Volume 18, #28
Autumn 2012

Waldorf Science Newsletter

David Mitchell, Editor
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Waldorf Science

Explorations in Phenomenology as Practiced in Waldorf Schools

A Science News Roundletter

Editor: David Mitchell
Assistant Editor: Ann Erwin

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FROM THE EDITOR

David Spear Mitchell
6 December 1945 – 8 June 2012

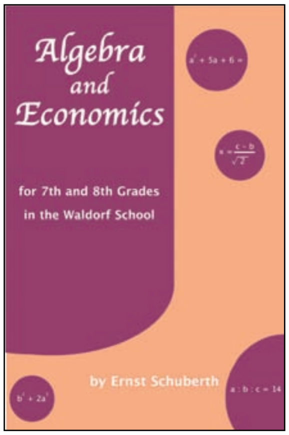
This edition of the *Waldorf Science Newsletter* comes with a quality of memorial to it as it is the last newsletter David Mitchell prepared before his passing on June 8, 2012. David was a teacher of science through and through, and this newsletter has been his own expression of his limitless enthusiasm for the way in which Waldorf education brings science to young human beings through the curriculum. It was one of David's greatest wishes to bring science teaching to its proper place as a hands-on, experience-first, observational pathway to understanding the deep truth, beauty, and goodness of the phenomena of the world.

Though plans are afoot to continue the *Waldorf Science Newsletter*, change will come inevitably without David's torch lighting the way. Still, with the many lights he lit as class teacher, high school teacher, teacher educator, publisher, researcher, friend and mentor, we are likely enough to find the way. Read this along with us, proffering an inner salute to this mighty and dedicated warrior for true science, so needed in our world.

Douglas Gerwin
Co-Director, Research Institute for Waldorf Education

Patrice Maynard
Leader for AWSNA Outreach & Development

Books of Interest



Algebra and Economics
for the 7th and 8th Grades
by Ernst Schuberth

This book about teaching mathematics in the Waldorf school contains algebra lessons for classes seven and eight (and some forward-learning inclusions in the addendum). Like the other books in this series, it is geared toward class teachers for these grade levels. There are several recommendations in the introduction concerning the division of the study material. However, the book is also well-suited to anyone who wishes to become familiar with basic algebra through independent study.

Themes include:
• An Economics Project
• Introduction to Negative Numbers
• The Basic Rules & Properties of Algebra
• Multiplying & Dividing with Positive & Negative Numbers
• Recursive Arithmetic
• Introduction to Higher Mathematical Operations
• Calculating the Square Root
• Quadratic Function
• Calculating the 3rd Root (Cubic Root)
• The Euclidean Algorithm

Pages 240 6 x 9 inches Softcover
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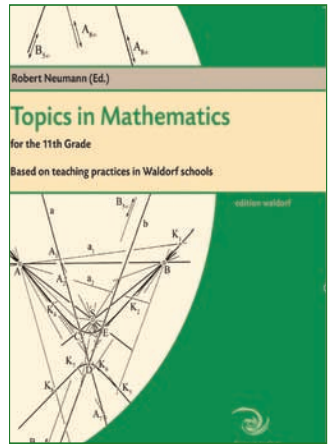

Topics in Mathematics for
Waldorf High Schools—11th Grade
edited by Robert Neumann

The series Mathematics for the High School was specifically designed with math teachers in mind. Not only are the books useful resources for gaining familiarity with teaching approaches used in a Waldorf school, but they are also a source of inspiration – offering fresh perspectives and new insights – for courses that have perhaps been taught many times.

This book contains experienced teachers' suggestions for lesson blocks covering topics taught in the 11th grade in the Waldorf curriculum.

Themes include:
• Analytical Geometry
• Projective Geometry
• Spherical Geometry
• Sequences and Limits

The emphasis is on projective geometry, since this topic is not very familiar to most teachers. The material is not only described theoretically, but includes many examples, exercises and "hands-on" hints for the lessons. Some information about the historical background of the major themes rounds out many of the contributions.

Pages 288 7.25 x 9 inches Softcover
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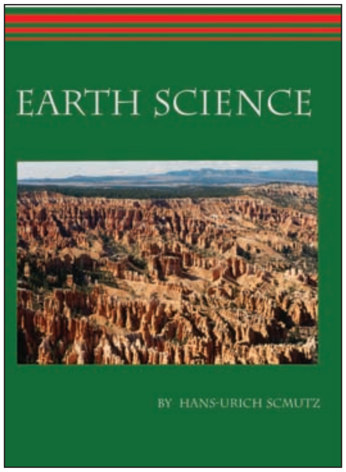
ISBN 978-1-936367-11-5

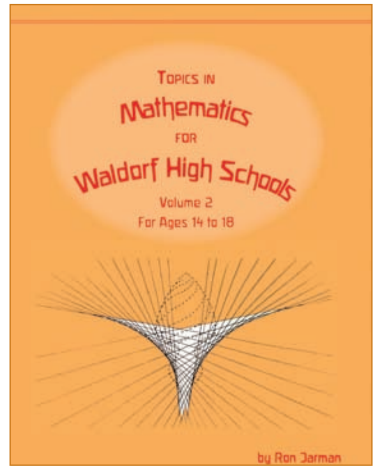


Earth Science

by Hans-Ulrich Schmutz
translated by Thomas Wassmer
edited by David Mitchell

This book contains a comprehensive curriculum for teaching earth science in Waldorf/Steiner high schools which is entirely consistent with the developmental stages of high school students. The author's consistent and carefully developed curriculum guides the student from geology through the dynamics of ocean currents and global climatology, crystallography, technology, and economic geography to astronomy and paleontology. All these subjects are provided with new and interesting point of views, which gradually contribute to a discovery of the living connection between the earth and the human being.

Pages 224   7 x 10 inches   Perfect bound
AWSNA Publications   Illustrated
ISBN: 978-1-936367-09-2



Topics in Mathematics for Waldorf High Schools

by Ron Jarman
edited by David Mitchell

This book lays out topics for the study of mathematics in Waldorf high schools. It provides anecdotes and humor to stir the feelings of interest in adolescents. Profusely illustrated, it leads the reader into many mathematical concepts.

Pages 230   7 x 10 inches   Perfect bound
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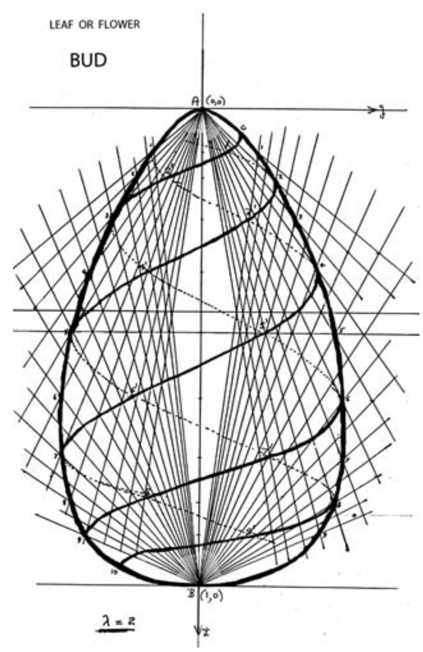

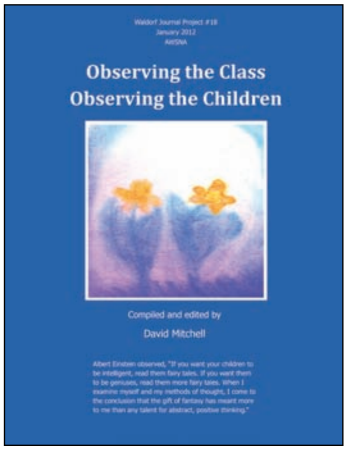

Waldorf Journal Project #18

OBSERVING THE CLASS,
OBSERVING THE CHILDREN

Edited by David Mitchell

CONTENTS

- *The Art of Observing Children* by Christof Weichert
- *What Does a Good Child Observation Entail?* by Klaus Hadamovsky
- *Different Children – Changed Childhood* by Anna Seydel
- *Born as an Original – Died as a Copy* by Armin Krenz
- *Love Melts Away Fear* by Henning Köhler
- *The Secrets of Children's Drawings* by Armin Krenz
- *Normal Is the Difference: Maxims for Successful Integration* by Henning Köhler
- *Anything but Children's Play* by Dr. Irene Jung
- *Love Enables Knowledge* by Lorenzo Ravagli
- *Methods before the Age of Nine* by Ted Warren
- *What Was That? Forgetting and Remembering* by Albert Schmelzer
- *Brought to School by the Police* by Henning Köhler
- *Elemental Beings Are Real for Many Children* Conversation with Katharina Dreher-Thiel
- *Laughing with the Ninth Graders* by Florian Heinzmann

Pages 92 | 8.5 x 11 inches | Spiralbound, Illustrated

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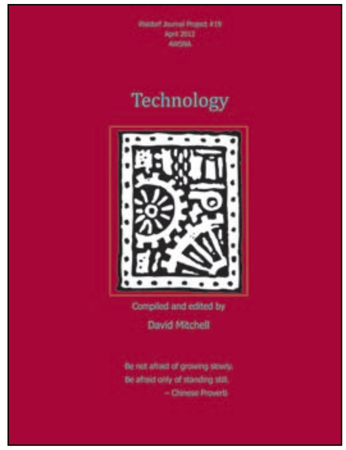

Waldorf Journal Project #19

TECHNOLOGY

Edited by David Mitchell

CONTENTS

- *Rudolf Steiner and Technology*
- *A Few Quotes on Technology* by Rudolf Steiner
- *Education for Adolescents* by Rudolf Steiner
- *On the Philosophy of Freedom* by Lorenzo Ravagli
- *On Freedom* by Henning Köhler
- *Human Capital – Commercial Value or Creative Potential?* by Henning Köhler
- *An Information and Communication Technology Curriculum for Waldorf Schools* by William Steffan
- *"Building Inner Fire" Independent Working and Learning: Teaching through Projects* by Sibylla Hesse
- *I Question, Therefore I Am* by Henning Köhler
- *Technology and the Celebration of Work as Developed in Waldorf Education* by David Mitchell
- *Will-Developed Intelligence: Craft and Movement Gesture in Waldorf Education* by Bernard Graves
- *Praise for Authority* by Henning Köhler
- *What Does the Extention [for Electric Power Plants] Have to Do with Our Children?* by Henning Köhler
- *Helping Adolescents Improve Their Memory* by Albert. Schmelzer
- *When a Child Has Problems, It's Not Always the Parent's Fault* by Henning Köhler
- *Education through Experience* by Dietrich Esterl
- *Panacea: The Magic Remedy for a Contemporary Education* by Johannes Kiersch

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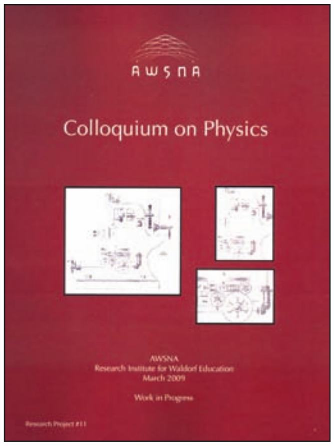

Colloquium on High School Physics

Organized by the Waldorf High School Research Group through the Research Institute for Waldorf Education, a group of experienced teachers discusses and explores the Waldorf physics curriculum and suggests new ideas while solving some of the riddles found in the current curriculum.

