clear distinctions between the concepts of heat and temperature. A modest beginning, no doubt. However, by the end of the second week of the block, the class will have progressed toward the solution of basic algebraic problems in thermal physics. For example, the students can calculate how warm a known mass of cool water in a bucket will get, if a specific piece of hot copper is cooled by plunging it into the bucket. In our school the students

perform this activity in the context of making a hammered copper bowl. The physics block ends with a fairly thorough understanding of a four-stroke internal combustion engine. And yes, the students do disassemble an automobile engine before we speak about how it works.

In the 10th grade, the students develop the laws of Mechanics and take up some of the same questions that Galileo wrestled with as pointed out earlier.

In the 11th grade, the students deal with the non-material world in physics, the field theories of electricity and magnetism. Here the students wrestle with forming concepts from experiments that can only tell us indirectly about what is being experienced. The electric or magnetic fields themselves are not visible. Yet, we can see effects on sensible phenomena (objects) that tell us how these forces behave. In our school the students also study Atomic Theory in the 11th grade. Now the students have the mental ability to really work with the phenomena as well as the conceptual framework that evolved in to the atomic model of matter. What is more, by waiting so long to expose the students to this model it is possible to take the students beyond the simplified version of this theory usually studied in more conventional science programs. This means that in conjunction with the work on field theory described above, the students can now develop an appreciation for the general descriptions and ideas that are being discussed in even the most recent research, in which the experiments result in phenomena that have lost most of the qualities we normally associate with matter! Again, this can only occur when the students have developed a clear understanding of the distinction between the perceptual world of the senses and the conceptual world of the mind.

In the 12th grade, the students delve into visual phenomena. Now, they can finally take on some of the philosophical questions that arise when we ask, "How do we see the world?" Or expressed in another form, "What is the foundation for knowing?"

INSTRUMENTATION AND EQUIPMENT

As a final note, when speaking with parents about phenomenological methods, the question of instrumentation can often arise. Yes, electron microscopes and electric-meters can be very useful tools for scientists and engineers. However, it is very easy for students, most adults and even many scientists to lose track of what is actually being observed. For example, the "image" created by an electronmicroscope appears to be an "object" but is in fact a visual representation of varying strengths of an electric field. While the distinction made can seem small, the implications of such statements can be tremendously important as one proceeds deeper into the sciences. Therefore, in the schools we would only want to use equipment that students are able to understand with their present mode of consciousness. This implies simple equipment in the middle school years and somewhat more sophisticated instrumentation later on. Remember, the thinking capacities of the students have less to do with what instrumentation they can use and more to do with how they work with the observations they have made.

Michael D'Aleo teaches Physics and Physical Sciences at the Waldorf School of Saratoga Springs in Saratoga Springs, NY and is an instructor in the summer high school teacher training program at The Center for Anthroposophy in Wilton, NH. After being a class for teacher for grades 6-8, he co-authored a book with Stephen Edelglass, *Sensible Physics Teaching*, a guide for teaching Physics in grades 6-8. Prior to teaching, Michael worked as a design and development engineer in the electronics industry and is listed as an inventor on seventeen U.S. Patents. He is currently the director of research for SENSRI, a non-profit scientific research group that investigates that methods and applications of phenomena based science.

(continued from page 3)

4. Have study sessions on the teaching of science in your faculty meetings

5. When possible, occasionally have recognized Waldorf-trained science teachers work with and inspire your faculty

6. Distribute the *Waldorf Science Newsletter* and keep a ring-binder archive in your faculty library for reference

Science teaching in Waldorf schools will improve as well as the confidence in teachers if each school takes it upon themselves to set professional expectations and provide the necessary resources. Our schools are active learning centers.

Your comments and suggestions are welcome.

— David Mitchell
— John Petering
editors

A Call for Research

The WHSRP Waldorf high school research project) has received funding to support ten new research papers at \$500 each. The following topics are particularly being sought:

- Sex awareness as taught in grades 6-12
- Changes in pre-adolescence (grades 5-8)
- Use of computers and the teaching of technology
- The development of a new Waldorf high school
- Art and experiential education

However, all proposals will be considered. Guideines are posted on the On-Line Waldorf library at:

<http://www.waldorflibrary.org/>

The Design of Human and Animal Bodies

Exercises from a Ninth Grade Biology Main Lesson
excerpt from a Workbook in preparation for publication
by Peter DeBoer,
Sacramento Waldorf High School