Pages 98 8.5 x 11 inches Spiralbound
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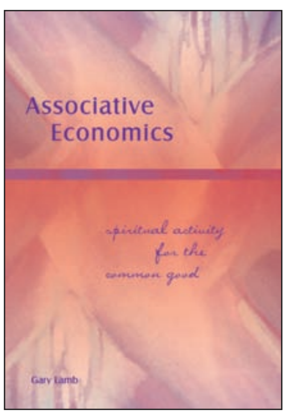

Associative Economics

Spiritual Activity for the Common Good

by Gary Lamb

This comprehensive book guides the reader to substantially rethink aspects of economic life. It opens doors for new perspectives, describes pitfalls and successes, and gives practical small steps one can take in order to effect change and improve the human condition.

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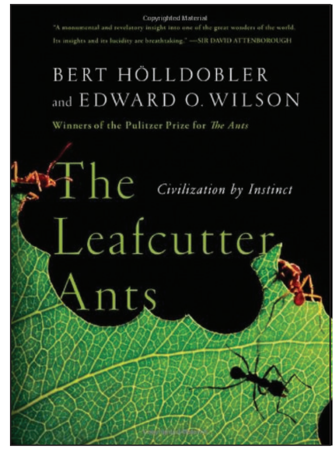

The Leafcutter Ants

by Edward O. Wilson and Bert Hölldobler

Leafcutter ants are familiar to all those who live in rural Texas and Louisiana. These are the ants busily running in columns on trails they keep free of debris and vegetation, carrying freshly-cut sections of leaves and flower petals over their heads like umbrellas. If one followed the ants to their nest, one would discover an immense network of tunnels, the majority of which are an underground garden in which the ants grow their food—fungus planted onto a substrate of chewed plant material previously brought in by the ants. As readers we are introduced to earth's most evolved animal society. With the colony's queen as its reproductive organ, the various ages and types of workers as the brain, heart, and other organs; and the communication among the ants similar to the communication of nerves and ganglia, a leafcutter ant colony can be truly considered as a superorganism.

Pages 160 6.1 x 8.2 inches Softcover
W.W. Norton & Company Illustrated
ISBN: 978-039333-86-83

Research Bulletin, Autumn/Winter 2011
Volume XVI Number 2

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- *Science and the Humanities: The Great Rift in Modern Consciousness* by Douglas Sloan
- *What Lies Behind a Waldorf School?* by David Mitchell
- *On Earth as It Is in Heaven: The Task of the College of Teachers Part I* by Roberto Trostli
- *The Plight of Early Childhood Education in the U.S.* by Joan Almon
- *The Art of Knowing: Epistemological Implications for a Schooling of the Imagination* by Jonathan Cole
- *Painting from a Palette Entirely Different* by Johannes Kiersch
- *Authenticity in Education* by Elan Leibner
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- Reports from Current Projects of the Research Institute

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Research Bulletin, Spring/Summer 2012
Volume XVII Number 1

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- *"Spirit Is Never without Matter, Matter Never without Spirit"* by Liz Beaven
- *The Artistic Meeting: Creating Space for Spirit* by Holly Koteen-Soulé
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- *The Philosophical Roots of Waldorf Education Part I* by Frederick Amrine
- *The Concept of Learning in Waldorf Education* by Jost Schieren
- *Modeling Clay – for All Ages?* by Arthur Auer
- *Anything but Children's Play: What Play in School Means for Learning* by Irene Jung
- *Higgs Field and a View of the Material World that Makes Sense* by Michael D'Aleo

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THE HIDDEN GEOMETRY OF FLOWERS: Living Rhythms, Form and Number

by

Keith Critchlow

The higher purpose of geometry is to participate—body, soul and spirit—in the objective universal laws that govern and cohere our universe. This activity can lead us directly to the center of our own understanding which unifies us with the whole.
– Keith Critchlow

Can we imagine a world without flowers? Their beauty offers us delight in their color, fragrance, and form, and their substance offers medicinal benefits. Flowers also speak to us in the language of the plant's form, provide cultural symbols in different cultures, and, at the highest levels, offer inspiration.

Flowers speak to us in the language of nature.They become teachers of symmetry and geometry (the eternal verities, as Plato called them). In this sense, we can treat flowers as sources of remembering ways of recalling our own wholeness, as well as awakening our inner power of recognition and consciousness. What is evident in the geometry of a flower's face can remind us of the geometry that underlies all existence.

In this beautiful and original book, renowned thinker and geometrist Keith Critchlow focuses on an aspect of flowers that has received the least attention. Working from his own flower photographs and hand-drawn geometric patterns, Critchlow reviews the role of flowers from the perspective of our interrelationship with the natural world. His illuminating study attempts to re-engage the human spirit in its intimate relation with all nature.

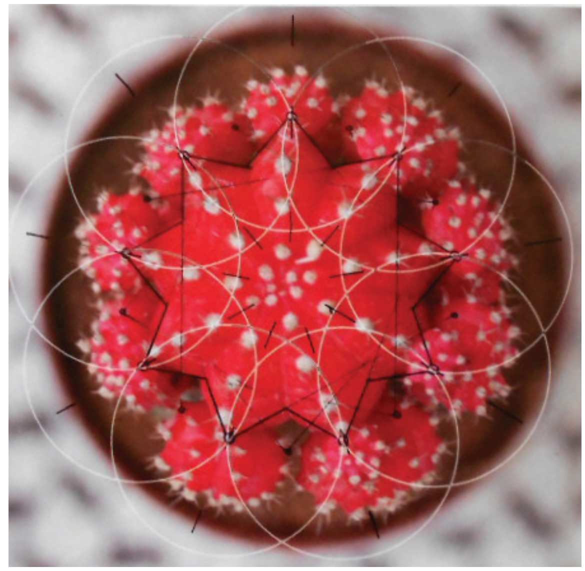
Critchlow has spent his lifetime researching the universal principles of geometry, the area of design where art and mathematics meet, and in the study of nature and ancient and medieval sacred cosmological stone, temple, cathedral, and mosque architectures.

The Hidden Geometry of Flowers is a culmination of his life's work. With over 500 breathtaking color photographs supporting the eloquently written text, Critchlow reveals the hidden geometry of flowers through his hand-drawn geometrical drawings, drawn to exactly correspond to the flower and plant photographs.

The 448-page book is divided into six parts. The introduction gives an overview of how we can begin to look at flowers anew, the quality of number in flowers, and modern science, truth and beauty. The second part of the book, "Viewing Flowers from Different

Another tiny favorite in my childhood is the Forget-Me-Not. The geometry of this remarkably proportional small flower is startling in its conformity to pentagonal symmetry. It is clear that the center of this flower is a decagon or ten-pointed white star.

When seen from behind, the sepals and petals of this modest but beautiful Borage flower dramatically celebrate fiveness in line and plane.



This is a fine example of the nineness which is found in some types of cactus.

Perspectives," looks at traditional perspectives of flowers, quality as well as quantity in observing number and flowers, and the seed as point of origin and potentiality. It concludes with a wonderful section on symmetry in flowering, the spirals of unfolding, the orientation of the face of flowers, and the archetypal geometric form and spirals.

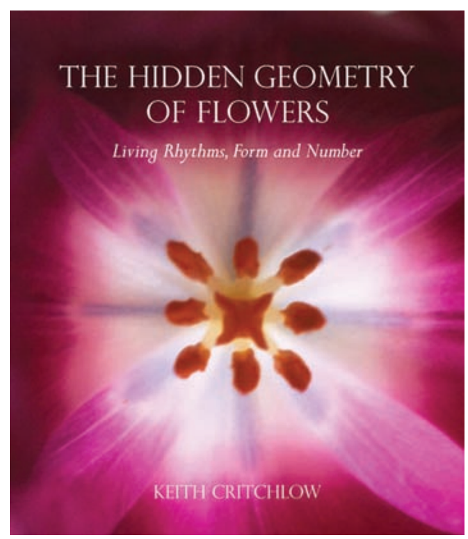
Part three, the "Geometry of Flowers," is the largest section of the book and has over 100 pages of photos and drawings of dozens of flowers, both in pure color and highlighted by geometric overlay. Many charts, line drawings and historical information accompany the different flowers.

"Flowers of Geometry," the fourth part of the book is a section on the many ways to draw, construct and appreciate the different geometric forms revealed in flowers. "Leaves and Life's Most Consistent Miracle: Photosynthesis" explores the beauty in all facts of photosynthesis.

The final section of the book, "Conclusions," ties everything together and explores our human relationship to flowers for the future. It begins with a short excerpt from "The Rock" by T.S. Eliot:

Where is the Life we have lost in
living?
Where is the wisdom we have lost
in knowledge?
Where is the knowledge we have
lost in information?

The Hidden Geometry of Flowers is a treasure for any teacher or student of nature. Learn more about this book on the SteinerBooks website www. steinerbooksorg.



ADOLESCENTS:

Their Relationship to the Night and the Senses in Connection with Their Own Development

by Peter Glasby
Mt. Barker, Australia

This is a description of the workshop *Today's Child, Tomorrow's World,* which took place over three days at the Kolisko Conference in Sydney, Australia. The methodology of the workshop was to develop several strands simultaneously by providing experiences which were then allowed to ripen overnight and developed further on the subsequent day.

In his many courses to teachers, Rudolf Steiner gave material which provides a rich resource for understanding the theme, posing new questions and providing practical insight into working with adolescents in the classroom. Some of the answers are astounding. For example, education is not all about providing "light" for the students but also "darkness." The beginning of the learning process is a "conclusion," not the end of the learning process (Guttenhöfer, 2004), i.e., to differentiate between "living concepts" and "dead concepts," a critical differentiation for education. He provided indications for the way a teacher arranges his lessons and for the way in which the day is organized for the students. In this workshop we attempted to explore this area using text material from Steiner's work, experiments, biographies, group discussion and active participation. We attempted to work with the same elements with which we work at school, i.e., the sleep life, the structure of the lesson and the day- and three-day rhythms.

Day One

To which rhythm of life does sleep belong? What are the rhythms which happen within our daily lives? The astral body is the name for that spiritual member of the human being, which, in a certain way, contains our thoughts, feelings and impulses.

The day rhythm of the sun is one of renewal, of starting again. The change from our waking consciousness to sleep consciousness and then back again to waking consciousness is one of the fundamental rhythms of our existence. Without one side of the rhythm we would become ill and wasted; without the other we would lack the basis of experience for burgeoning independence. On behalf of the adolescent, who is undergoing significant changes in his or her own relation to his/her soul life, there are particular things to which the teacher should pay attention:

- How is this change happening for boys and girls?
- How is the 'sense life' to be cultivated?
- How is the process of 'knowing' managed in school so that the students can be active participants?

In the first lecture of the series given to the teachers at the first Waldorf school, we find the interesting statement: *"We must teach the children how to sleep.* " Surely school should be about keeping children awake, even amused, but what on earth are we to understand about teaching them to sleep? This statement leads us into the question of what is sleep? What is this state where we lose our memory, where we recover, reorder and heal?

During our waking consciousness, our senses are filled with the images of the world. During sleep they are closed and our consciousness is partially extinguished. Steiner described what occurs then in our soul. Freed from the distraction of the senses, the soul is given over to a world of order and archetypes out of which the creative forces of the universe flow.

The symbol for the sun is a circle with a point in the middle. This is a picture of the human experience

of the day rhythm. We are a point when we wake up into our senses, our day waking consciousness. At night we lose our consciousness into the world of sleep, the world of the dark, the stars and the periphery.

What are the phenomena we can recognize in relation to our sleep life? It replenishes us so that we are ready to look at things afresh, to take up new tasks. We can go to bed plagued by a problem and then wake to find the solution has dawned upon us. There is also a ripening that happens with sleep, during which skills and abilities mature to new levels. The closeness of events from the day appears in a new perspective, which is why we often say we are going to "sleep on" a situation before we make a decision. We can consciously take a problem or situation involving another human being into our sleep and experience how, upon waking, much of the tightness of the "problem knot" has relaxed and new possibilities have emerged.