Pedagogical Themes

The ninth grader (age 14-15) is generally experiencing some part of the developmental stage known as puberty, in which the limb region of the body and associated processes reach a "near" maturity. In this way, the body may be described as "earth-ripe".¹ This physical development coincides with the continued maturation of cognition, especially in the formation of abstract thoughts. Abstract thought is by its nature capable of being formed separately from the immediate life of sensation. At times this may become unrealistic or "fantastic" thought, and may lead to very aberrant behavior. Just as work gives the physical body something lawful and constructive to do with its energy, encouraging thinking to be anchored or checked by the apparently lawful qualities of nature accessed through careful observation provides a constructive outlet for abundant forces in the thinking life.²

The Anatomy block, from which this example is drawn, endeavors to use observation, a manifest capacity of will in the activity of thinking, to balance the growing capacity to form abstract thoughts. This balancing or rhythmical approach can build a healthy practice of thought. It is a healthy practice of thought that can help overcome the tendency to live habitually in fantasy and can lay the foundation for more complex thought necessary for morality, individual responsibility and free choice later in life.

The skill of pattern recognition is an important element in balancing perceptual and conceptual aspects of the developing human thinking. The more complex a pattern, the more complex the thinking must be, to understand or comprehend its different levels of meaning. While patterns can get very complex, the capacity of pattern recognition must start simply just like any living entity or process.

Pattern recognition can be encouraged through a number of in-class activities centered around observation. If observation activities are well-structured, they can serve as the foundation for an inquiry based approach to interesting puzzles and pattern anomalies. An example of a observation-based activity are "Observe and Describe Exercises."

Observe and Describe Exercises

These are short classroom inquiries which help provide the necessary structure for a novice observer, as opposed to the vague "please take a look at ..." approach. Each exercise includes an observation phase (perhaps a shorter focused "looking" period or a longer "looking and illustrating" period), a description phase, and a set of clear instructions such as: "Please take out a pencil and piece of paper, observe 'said' specimen or 2-3 minutes and describe at least five observations about ... (some aspect of "said" specimen).

¹ "Earth Ripeness": a specialized term coined by Rudolf Steiner (Ref. 1); also discussed by Michael Martin (Ref. 2) and in David Mitchell (Ref.3).

² "Logical thinking anchored in observation" first stage in development of thinking, discussed in Holdredge (Ref. 4).

Example Lesson Material:

A Descriptive Study of the Human Limb Bones

The human skeleton becomes the focus during the second week of my three week 9th grade Anatomy Main Lesson block. After reviewing and continuing the study of the skull started in grade 8, the students embark on a study of the human limb bones. The limbs are an anatomical region, the skeletal portion of which is also known as the Appendicular skeleton. The skull and limbs, both as regions and bony structures, are in direct contrast with one another—a clear example of polarity in living forms. The skull with its plate-like bones, still posture, and spherical shape is a clear polarity to the limb bones with their tubular bones, active mobility, articular orientation, and raying shape (see figure 1). To introduce studies of the limb, students are asked to explore the regular sequences of formation in this region and describe a general "limb pattern."

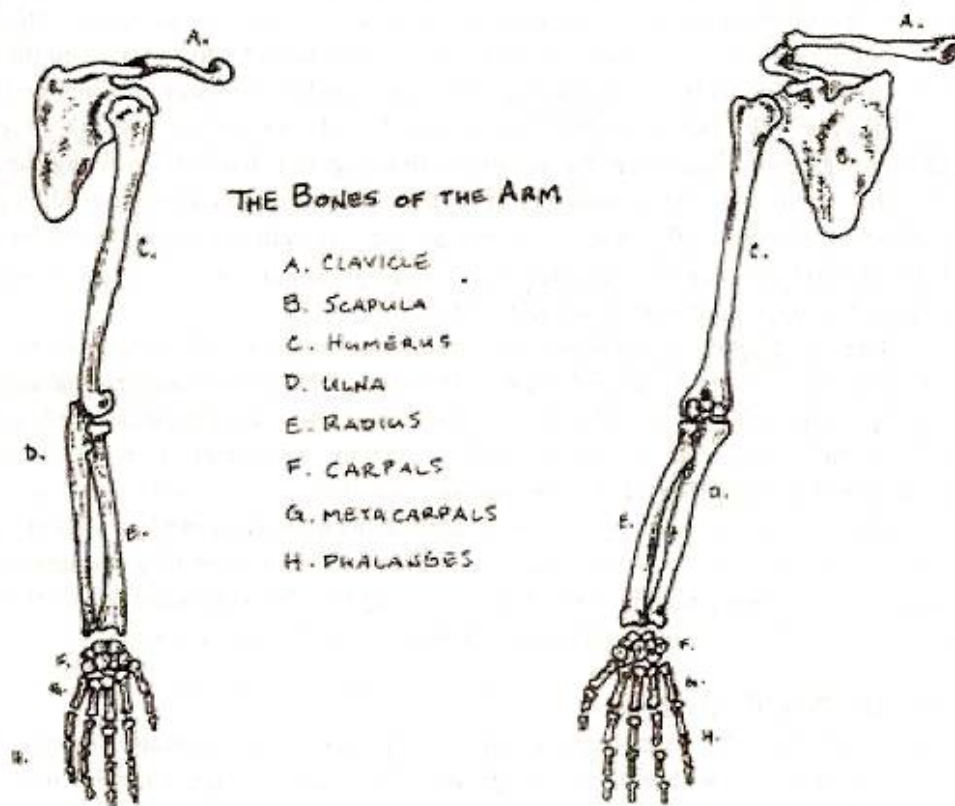
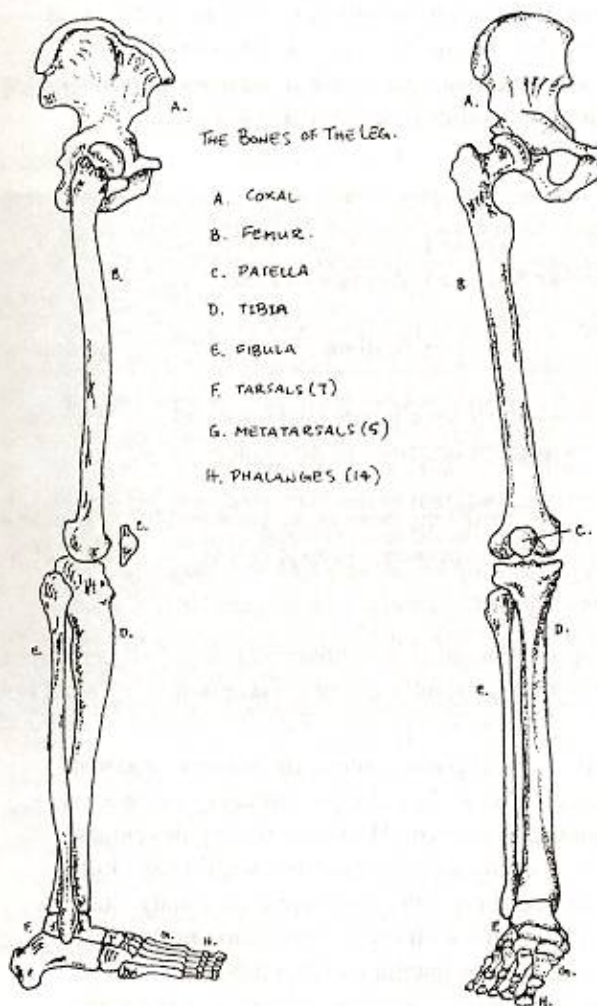


Figure 1 Appendicular skeleton: arms

Observe and Describe Exercise:

"Observe the bones of the limb, either arm or leg that are provided, and describe at least four characteristics of the osteological form. If you were creating a description of a general limb starting at one end or another, what characteristics would you include?" Using specimens and their own bodies, the students take about 10-15 minutes, and generally come up with some version of the following themes, which are then shared in discussion to assure that each student has a complete sequence (the following is oriented from proximal to distal):

- i. *Point of Attachment*: the shoulder girdle (scapula and clavicle) in the arms or the pelvic girdle (coxal or innominate bones) in the legs, both with multiple, flat or plate-like, sometimes fused bones
- ii. *A Ball and Socket Joint*:
- iii. *Linear shaped, single, long bone* (i.e.: humerus or femur)
- iv. *Continued series of joints* (generally hinge) *alternating with continued series of bones* (generally long bones) *of increasing numbers* (most evident in the fingers) .
- v. *Overall prevalence of linear, tubular bones and joints for movement*



This descriptive list becomes the *limb pattern*, and is used by the students as a starting point from which to make comparative inquiries. The first of these further studies is the investigation of how the bony structure at the point of attachment, or location on the trunk where the limb is joined to the whole body, differs from the overall pattern of the limbs. To do this the class is led by the teacher through a closer look at the three regions of the leg: the pelvis, the thigh and lower leg, and the foot (see Figure 2).