Steiner mentioned teaching the children to sleep in Lecture I of *The Study of Man.* One could think

*FIG. 1. The Zodiacal human being is a recurring theme in medieval manuscripts. The signs are associated with corresponding principles in the body to show the human being, the most perfect creature in the world, as the microcosmic image of the heavens—a reflection of the celestial mirror. (*Anatomical Man *from* Les Très Riches Heures du Duc de Berry, *15th c.)*

of this as teaching the children to breathe between the periphery and the center. The medieval mystic Angelus Silesius refers to this aspect of the human existence between center and periphery:

I don't know what I am, I am not what I know,
a thing and not a thing, a drop and a circling.

This concept was depicted in medieval times in many different ways, one of the most beautiful represented in Fig. l of Steiner's *Occult Science* (1925) in the chapter about sleep and death. Waking and sleeping are described as the astral/ego being within and without the physical/life bodies. The life body is form-giving but only if it receives from the astral body the "pattern forms" or archetypes. In wakefulness, we turn our senses to the surrounding world to form mental images. These are the "disturbers of the peace."

The physical/life bodies contain the organs by which the astral body perceives the external world and has to be separated from its own world (see *Occult Science*, p316). In sleep the astral body is united with the world out of which the human being is born. Apparently people in medieval times experienced this world out of which we are formed as being the zodiacal starry world.

Through the senses our experience is dismembered among twelve fields of experience. In cognition this dismemberment can be remembered, reintegrated. How this happens is important for the art of teaching. It swings between the dismemberment of waking consciousness in the twelve fields of experience (twelve senses) and the reunification in the nightly starry world of twelve zodiacal directions of space. We can have experiences of the dismemberment, but we cannot so easily have experiences of the reunification within the starry world. We can, however, experience the extraordinary rejuvenating power of sleep.

Up to puberty the astral body is in gestation. Like the physical body in gestation, it is there, being nourished, but not yet been born until adolescence dawns. The birth of the astral body is related to the development of judgment at many levels through the high school years. This synchronization is important for educators to realize. Goethe (1960) wrote about the space between the experience of a phenomenon and the judgment about it:

One cannot give enough importance to the fact not to draw conclusions, not to prove things too quickly, or support a theory. Between the observation of the facts and the judgment, there belongs a space in time to take up the facts in a pure way. They must live. The mind has the tendency to jump to conclusions.

– Goethe, "The Experiment as the Mediator between Object and Subject"

This has important implications for the way experiences are prepared for the students, the timing of the explanation, and the way of the explanation. This principle was a central theme in Steiner's lectures of 1919 and 1921 on the practice and art of teaching. In Lecture 9 of *The Study of Man*, he characterized the sequence: Conclusion, Judgment and Concept, whereby the Conclusion is characterized as a "happened event" and stands at the beginning of the process of cognition not as a "conclusion concept."

* * *

At this point in the workshop, we did two experiments (from von Mackensen, 1992). The first involved going out into the parking area and looking into a grey trough, full of water, with two tiles at each end, one vertical, one horizontal, with alternating black and white stripes painted on them. We tried to pay particular attention to the transition areas of dark to light. The second experiment was conducted inside. We looked at a person through a large water prism, again paying attention to the transition areas between light and dark.

In the first experiment, after some time we noticed that there was a shift of the image in the water. The closer we brought our point of view to the water, the more the tile seemed to be compressed towards the surface of the water. At the same time colors appeared at the edge of the strip—warm colors on some edges and cool colors on other edges.

What we saw through the prism has been drawn in the picture above. Notice the colors on the edge of the dark and light areas. These experiences were described and somewhat characterized, and then left. We concluded our first day with the following story (Davidson, 1965):

In the 1860s an Irish couple, Alice and Thomas Sullivan, escaped the famine in Ireland and settled in a little farming community in the eastern United States. Their first child, a little girl, Annie, was born on April 14, 1866. Her first two years were blessed, and then her life became filled with hardship. When she was two years old, her eyes became itchy and her parents, using the poor man's doctor, Time, waited for the condition to go away, but it did not and was finally diagnosed as trachoma. Soon after, her mother developed tuberculosis and the next child, Jimmy, born in 1869, had tuberculosis of the hipbone. Thomas began to drink. A third child was born. Annie became a difficult child with frequent, violent temper tantrums. One day, after she had thrown his shaving gear all over the bathroom, her father said, "Are you a devil? See what you've done. Brought bad luck to the house. Seven years of bad luck."

When Alice died, the children were all separated amongst the relatives. No one wanted Annie because of her tantrums and because by now she could hardly see. After an unsuccessful stay with a cousin, Annie and Jimmy were taken to the Tewkesbury poorhouse. Jimmy was allowed to stay with his sister only by wearing an apron. They lived in appalling conditions; their playroom was the room where those who died were kept until burial.

Then Jimmy died, and Annie's only friends were two old women, one of whom was blind and the other arthritic. The blind woman told her stories and the arthritic woman would read to Annie from magazines in exchange for little chores. A year later, a visiting priest, Father Barbara, noticed Annie and took her away to the Sisters of Charity Hospital in Lowell, Massachusetts, for an eye operation. This was unsuccessful and Annie was returned to Tewkesbury where she continued to live in deplorable conditions for three more years, 1878–1880. During a government inspection of the poorhouse in 1880, Annie ran amongst the inspectors as they were about to depart and cried out that she wanted to go to school.

A few days later, a coach arrived to take Annie to Perkins Institution, a school for the blind and deaf. She was now fourteen years old and had had virtually no schooling. She was difficult with the other children who called her Big Annie. She learned both signing and Braille quickly but could see no point to spelling. Her stubbornness and the unkindness of one of the teachers led to another serious tantrum and her leaving the room—and nearly the school.

One of the teachers, Miss Moore, took on the responsibility for Annie, setting aside time every week, during which the two studied or talked or walked the grounds. Over time Annie began to heal. She began to imitate Miss Moore's soft voice, her gentle ways, and her kindly interest in other people. Slowly the manners she imitated became part of her, and the other girls began to warm to the new Annie. It was the beginning of a new experience, one she had not had for so long that she had forgotten it—the feeling of happiness.

Two other people contributed to Annie's further development. One was a young Irish man whose rooms Annie cleaned. He convinced her to see a Dr. Bradford who eventually convinced Annie to attempt a series of operations, which finally gave her back relatively good vision. Annie was one of the earliest patients to have ether as an anesthetic. The second was Mrs. Hopkins, a widow from Cape Cod, who had lost a daughter of Annie's age and who became Annie's housemother. In fact, she became a mother figure for her until Annie completed her education in 1886. There were eight graduates in that class and Annie led them all. She was the class valedictorian and at graduation gave a speech memorable for its universality:

> *Now we are going into the busy world to take our share of life's burdens and do our little part to make the world better, wiser and happier. ... Self-development is a benefit, not only to the individual but also to humanity. Every person who improves herself is aiding the progress of society, and everyone who stands still is holding it back.*

Annie was dreading what life would now bring her after graduation. As she contemplated an uncertain future, the principal of the school brought her a letter, which asked if she would consider taking a position as governess for a little blind, deaf, mute girl from southern United States. The girl's name was Helen Keller.

Day Two

The question arose about scientific language and the appropriateness of its use. This led to the consideration of "dead concepts" and "living concepts." Scientific language can carry implicitly dead concepts within it. Sometimes these unconsciously-carried concepts are brought to consciousness with application and then they may

Helen Keller with Anne Sullivan

shock us. This type of experience is becoming more common as the applications of biotechnology become more prevalent in society.

On the one hand it is necessary that children learn names of things and have knowledge about the actual nature of the world—how high mountains are, how deep the sea is, how long rivers are, what time it takes to travel between places. In learning about rocks and volcanoes in class 6, one may well learn some of the language of geology such as igneous rocks, plutonic rocks, sedimentary rocks and so forth. No real model is implied—the names are descriptive.

An example of inappropriate language is the language of rays and particles in explanations of brightness and shadow in classes 6, 7 and 8. In the light ray example a model is implied. Here it is better for the teacher to develop his own language as in the cases of von Mackensen (1992) and Maier (1986).

We read a section from Chapter 8 of *The Study of Man* (Steiner, 1919) about the senses and the polarity of disparateness in the day-waking state compared to the unity of the night state. This gave us indications about working with the night and the process of judgment. The integration of sensory experience is an important part of process of judgment, and Steiner described how it begins in the way that sensory experience is integrated, as in the example of looking at a shape with color. There the sense of sight and the sense of movement are integrated.

The senses give us a separate experience of existence; in fact many separate experiences, which, Steiner suggested, have twelve sensory fields. This disparity of the twelve senses and the unity of the archetypal human being represented by the twelve zodiacal signs forms an interesting polarity.

Masters of Physics, Imagination and Play

by Len Barron

The purpose of education is to nurture thoughtfulness.
The lesser function of thinking is to solve puzzles and problems.
– Albert Einstein

As profound as was the work of Einstein and Niels Bohr in physics, their thoughts and practice in education were of the same nature. In 1952 Einstein wrote an article titled, "Education for lndependent Thought":

> *Overemphasis on the competitive system and premature specialization on the grounds of immediate usefulness kills the spirit on which all cultural life depends, specialized knowledge included. This competitive mentality prevails in schools and destroys feelings of human fraternity and cooperation. It conceives of achievement not as derived from love for thoughtful and productive work, but as springing from personal ambition and fear of rejection.*

He later would say: "The essential purpose is to decide for yourself what is of genuine value in life … and then to find the courage to take your own thoughts seriously." At the turn of the 20th century Einstein changed our perception of time and space. Now in the early years of the 21st century he can help change the common perception of what constitutes the basics in education.

He saw no causal relationship between competence in reading, writing, and mathematical skills, and being an imaginative, generous-hearted human being. The three Rs are crucial and critical tools; nevertheless, they are only tools. Einstein said, "Let us not forget that knowledge and skills alone cannot lead humanity to a happy and dignified life. Something more is needed to produce a truly educated person." The magic for Einstein was in the "something more"—a mix of fairness, beauty, and playfulness … the building blocks, the energy field for encouraging wonder, discipline, and a generous heart.

Albert Einstein in Santa Barbara

The proof is in the pudding. Find anyone whose life is grounded in these qualities and you will be in the company of someone who leads a fertile life and is dearly loved. It is a beautiful equation—an $E = mc^2$ for our time.

Imagine any setting at home, at work, or in the street in which these qualities set the tone for the time. Imagine sending your child off to school where fairness, beauty and playfulness fill the air in the classroom, the hallways, and in the neighborhood. Imagine that.

Late in Einstein's life he was talking with a group of parents about children, and he said, "If you want your children to be intelligent, read them fairy tales." He then smiled and added, "If you want your children to be more intelligent, read them more fairy tales."

Niels Bohr was mentor and companion for two groups of people: the physicists who came to Copenhagen to work with him and his children and

Neils Bohr and grandsons

grandchildren. The physicists came from everywhere; they were the young stars in the world of physics. The first line of business was quantum mechanics, and Copenhagen was the center of that dazzling enterprise. The informality at the Institute was unlike anything anywhere in scientific circles; all had equal standing, a newly minted PhD or a Nobel Prize winner. What mattered was the strength of an idea, from whomever it came.

In this spirit of open and critical inquiry, these brilliant theorists ate and worked together, they walked, skied, made music, and went to the movies together, and they played ping-pong, the favorite indoor sport at the Institute. And these very literate physicists made up skits. In1932, on the l00th anniversary of Goethe's death, it was a parody of his Faust. Bohr was the Lord; Pauli, quite naturally, was Mephisto; and in perfect casting was the conflicted Ehrenfest as Faust. And these wild-minded theorists also had great fun playing soccer with Bohr's children. The mixing of ages was a keen passion for Bohr.