Figure 2: Appendicular Skeleton, Legs

- i. The leg's point of attachment is named the pelvic region and is composed of the two "coxal" bones (hip joint). Each coxal is composed of three fused, mainly plate-like bones: the Ilium (superior process), the Ischium (posterior process), and Pubis (anterior process).
- ii. For efficiency of time, we then discuss together the question: "how do the coxals compare with the long bones?" [alternatively, this could be done as another observe-and-describe exercise]

Some findings the class comes to include:

- a. The coxals are plate-like, rounded (while not quite spherical), and joined with sutures or fibrous joints.
- b. In comparison the limb bones are of the tubular or linear type and possess moveable or synovial joints.
- c. The students realize quickly how this pattern is similar to observations made about the skull (with its cranial and mandibular polarity)

To further develop these observations the students are then asked to describe (using the terms of position and direction: superior and inferior) where the plate like and tubular bones are located within the different regions of the human body. To aid in structuring this the students are asked to complete a data table including: the region's name, position of plate-like bones, continuation of the pattern, and any pattern anomalies (see TABLE 1 for a completed example).

Region	Plate-like bones	Do they continue?	Anomalies
leg	coxal (superior) that are fused	no—linear long bones take over and movement becomes more evident	Patella
arm	scapula (superior) but clavicle is not plate-like	no—linear long bones take over and movement becomes more evident	clavicle & lack of fused plate bones
head (skull)	cranium (8 bones) many facial bones	yes (generally) and movement is not evident; only a single exception	mandible and facial bones

As these patterns are "fleshed out" and given context, the students become interested in the anomalies within each area. Usually this initially emerges as questions of whether these invalidate the pattern. However, having developed an understanding of the polarity of cranium and mandible within the skull region, the students are now experienced enough to explore an anomaly, such as the clavicle (see figure 1 above, again), with their observation rather than speculation and abstraction. Optionally, the patella and facial bones could be explored as anomalies with their appropriate anatomical region in the same manner as the clavicle exploration below.

Observe and Describe Exercise (“Exploring the anomaly of the clavicle”)

“Observe the point of attachment in both the arm and the leg, and describe in one sentence each, how the arms and legs move differently at these locations.” The students are reminded of their understanding of joint types, particularly the ball and socket joint, at which a limb has three directions of movement: anterior/posterior, medial/lateral, and clockwise/counter-clockwise.

- i. The leg moves most freely in an anterior/posterior plane and experiences decreased range of motion in the other orientations; however, it supports the weight of the upper body and the coxal provides necessary solidity
- ii. The arm moves in a much more flexible manner (greater range of motion in all three directions) and hangs freely at the sides

The students are then able to conclude that in the arms, where greater movement is called for, the point of attachment includes in its design a linear/tubular bone, the clavicle. In regions where movement and activity are called for the body employs these linear/tubular bones and synovial articulations (see figures 1 or 2, again). In comparison, the leg must serve the body as a structural support, bearing the weight of the body against the resistant force of gravity. Thus, in the leg, the body employs: fused plate-like bones that encourage solidity and stability, with the compensation of less flexibility and movement. So, while the clavicle may seem to interrupt the recurring patterns of polarity in the human skeleton, it actually serves to further confirm its influence through out the body's regions.

Further Application in Comparative Anatomy

Often this activity can be completed over the course of one period, or spread out over two days if it is not begun at the start of the Main Lesson period. Usually this activity serves as a foundation that is continued in a study of the hand and foot—perhaps the most complex morphological sub-region of the human limbs. However, this activity also serves as the basis for a comparative anatomical study of vertebrate skeletal structure in the third week of the course.

Using a further sequence of observation-based activities focused on the hoofed mammals, the students conclude that the animal and human share a similar limb structure. The *limb pattern* is not only good for humans, but for all vertebrates! However, human limbs are certainly not the same as animal limbs in their development or adult structure.

At least two clear differences stand out for the students almost immediately. First, the animal leg is clearly different in that it is proportionally emphasized in the distal region, while the human limb has a greater proximal proportion—yielding a more balanced, functional form. Second, looking at the limbs from a paired perspective: front and rear limbs, the human limbs are regionally unique, while the animal limbs are regionally quite similar. Many animals have generally similar front and back distal limb structure: paws or hooves, while the human does not.

Once clear differences have been pointed out, it is healthy for the student to become very clear about the actual similarities, since after clearly describing these differences it seems that it is quite remarkable there are any similarities at all. Both human and animal limbs have similar placement of tubular bones and moveable joints, the limbs typically have three regions, and of course the bones have similar composition, chemical and otherwise. The students can be prompted through review questions to conclude that the same was the case with the skulls of animals and humans when they studied them the previous week.

The fruit of this pattern recognition process, the clear and living understanding of the form and organization of human limbs, can then be used as the perceptual basis

for some challenging, but appropriate initial concepts about the relationships between the human being and the animal. The skeletal structure of the limb of the human being is organized in a way to maintain flexibility and balanced proportion, while the skeletal structure of the animal limb has been fused, joined, immobilized, and generally specialized in a manner that compliments a specific form of behavioral expression. In a way, the human being can be thought of in a balancing, central position among the animal kingdom, with the diverse collection of specialized animal types spread out around that point of balance.

Developmentally, the human being is held back from a fixed state of adulthood representative of animals, where little growth or learning continues past the age of sexual maturity. In this way, the animal is developmentally more complete at the age of sexual maturity; much or all of its instinct-development and learning takes place before that point. The development of a culture of learning, of art and technology can then be seen as closely associated with the human being as a life-long learner.

It seems very reasonable that the forces which normally go into physical formation in the animal, are used to develop other capacities in the human being, including individual thinking, free choice, morality, and spiritual vision. However, while great opportunity is a natural outcome of the development of these unique characteristics, great obstacles or challenges of discipline, responsibility and self-sacrifice become equal companions on the road of human development.

With each student group, these concluding ideas are formed in a unique manner and the point is not to make sure they are all brought to life through the activity of the group, but rather they give an example of where adolescents might go with experiences gleaned through pattern-recognition. To better understand and explore these ideas about the relationships of human beings and animals, a reader may reference some of the author's favorite titles in the bibliography below, under the subtitle: "The Overall Human Form and Comparative Morphology."

Conclusion: In the students' words . . .

The educational process of pattern recognition is clearly challenging, but the students have some real successes. There is no question of whether the students can do this. They certainly can do this, quantitatively and qualitatively, but how much and to what extent is the question. It is merely a matter of keeping the level of study (structural, functional, developmental, evolutionary) not necessarily the nature of study (quantitative, qualitative) appropriate to the developmental level of the class. Generally, most ninth grade students have been able to recognize general, structural patterns—previously described elsewhere—in a new but related experience. This is often tested at the end of the course, when the students are asked on the final quiz whether the patterns of polarity evident in the form of the skull or limb are present in the hand, a region the class has usually not studied as a group in the same manner as the skull and limbs. The following is a passage from one ninth grade student's work.

"The main similarity between the skull and the hand is that both have a region of non-moving, plate like bones that provide stability, with an attached region of linear-type bones that are moveable. The moveable bones of the skull and hand are similar in this way, yet they are different in their structure in an important way. The mandible is attached to the skull at both ends, which limits its movement but increases its strength, while in the hand, because its part of a limb it has its moveable bones connected at only one end. This provides less strength, but great flexibility and movement."

This work with pattern recognition provides the solid basis of observations with which to create and apply the concepts of bodily specialization and lack of specialization to help substantiate and clarify the general theme of balanced, proportionate form in the hu-

man being. Again, questions from the last quiz of the course are used to test the thinking of the ninth graders. The following is a passage from a different ninth grader's work.

"Human bodies are built in such a way that they can do a wide variety of things, depending on how the body is worked and taught to do something; humans are not meant to do one thing in particular. Humans walk upright, which leaves their arms (with opposable thumbs) free to grab, lift, and move things. Humans can also speak, which opens up many more windows of opportunity to them for a choice of occupation."

As a teacher it is exciting to share this type of inquiry with students. It is often difficult for them, just as learning any new skill carries with it trials and obstacles, and it does not often fit the category of "education as entertainment," as so much "whiz-bang" science does these days. However, it is rewarding and the students gain real insights, the kind of insights that are "living" just like the organisms they help to portray.