Niels Bohr had six sons, eight grandsons, and nine granddaughters, and all were gifted by Bohr's dramatic reading of the old fairy tales, particularly the Icelandic sagas that had been read to him as a child. The children had their favorites and often one of them would shout out, "Oh, Grandpa, read it again, please, please." And Bohr would shake his head and do it again as if he were telling it for the first time ever.

It was hands-on experience at the Bohrs' as youngsters helped in the garden, the kitchen, and a host of other projects including planning parties and other gatherings. Bohr was fond of saying that imitation is a prime method of learning, and combined with a child's energy and curiosity, there are many opportunities for children to be happily engaged while gaining a sense of their own abilities. The children especially loved to be outdoors and Bohr would often join in their play. When caught once in the middle of a romp, he said, "I love playing with children."

The Bohrs, Niels and Margreth, were models of kindness, and with a house full of children there were occasions when being fair was part of the conversation around the dinner table. For Bohr, being fair was more than a moral issue, for in being fair one witnesses people and events in a clearer light. Fairness is at the root of wisdom. It all begins with being fair.

Bohr's openness to experience was passed on the children. Aage, one of Bohr's sons, who also won a Nobel Prize, shared a thought about his father's ways: "Our father was very good at teaching us how to make mistakes."

Paul Ehrenfest © expired

Bohrs and Einstein think it over. (December 1925)

Over the last twenty years Len Barron has been presenting his one-person theatre piece, "Walking Lightly… A Portrait of Einstein" and now his latest work, "Einstein and Niels Bohr...A Fairy Tale," for a wide range of audiences across the country. He has worked with students and faculty at all levels, sharing Einstein and Bohr's perspective on education. He lives in Boulder, Colorado, and is a frequent contributor to the Boulder Daily Camera. This article is from Sunday, January 15, 2012, and is reprinted with the author's permission.

Teen Brains' Growing Pains
Striking Changes Are Possible in IQ and Neuroanatomy, Study Finds

by Laura Sanders

Reprinted with permission from *Science News*, November 19, 2011, Vol. 180 #11, p12

The roller-coaster teenage years can take IQs along for the ride. A person's IQ can nosedive and climb sky-high during adolescence, while corresponding brain regions wax and wane in bulk, researchers report online October 19 in *Nature*. The results suggest that the IQ number given to a child is not immutable, as many researchers believe, says neuroscientist Richard Haier of the University of California, Irvine. "This is an extremely interesting paper."

Back in 2004, Cathy Price of the Wellcome Trust Centre for Neuroimaging at University College London and colleagues tested the IQs of 33 healthy participants who were, on average, 14 years old. While the teens were in the lab, structural MRI brain scans measured particular brain regions.

About four years later, Price and her team invited the teenagers back for a redo. Overall, IQ scores held steady: Average IQs were 112 in 2004 and 113 four years later. But when the researchers zoomed in on individual teens, they found that about a third of the teenagers had meaningful changes in IQ, and a handful showed dizzying climbs or plunges.

One such plunge was 18 IQ points—which would be enough to demote a person from genius status to merely above average. The retest also turned up an IQ gain of 21 points—which would elevate a below-average person to above average. Some people who scored high the first time around scored even higher later, and some low scorers scored even lower.

To Price and her colleagues, these results were so surprising that they initially suspected mundane explanations such as differences in the teens' levels of concentration at the time of each test. But the brain scan data argued otherwise.

The IQ changes were accompanied by changes in the brains' gray matter, which is made up of nerve cells. Boosts in verbal IQ came along with denser gray matter in the left motor cortex, a part of the brain that's involved in speaking. And boosts in performance IQ, which measures abilities such as understanding pictures, were accompanied by denser gray matter in the anterior cerebellum, a part of the brain important for movement.

These brain changes mean it's less likely that the IQ variations represent someone having a bad testing day, Price says. "We therefore concluded that the fluctuations were meaningful changes in IQ, not measurement error," she says.

Evidence for a malleable intellect could change how people's abilities are evaluated, she says. For instance, it might help educators to know that intelligence scores are still in flux during the teen years. Some studies, including work by Haier, have found that intense brain training can boost gray matter, although no one knows exactly how those brain changes relate to IQ.

Because the current study followed teens in their normal lives, scientists don't know what prompted the IQ and brain changes. Rapidly developing interest in socializing, school, and even sports might all influence the brain, Haier says, "So much is going on in the teenage years."

Citations: S. Ramsden et al. Verbal and non-verbal intelligence changes in the teenage brain. *Nature*. Published online Oct. 19, 2011. doi:10.1038/nature10514.

Suggested Reading
B. Bower. Smarty Brains: High-IQ kids navigate notable neural shifts. *Science News*. Vol. 169, April 1, 2006, p. 195.
J. Raloff. Study reports hints of phthalate threat to boys' IQs. *Science News Online*. April 5, 2010.

THE MIND'S EYE REVEALED:
New Technology Uses Brain Scans to See What a Person Is Watching

by Laura Sanders

Reprinted with permission from *Science News*, November 19, 2011, Vol. 180 #11, p12

Researchers have just wrapped production on a special movie of the mind that stars a brain scanner, a sophisticated computer program, and millions of YouTube videos. By monitoring people's brains as they watched movies and then re-creating what they saw, the new release has tiptoed closer to technology that can read minds by decoding mental activities, researchers report in an upcoming *Current Biology* paper. "It's very dramatic. It really is like *Minority Report*," says neuroscientist James Haxby of Dartmouth College, referring to the 2002 Tom Cruise vehicle in which decoded visions from psychic brains help identify criminals before any crime is committed.

In the study, researchers led by Jack Gallant of the University of California, Berkeley, used a type of brain scan called fMRI to record brain activity in three people (who were all coauthors on the paper) as they watched hours of Hollywood movie trailers. Brain signals were fed into a computer program that learned how each person's visual system responded to scenes in the movies. Once the computer program had a good handle on the brains' responses, the researchers went backwards and attempted to re-create what people were watching solely on the basis of brain signals.

It worked. The technique roughly reproduced movie clips that showed a red bird swooping across the scene, elephants marching across the desert and Steve Martin's hilarious antics, the team reports.

The reproductions reflected only visual details such as the red of a feather, shape of a face and motion of an airplane—not the viewers' full emotional reactions to the films. One of the main reasons the method worked was that scientists have a deep understanding of the visual system, Gallant says, an understanding that's lacking for most other mental tasks. As researchers learn more about how the brain dreams, thinks, or even feels emotions, other cognitive processes could be revealed by reading brain signals, too, he says. "Eventually I think we'll be able to decode other kinds of things."

Until now, such technology had been successful at decoding only stationary objects—such as an image of a chair—from brain activity. fMRI detects sluggish blood flow changes in the brain—signals that are usually too slow to capture the activity that accompanies watching a fast-paced movie. To get around this, the researchers fed the slow fMRI signals through a complex program that filled the gaps in the data to approximate the rapid chain of events as nerve cells in the visual system detect a moving scene. Estimating these quick brain changes from slow data was a key to the technique's success, Gallant says. "Here, we're modeling in way, way more detail than anyone has ever done before," he says.

Guided by these lightning-quick predictions, the computer program then cobbled together scenes from a library made of millions of one-second snippets from YouTube videos. When Gallant and his team averaged the program's top 100 predictions, the result was a blurry clip eerily similar to what had been watched.

Scientists will probably attempt other brain decoding feats soon, Haxby says. "I'm sure people are going to try to do imagination," he says. "We'll calibrate someone's brain somehow, and say, 'OK, I'd like you to imagine an ocean beach scene or imagine looking at your mother's face.' And then we'll say, 'Imagine whatever you want to, and we're going to try to guess what you're looking at.'"

Citation: S. Nishimoto et al. Reconstructing visual experiences from brain activity evoked by natural movies. *Current Biology*. Published online Sept. 22, 2011. Doi:10.1016/j.cub.2011.08.031.

Suggested Reading:
L. Sanders. People can control their Halle Berry neurons. *Science News.* Vol. 176, Nov. 21, 2009, p.9.
L. Sanders. Reading the patterns of spatial memories. *Science News Online*. March 12, 2009.
T. Ghose. Reading minds...or at least brain scans. S*cience News Online*. May 29, 2008.

THE PERPLEXING PATTERN OF THE PAINTED TURTLE

by Jeff Minton

A week ago, I stood on the shore of a lake in the Sand Hills of Nebraska, watching the sun rise through diaphanous clouds. The surface of the lake was a gently undulating mirror, reflecting dawn's colors. But I was intrigued by little periscopes, about as thick as my thumb, that would rise gently to project an inch above the water and then subside and disappear after about 30 seconds.

I thought I could identify the periscopes, but my hunch was not confirmed until I found them along the sandy road at the edge of the lake. Painted turtles, *Chrysemys picla,* were emerging from the lake to lay eggs in the sand.

In places, the sandy road was the first terra firma that the turtles encountered as they emerged from the marsh. In these places I watched them digging holes to lay eggs, but I could not bear the idea of trucks riding over turtle nests, so I moved about six turtles off the road to safer nesting sites.

When I approached a turtle on the road, it did not attempt to escape but simply stood still. I could pick them up to admire them, particularly their undersides, and they did not hiss or attempt to bite, but calmly withdrew into their shells. When I placed a turtle upside down in the sand to photograph its underside, it endured the ignominious treatment peacefully. They are gentle animals.

Fossils show that painted turtles were living 15 million years ago. It is thought that, during the last ice age, painted turtles were isolated in three glacial refugia, where they developed distinct scale and color patterns. Today, four subspecies are recognized: Eastern, Midland, Southern, and Western. The Western subspecies is found west of the Mississippi in the Great Plain, and also in the Southwest and Northwest. It is Colorado's state reptile.

The subspecies are controversial. At one time they were recognized as four distinct species. Recent genetic evidence suggests that only the Southern subspecies should be recognized as a different species and the other subspecific designations should be abandoned.

Having grown up in the Garden State, my mental image of the painted turtle is the Eastern subspecies, which is dark olive green to black on the top and plain cream or light yellow on the underside of the shell, also called the plastron.

The underside of a painted turtle has a bright pattern combining large patches of bright orange with black-and- yellow lines.

The plastrons of the Midland and Southern subspecies are also pale and plain. While moving females off the road in the Sand Hills, I was delighted to note that the *plastron* of the Western subspecies has a bright *orange* background with an elaborate pattern of black and yellow stripes. Why is it that the Western subspecies has a brightly colored, intricately patterned plastron, while the others are plain with subdued colors?

Bright colors often serve to warn predators that a species has dangerous defenses such as poison, venom or stingers, but that is not the case with these turtles. Bright colors also serve to help individuals identify others of the same species, or to help the males attract a mate. But when turtles meet on land, neither sees the brilliant plastron, for it is against the substrate. But when the turtles are swimming in a pond, the plastron would be plainly visible to others.

Then, the question is, why is the Western subspecies so distinctly different from the others? This is an interesting puzzle.

Painted turtles spend most of their time in shallow streams, lakes and rivers. They can also be found in prairie sloughs, cattle tanks, and farm ponds. Water that is slow-moving with a soft, muddy bottom, vegetation, and submerged logs is ideal habitat for painted turtles. Painted turtles can occasionally be found attempting to cross highways in the summer. Why would an aquatic turtle be on a highway? These are usually the females attempting to travel to nesting sites to lay their eggs. It is best not to transport or keep them, but simply to let them be or help them cross the roadway.

Painted turtles are mainly carnivorous, but as they mature they eat more vegetation. They forage for insects, crayfish, small mollusks, worms, minnows, and aquatic plants. They are also scavengers, eating carrion and cleaning up much of the organic garbage of ponds, thus keeping the water fresh. Turtles do not have teeth but simply swallow their food whole or tear it with their beak or claws.