Bibliography

1. Rudolf Steiner introduced the term "Earth Ripeness" for example in *Soul Economy: Body, Soul, and Spirit in Waldorf Education*, 16 lectures in Dornach, Switzerland, Dec. 23, 1921-Jan. 7, 1922 (GA 303) [previous title: "Soul Economy and Waldorf Education"]
2. Martin, Michael. *Education through Arts and Crafts*, Forest Row, England: Steiner Schools Fellowship Publications, 1999.
3. Mitchell, David and Patti Livingston. *Will Developed Intelligence*, Fair Oaks, CA: AWSNA Publications, 1999.
4. Craig Holdrege discusses the stage of "logical thinking anchored in observation," in "The Art of Thinking: Helping Students Develop a Truly Human Capacity," *Renewal*, Vol. 10, #2, Fall/Winter 2001, pp. 28-31.

Overall references on Human Form and Comparative Morphology

Glockler, Michaela M.D. *A Healing Education*, [Lecture #2], Fair Oaks, CA: Rudolf Steiner College Press, 2000.

Holdrege, Craig. "Genes and Life: The Need for Qualitative Understanding." *Research Bulletin of the Waldorf Education Research Institute*. Vol. IV, #2, June 1999. pp. 14-22. [Comparative morphology, particularly skull morphology, Goethe and the intermaxillary bone]

_____. *Genetics and the Manipulation of Life*, [Ch. 6 "Heredity and the Human Being": Usage and development (particularly leg and foot) and its affect on morphology], Hudson, NY: Lindsifarne Press, 1996.

_____. "Seeing the Animal Whole: The Example of the Horse and the Lion" in *Goethe's Way of Science: A Phenomenology of Nature*. David Seamon and A. Zajonc (eds.), State University of New York Press. Albany, NY: 1998.

_____. "What Forms an Animal?" *In Context*. Number 6, Fall [Comparative morphology, particularly the structure and usage/activity], pp. 12-14, 2001.

Riegner, Mark. "Horns, Hooves, Spots and Stripes: Form and Pattern in Mammals" in *Goethe's Way of Science: A Phenomenology of Nature*. David Seamon and A. Zajonc (eds.), [Three-fold or complementary polarity patterns in mammals], Albany, NY: State University of New York Press, 1998.

Schad, Wolfgang. *Man and Mammal: Towards a Biology of Form*, [Chapters I, II and XIV especially], Garden City, NY: The Waldorf Press Publishers-Adelphi University, 1977.

Verhulst, Jos. *Development Dynamics*, Hudson, NY: Adonis Press, 2003.

The Brain and Finger Dexterity

by

Hella Kraus-Zimmer, Dornach

From *The Goetheanum News* for Jan. 14, 1996)

Recent research, at the Universities of Muenster and Constance have shown that the often-repeated and subtle finger exercises of violinists and guitarists enlarge the center of movement in the brain.

Scientific research thus confirms what Rudolf Steiner described in 1920:¹ our finger movements are significant teachers of elasticity in our thinking. A person with very clumsy hands will also not be a very subtle thinker. He or she will tend to think in less subtle terms and will tend to be more suited to materialism. This is because in order to be able to grasp a spiritual world-view, we require fine-meshed thoughts.

Rudolf Steiner then went on to speak of Waldorf education in which, for such very reasons, the boys as well as the girls' learn to crochet and knit. Waldorf teachers need to know the significance of being able to move the fingers skillfully.

Briefly said: our finger movements influence our brain and our ability to think—which has now been proved scientifically.

1. Steiner, Rudolf. *Man: Hieroglyph of the Universe*, GA 201, April 25, 1920.

Observations of a Neurophysiologist

by

Matti Bergstrom

The brain discovers what the fingers explore. The density of nerve endings in our fingertips is enormous. Their discrimination is almost as good as that of our eyes. If we do not use our fingers, if in childhood and youth we become "finger blind," this rich network of nerves is impoverished—which represents a huge loss to the brain and thwarts the individual's all-around development. Such damage may be likened to blindness itself. Perhaps worse, while a blind person may simply not be able to find this or that object, the finger-blind cannot understand its inner meaning and value.

If we neglect to develop and train our children's fingers and the creative form-building capacity of their hand muscles, then we neglect to develop their understanding of the unity of things; we thwart their aesthetic and creative powers.

Those who shaped our age-old traditions always understood this. But today Western civilization, an information-obsessed society that overvalues science and undervalues true worth, has forgotten it all. We are "value-damaged."

The philosophy of our upbringing is science-centered and our schools are programmed toward that end . . . These schools have no time for the creative potential of the nimble fingers and hand and that arrests the all-around development of our children—and of the whole community.

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