Like all reptiles, turtles are cold-blooded and cannot control the temperature of their bodies. Painted turtles are basking turtles, which means they spend as much time as they can in the sun to warm themselves after a long swim or a chilly night. They bask on a log or rock with their necks and legs stretched out and their toes spread wide apart to catch as much of the sun's warmth as possible. Basking also allows their body to produce vitamins and helps to kill fungi. Sometimes, if a good sunning space is scarce, one turtle will sprawl on top of a larger one's shell. Basking turtles are largely diurnal. Among the adaptations turtles have for living in water is the ability to slow down their heartbeat when they are underwater so that their bodies need less oxygen.

Western painted turtles survive the winter by hibernating. In the fall they put on extra fat and, as the temperature drops, they gradually become less active. Finally they burrow deep into the mud at the bottom of a pond and go into hibernation. Scientists have found that the blood of hibernating turtles actually changes. Like the antifreeze used in the winter to keep the water in car radiators from freezing, turtle blood changes so that it can withstand cold temperatures. As a result, turtle body temperatures can drop to only a few degrees above freezing—much lower than that of most animals that hibernate.

As the water warms up in the spring, turtles wake up and slowly become active. Early warm spells can be dangerous because if they wake up too soon, a sudden return to cold weather may catch them unprepared and they may freeze. In fact, winter weather can be the biggest danger a turtle faces in its adult life. Painted turtles are hardy though, and it is not unusual to see them swimming under ice during the winter.

Painted turtles mate from May to July, and lay l to 2 clutches of eggs a year. Mature males are smaller than the females and have elongated claws on their forefeet. In courtship, the male swims to the front of the female and caresses the sides of her head with the backs of the claws on his outstretched forelegs. After mating, the females travel to nesting grounds that have been used for generations. The female's desire to lay her eggs in a certain place is very strong. This can be a hazardous time, as she will try to cross any barrier—including, backyards, fences and busy highways—to reach her nesting site.

The mother turtle often waits until the middle of the night and lays her eggs in the safety of darkness. Using her hind legs, she digs a nest 4 to 6 inches (10–15 cm) deep in the soil, into which she lays 5 to 15 eggs. It may seem strange that an aquatic turtle lays its eggs on land. However, this is a requirement for all reptiles, as their shelled eggs would drown if laid under water. Covering the nest, she packs down the loose soil with her body. She may pack the soil for quite a distance in order to confuse predators. Having finished her maternal duties, the mother turtle returns to her aquatic home.

Even though the eggs are buried, the 10-week incubation is not a safe time for the turtles inside. During incubation the leathery, roundish eggs may be found and eaten by foxes, skunks, raccoons, and other animals. The nest may also be flooded during heavy rains and the eggs washed away, or the eggs may dry out if they are not buried deep enough. The incubation temperature of the eggs determines the sex of the turtle hatchlings. If the eggs are kept at 82°F (28°C), about two-thirds of the hatchlings will be male. If the temperature is kept above 86°F (30°C), two-thirds of the hatchlings will be female, and a temperature between 82 and 86°F will produce mixed male and female clutches.

Turtle hatchlings are tiny, about the size of a quarter. Once the turtles are out of their eggshell, they climb up through the soil or sand to the surface. They set out to find water and—even if they cannot see the water—they seem to know instinctively in which direction to go. This is another dangerous time in the lives of young turtles. Hawks, gulls, raccoons, skunks and even fish see the tiny baby turtles as an easy meal. If they survive, the males will reach maturity in 2 to 5 years and the females in 4 to 8 years. Painted turtles may live 20 years.

The Lakota name for turtle is *keya* and they are often portrayed in Lakota stories, artwork, and crafts. Beautiful animals, Western painted turtles are frequently sold in pet shops. They are an important link in the food chain as both predator and prey. Painted turtles are no threat to game fish, although they may steal the bait off a fishing line. Hardy themselves, Western painted turtles consume quantities of amphibians and small invertebrates which can be very sensitive to pollution and water quality. Maintenance of high quality wetlands is probably the most important thing we can do to preserve Western painted turtles.

Jeff Mitton is a professor in the Department of Ecology and Evolutionary Biology at the University of Colorado.

Learning Languages

Excerpt from an article in *New Scientist Magazine*,
issue 2844 of 20 December 2011, p11

Language classes of the future might come with a physical workout. People learn a new language more easily when words are accompanied by movement.

Manuela Macedonia and Thomas Knösche at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany, enrolled 20 volunteers for a six-day course to learn "Vimmi," an artificial language designed to make study results easier to interpret. Half of the material was taught using spoken and written instructions and exercises, while the other half was taught with body movements to accompany each word, which the students were asked to act out.

Students remembered significantly more of the words taught with movement, and used them more readily when creating new sentences ("Mind, Brain and Education," DOI: 10.1111/j.1751-228X.2011.01129.x). While this may seem intuitive for words that have a physical counterpart, like "cut", the researchers were surprised to find the trick also worked for abstract words like "rather" that have no obvious gestural equivalent.

Based on fMRI scans, the pair argue that enactment helps memory by creating a more complex representation of the word that makes it more easily retrieved. Unpublished results from tests in real language classes suggest that the method "could really speed up foreign language learning in schools," says Macedonia.

Fifth Grade Projects

by David Mitchell

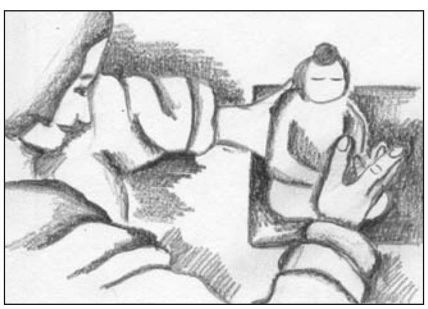
Mesopotamia:
Cuneiforms (clay tablets and flattened stick)
See *Modeling* by Arthur Auer, p91, AWSNA Publications

Persia:
Work in plaster to create a "Winged Griffin"
See *Art Through the Ages* by Helen Gardner, p300, Harcourt, Brace and Company

Copy the "Stele of Urammu"
See *Art Through the Ages*, p85

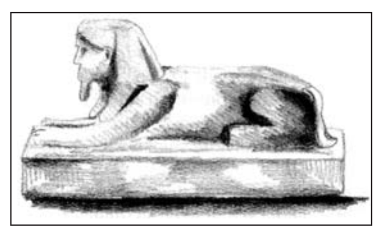
Copy the "Guardian of the Gate"
See *Art Through the Ages*, p92

Create an oil lamp and allow it to dry in the sun. Test it with oil.



India:
Sand picture (different colored sands sprinkled on 3′ x 4′ board covered with white glue)

Buddha model
See *Modeling*, p90

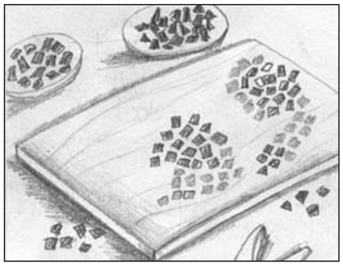


Egypt:
Sphinx model or Seated Pharoah
See *Modeling*, p92

Create a *bas relief* panel with a person and hieroglyphics.
See *Art Through the Ages*, p48

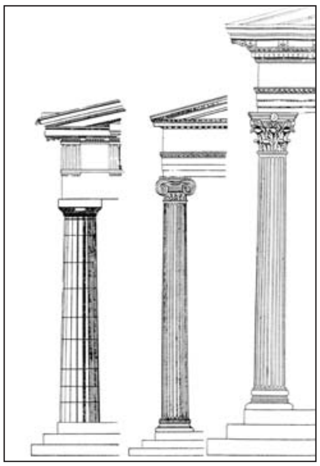
Model an Egyptian column.
See *Art Through the Ages*, p61

I like to do a play about Egypt.
See "The Light of Isis and Osiris" by Jim McClurkin, *25 Plays Inspired by Waldorf Teachers*, David Mitchell, ed., AWSNA Publications



Crete:
Mosaic – build a 3′ x 4′ frame and create a picture using pieces of broken tile or ceramic. Or you can substitute broken colored glass or stones. See any art book for good examples.
See *Art Through the Ages*

Greece:
Create a vase amphora or a bowl in terra cotta and black glaze (for scene) with a scene from a myth.
See *Art Through the Ages*, pp146–153

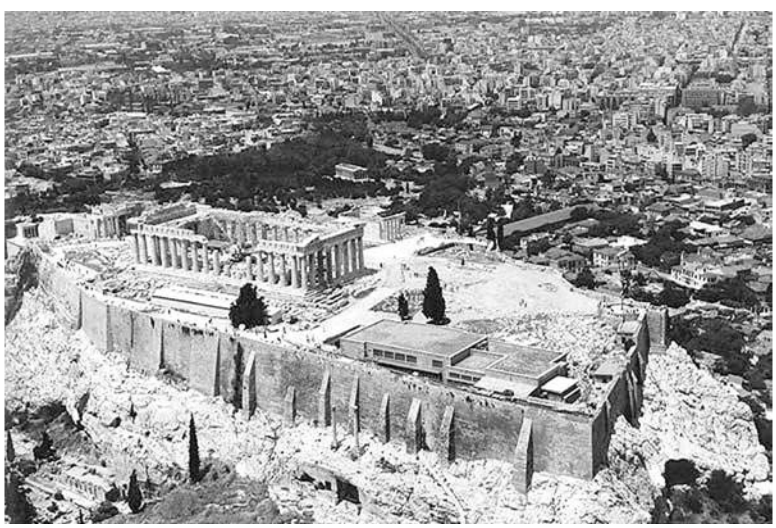


Create the three Greek columns.
See *Art Through the Ages*, pp124–126, p164

Clay relief
See *Modeling*, p104

Greek temple
See *Modeling*, p90

I like to do a play about Greece.
See "Demeter and Persephone" by William Ward, or
"Prometheus the Fire-Bringer" by Arthur Auer,
25 Plays Inspired by Waldorf Teachers, David Mitchell, ed.,
AWSNA Publications



The Acropolis, Athens, Greece

A PATH INTO THE "BLACK BOX"
Making a 4-Bit Adder
Using Electromagnetic Relay Switches in Class 10

Adaptation/Translation by Peter Glasby and David Bowden
from the original by Peter Wenger

The following article is a free translation/adaptation of a part of a chapter written by Peter Wenger from the Wahlwies Freie Waldorfschule in southern Germany (Wenger, P., Chapter 2 from the book Ursprünge, Wesenszüge und Gefahren der Computertechnik *published by M.von Mackensen, with contributions from Wenger, Hofberger, Schupelius, et al. Third revised edition, 1990. Bildungswerk, lehrmittelabt., Brabanterstrasse. 43, 3500 Kassel, Germany).*

Introduction: I visited Peter there in the early 90s and was impressed by the innovative work he does there in the Physics and Natural Science Curriculum. Some parts of the article are adapted from Chapters by Hofberger, von Mackensen and Schupelius.

This article is based on my work with the ideas developed in those works. Any errors in what is presented are my own, as Peter Wenger has not had a chance to correct the translation.

– Peter Glasby, Mt. Barker, August 2010

Prerequisites in learning:

- Different number systems; Binary (dual) system and the Hexadecimalsystem
- Knowledge of introductory electromagnetism and relay switching should have been covered in the physics lessons of classes 8 and 9

When these preconditions have been met, the *minimum* time which should be available is 10 lessons as 5 double lessons. Group size should be about 14 students. (In Mt. Barker we generally work with a half class group for about 8 weeks of a term with 2 double lessons per week.)

The first lessons can begin with examples.

Example 1. When does a lift get set into motion? The students seek in lesson discussion an answer to this question and come quickly to the answer: All switches must be switched on in series where the button, the door switch and the main switch are closing switches and the overload switch is an opening switch. When a button is pressed for a floor number which is not where the lift is at the moment:

1. the door must be closed,
2. the overload switch must not be operated, and
3. the main switch must be on.

Example 2. A red lamp comes on at the front of a tram when one or more doors are open. Solution: The door switches must all be parallel set.

It is meaningful to look at a further couple of examples with the students and, if you have time, even demonstrate the examples, so that the weaker students are not lost already at the introduction.

Semiconductors have played an essential role in the development of the modern computer after vacuum tube technology, making possible: miniaturization (integrated circuits), economization of the process, less heat and energy use, and a huge increase in speed. On the way to understanding the use of semiconductors (possibly best left to Class 11), it is useful to follow a path from simple electrical circuits with mechanical hand switches to relay switches. The students can begin by building small circuits with 2 or 3 low voltage light bulbs. (I set up a low voltage power supply in the lab with DC plug outlets around the room so that I can deliver 6–30V to each.)

The following circuits (Fig. 1) can give a feeling for the relationship of Voltage, Current and Resistance in the circuits.

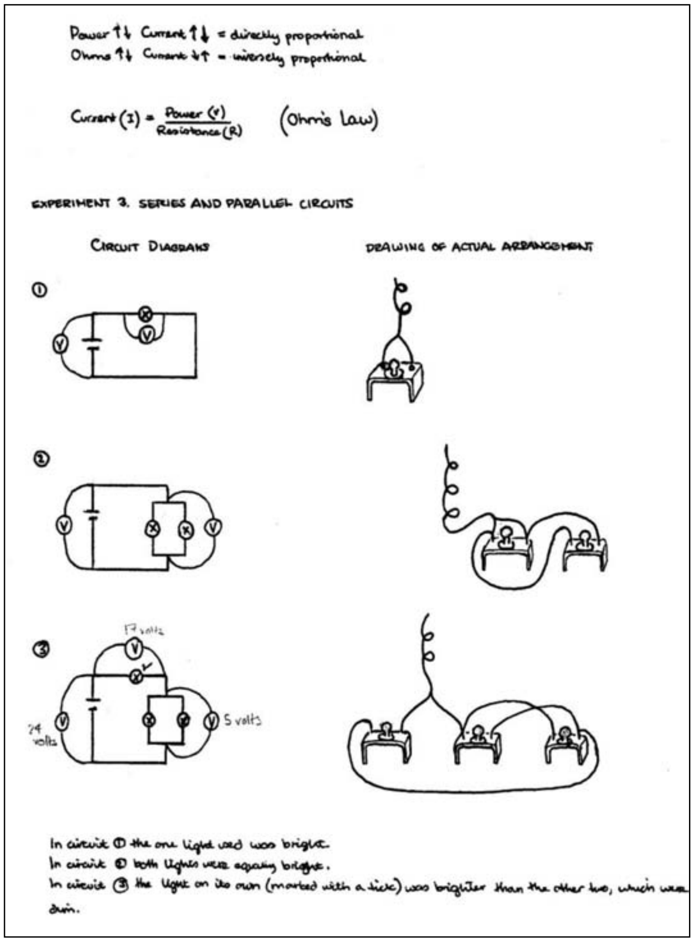


FIG. 1: Page from a student's lab book

Students can compare the brightness of the light bulbs with each other in the different circuits. If they are required to draw both the circuit diagram and the actual physical arrangement, it helps them later visualize the translation of the abstract circuit diagrams to the actual wired component.

The students can also be reintroduced to and draw a relay switch (Fig. 2) and discuss how it operates and what kinds of applications it has. (This provides for a return to the class 8 Electromagnetism main lesson, but in a new context.) The drawing of the switch in Figure 2 is of a one-switch relay. In the Half Adder we need to use relays with 3 switches.

It can be explained that in the digital technology, the series switching is called an AND connection and the parallel switching is call an OR connection. To this one introduces the following table. I call it a Function Table. (Please avoid the concept "truth

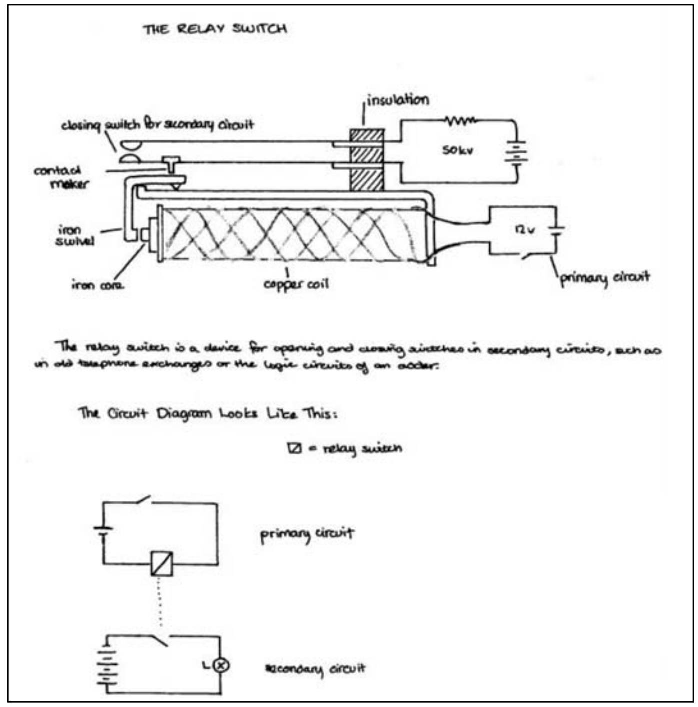


FIG. 2: Student page showing drawing of a relay switch and accompanying circuit diagram

table." It has nothing to do with truth.) One can equate the logic in a grammatical sentence with the AND and OR logic gates that can be built into a circuit. (See the chapter by Heinz Schupelius in Von Mackensen, 1990.) The direct switch is replaced by the relay switches (dotted lines, Fig 3).

In the following lessons (Fig. 4), the switching plan for the set-up is worked out together with the students. In this switching plan one should include—as well as the AND ($a \wedge b$) and the OR ($a \vee b$)—the connection exclusive, OR (a/b). It makes the building up of an adding circuit easier.

The XOR connection has the same function table as the usual OR, except for the last condition, in which both a and b have inputs. In this condition, the XOR has no output, compared with the usual OR.

Now the students now, usually in groups of two, build such a unit (Half Adder). At least eight such functional units need to be built. As each unit has two connectable inputs a and b, one needs two relays per unit. Each relay should have at least 3 switches. (In Adelaide, Australia, we have been able to source old electromagnetic relay switches from old Telecom exchanges.) If there is enough time students could be involved with taking apparatuses apart. Otherwise

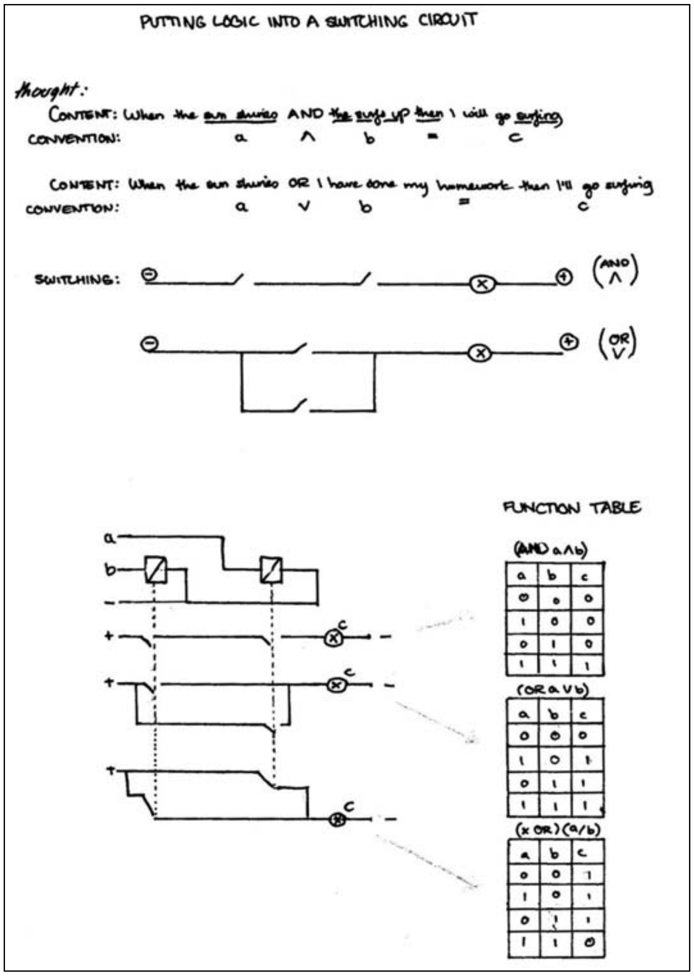


FIG. 3: A student's notebook showing the step from a sentence structure to the AND, OR and XOR circuits of a Half Adder

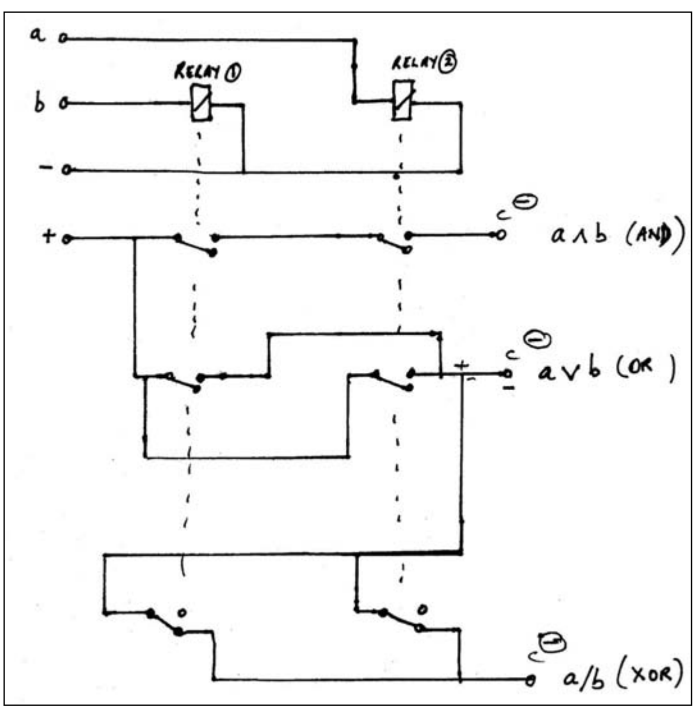


FIG. 4: Circuit plan for the Half Adder

it would be good to explore what is available on the market by way of relay switches that one can look into to see the internal workings.

Before the soldering can begin, a soldering plan needs to be drawn in which all solder points appear in their real, special relationships. I prepare a sheet (Fig. 5), which I hand out to all students. With this sheet in hand, and using an overhead projector and Figure 6, I explain how the circuit diagram above (Fig. 4) can be made by wiring it up in the way indicated. The different-colored wires allow the

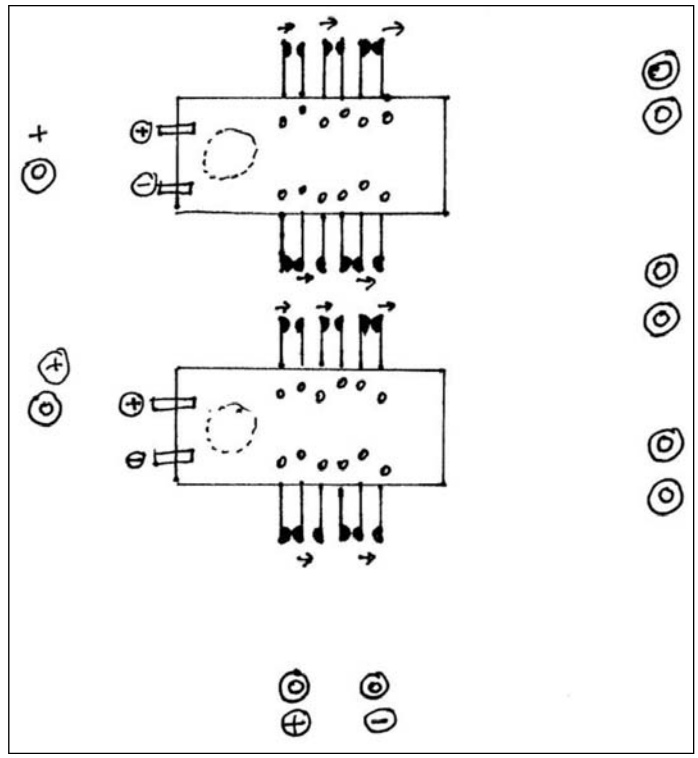


FIG. 5: Copy of sheet given to student, showing the two banks of switches and the terminals for the Half Adder.

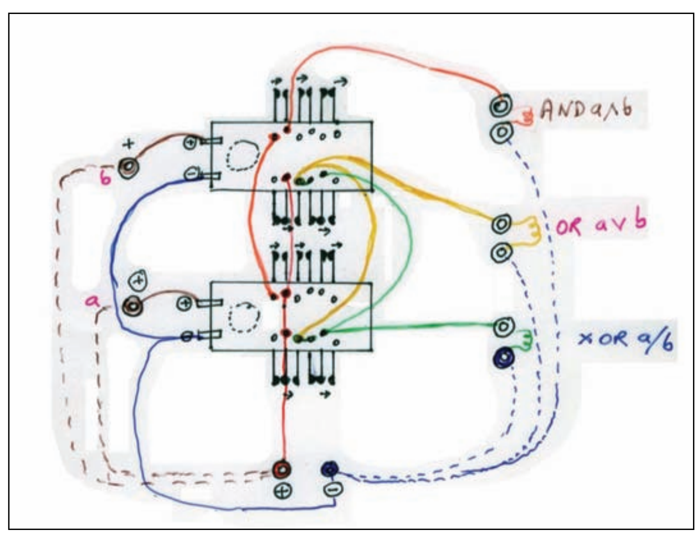


FIG. 6: The wiring diagram for the completed Half Adder unit.

separate logic circuits to be identified when students need to go back over and check their work. In this soldering plan each soldered connection is marked in color, so that no connection is forgotten and that none is soldered too much. This soldering activity is also possible in the classroom if the desks are covered with a board to protect against burn holes.

Each Half Adder can then be tested with light bulbs at the output points for each logic circuit, to test if the outputs appear as predicted by the Function table. The completed Half Adders look like this:.

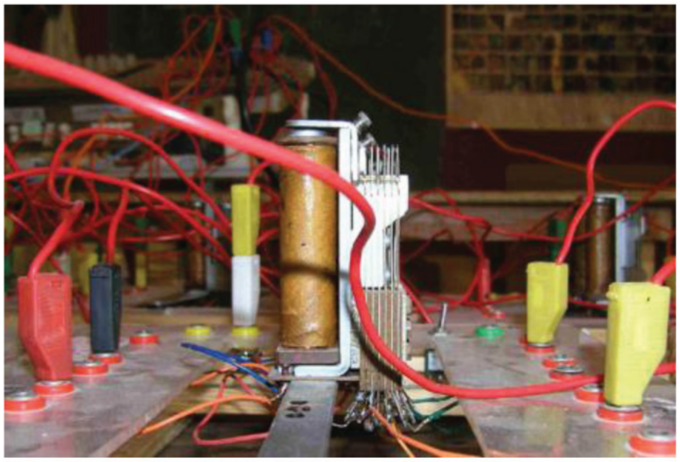


FIG. 7: Detail of Half Adder

The two relays are screwed onto a metal bar which spans a pine wooden frame with Perspex sheeting screwed to it into which the junction points are fitted. The switches on the relay are visible at the top with the switching terminals visible at the bottom.

Once again, one revises, shortly, calculating with Binary numbers.

A + B = C outcome
0 + 0 = 0 0
0 + 1 = 1 0
1 + 0 = 1 0
1 + 1 = 0 1

Thereby, the students realize, that this looks the same as:

A / B = C And the Carry A ∧ B = C
0 0 0 0 0 0
0 1 1 0 1 0
1 0 1 1 0 0
1 1 0 1 1 1

That means there is the same outcome in our Half Adder at outlet a/b as when outlets a and b had been added in binary. The outcome is found at the output a ∧ b. We have thus discovered a "partial (Half) Adder." The students will ask: "Why 'partial (half) adder'? What is missing?" One will then add with the students two dual numbers with many place values.

1 0 1 1 1 A
1 1 1 1 1 B
1 1 1 1 Carry
1 1 0 1 1 0 Sum

The students discover that such an "adder" needs three inputs, namely not only for A and B, but also from the outcome of the previous position (i.e., the Carry).

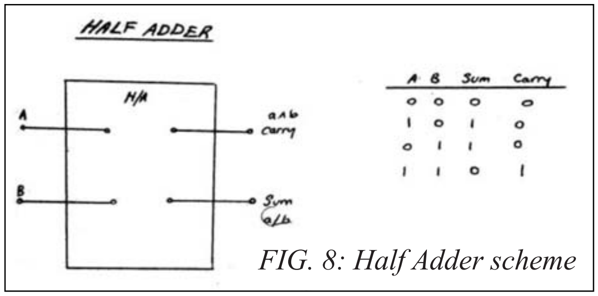


FIG. 8: Half Adder scheme

With the Half Adder, we have the following inputs/outputs: (the difference between A & a only became clear in a larger context). Because in the Full Adder, the carry from the previous position is added to it one can make a Full Adder out of 2 Half Adders. The function table is now worked out with the students:

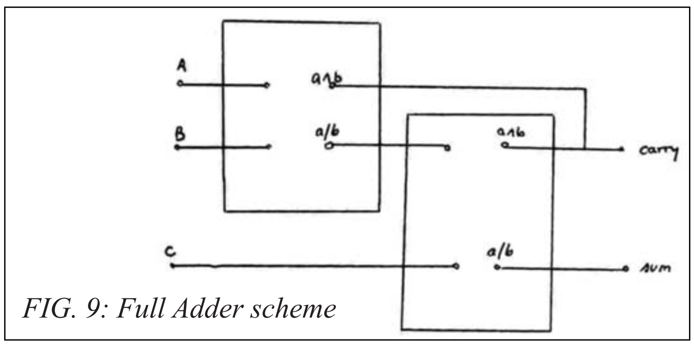


FIG. 9: Full Adder scheme

a + b + c = sum carry
0 0 0 0 0
0 1 0 1 0
1 0 0 1 0
1 1 0 0 1
0 0 1 1 0
0 1 1 0 1
1 0 1 0 1
1 1 1 1 1

The “Full Adder” which consists of two building blocks can now be drawn schematically like this:

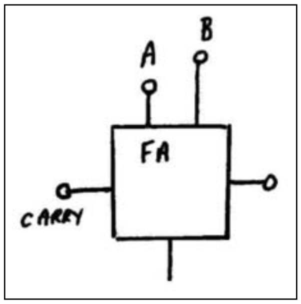


FIG. 10: Full Adder schematic

and it looks like this:

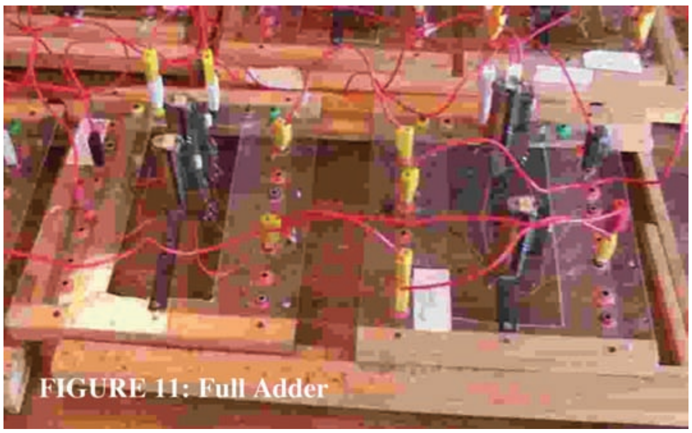


FIGURE 11: Full Adder

With this, a string of adders can be put together (Fig. 12). When one has built 8 half-adders, then one can add “two four-digit binary numbers” (four “bit” numbers). This way, numbers A & B are added and the sum is found in S.

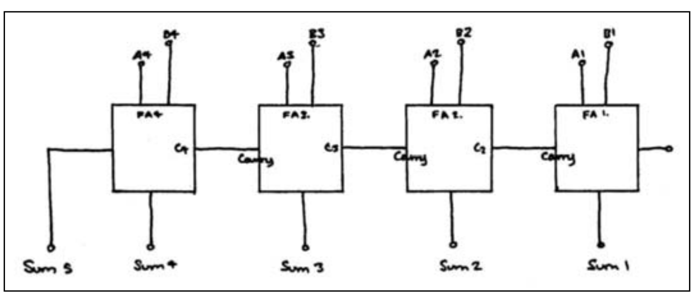


FIG. 12: Four-bit adder

So that this adder series can be put to use by the students, one needs now an input/output device. In our case, former colleague, James Steil, wired up an old telephone exchange to act as the inputs. One row of lights acted as the A inputs (light on = 1, light off = 0), the second row of lights acted as the B inputs, and a third row gave the answer in binary form. The whole wiring diagram looked like this:

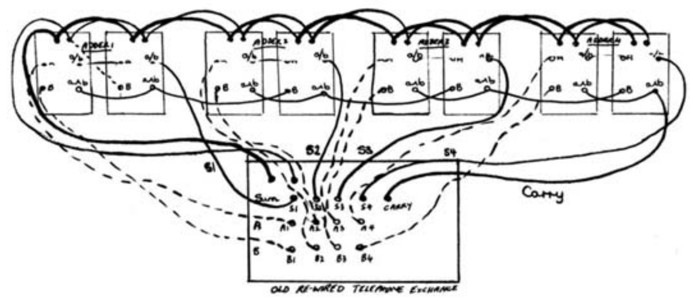


FIG. 13: Wiring of the 4-bit adder

When the students “add” some numbers with this adder series, they realize that absolutely nothing is being added. It is nothing else than the connecting of electrical conditions through conductors via a specific scheme. It is done in such a way that the result looks as though it is the sum of two numbers. With this, one has reached the most important result of this lesson: “It doesn’t think and it doesn’t calculate.” This apparatus indeed contains much thinking, but it doesn’t actually think. Therewith one has come up against one of the fundamental errors, namely that of “the thinking machine.” One notes the absurdity of the concepts: artificial intelligence, intelligent control systems, shared intelligence.

Of course we don’t yet have a computer with the Adder. It is at best part of the ALU (Arithmetic Logic Unit) which forms part of the CPU (Central Processing Unit) of the computer. One can discuss with the class, how the bit is the smallest unit of digital information (a binary digit). Information on a computer is in coded binary form for moving, storage, etc. Two 4-bit numbers make an 8-bit byte. Most computers operate at least on 32-bit bytes.

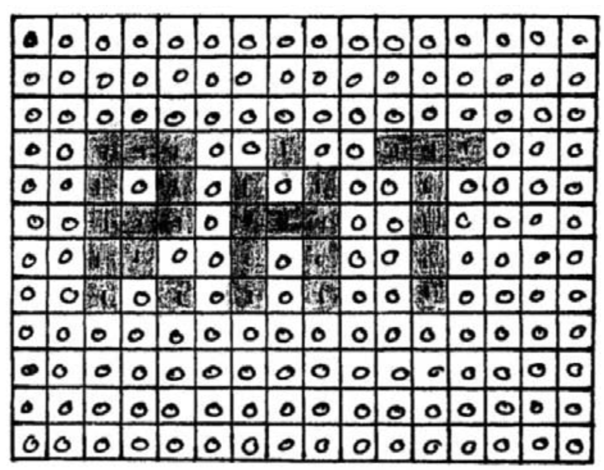


FIG. 15: Depiction of how a font can be understood as the result of binary coding

Students can begin to understand how computer screens are divided up into pixels, and images and fonts can be coded with binary numbers as the following picture shows. Where the letters are represented the pixels are 1s whereas the remaining pixels are zeroes.

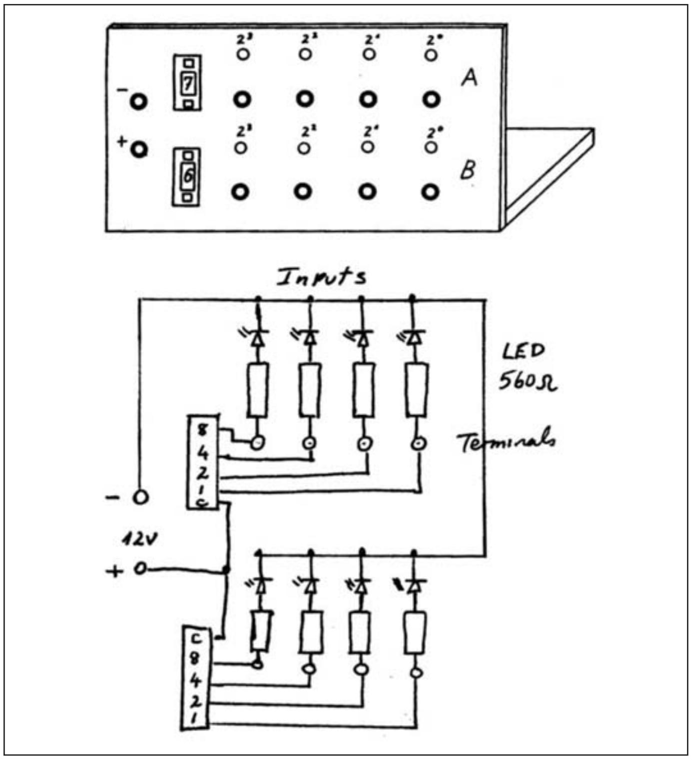


FIG. 16: Inputs

Appendix: An alternative way of setting up the Inputs to the adder described by Peter Wenger in his original article: For the input (Fig. 16), Peter Wenger used a "touch-code switch." In this way, the input is visible in both decimal and binary code. These switches are easy to understand for the students.

The output (Fig. 17) is easily translated to decimal from binary because of the simplicity of the binary system.

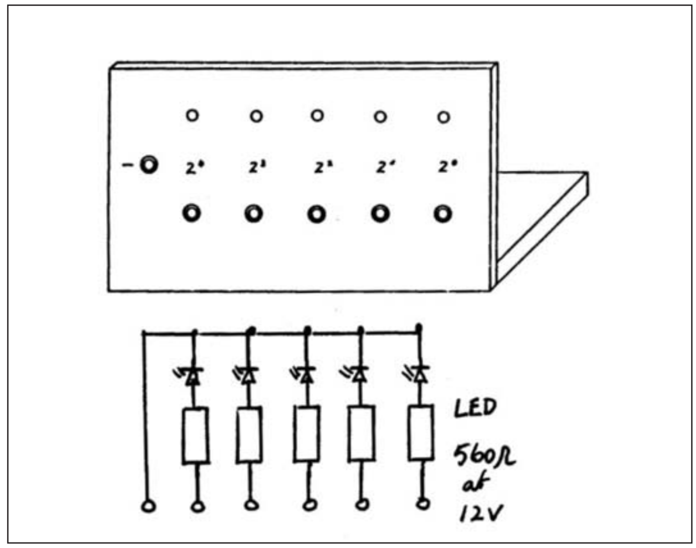


FIG. 17: Outputs

Alternative Approach to Making a Four-bit Binary Adder

Using 8 Modular Relay Logic Boards and displaying the output SUM as a decimal number

David Bowden (Mt Barker Waldorf School)

Two miniature 12-volt relays are mounted onto a modular perspex board. The relay connections are wired through to 4mm banana plug terminals, these being: the two relay operating coils (green & yellow in Fig. 18) and 3 sets of changeover switch contacts for each relay (red in Fig. 18). These relay logic boards are multi-function, i.e., they can be patched for any combination of AND, OR and EXOR gates. Eight such boards are needed to make a 4-bit adder.

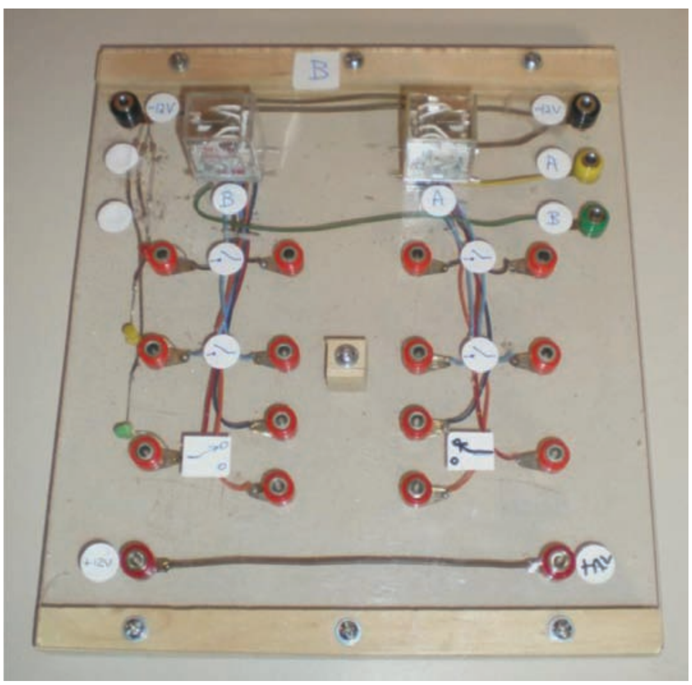


FIG. 18: One of the eight Modular Relay Logic Boards

Before the final project of building a 4-bit Binary Adder project, students can achieve mastery with the logic functions and logic gates by practicing with the design of simple functions that solve logical situations, such as: “When does a lift get set into motion?”

When satisfied that their design for the logic function will solve the problem, they patch banana plug jumpers between red terminals on one of the boards to wire up the combinations of AND, OR and EXOR gates that are needed to implement their design.

Small groups can be formed in the class, each taking on the patching of their own board for the logic gates that are needed to solve part of the

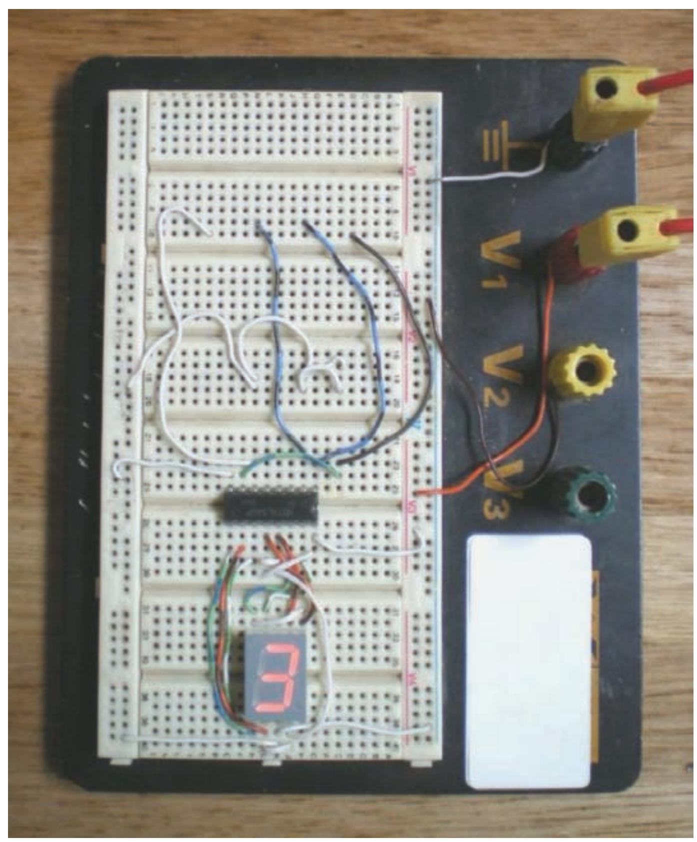


FIG. 19: Matrix board showing BCD to 7-Segment Decoder silicon chip and 7-segment LED Decimal Display Digit

problem. For the complete solution to the problem the separate boards are then brought together on the same bench and interconnected by patching between the boards. The logic outputs are then connected to 12-volt lamps, and the whole circuit is tested to check that it conforms to the correct operation of the lift as expected.

After attaining confidence through practicing with examples of graded difficulty, it becomes a straightforward task for them to finally build up four Full Adders and assemble these into a 4-bit Binary Adder, as described earlier in this article. This adder can then be tested out for different combinations of inputs.

A further extension is to display the binary SUM Outputs of the 4-bit Adder as a decimal number. Using a matrix board (Fig. 19), a BCD to 7-segment decoder silicon chip (74LS48N) can be wired to convert the binary output from the adder to drive a 7-segment LED decimal display digit.

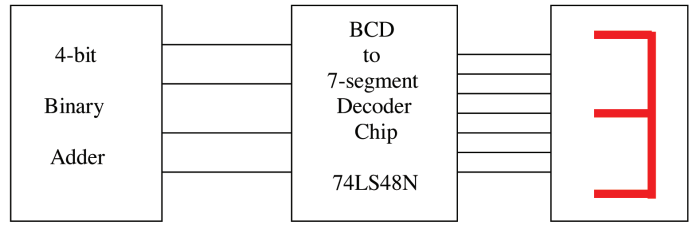


FIG. 20: Connection of the Adder outputs to the Decoder chip and 7-segment decimal display

The pin connections for the 7-segment display digit and the decoder chip are available in the data sheets. (Overall connections are shown in Fig. 20.)

INFORMATION TECHNOLOGY CURRICULUM
at Mt. Barker Waldorf School

Background

Computing begins for us, at the moment, in grade 9 or 10, though some advantages and disadvantages of communication media are touched on briefly in the grade 8 main lesson block Letter Writing, Mass Media and the Art of Communication. There are three main aspects of the IT curriculum here.

The first concerns teaching students about how computer hardware works and is taught as part of physics lessons in class 10. The second aspect is basic computer use (file management, word processing, touch-typing and spreadsheets). This is taught as a practical subject in class 10 “Computing,” and some practical applications for these skills are explored in the Surveying and Mechanics main lessons. The third aspect of the IT curriculum is the relationship we have as human beings to technology. This theme is taken up in the Class 12 Computing main lesson where we seek to explore the place of IT in our lives from a more philosophical point of view and to integrate the understandings already developed previously about computer use and architecture into an integrated whole. Throughout the curriculum it is our aim to present computers as tools and to give students an overview and some practical experience of the many uses to which they might be put.

Class 10 Computing - Learning to Drive

Students are taught on laptop computers in half-class groups for one double lesson a week over three terms. The emphasis is on teaching them basic skills in the most standard programs in order to make them more “work ready” and satisfy the need of class 10 students to learn things which are practically useful in the world.

In the first term they begin touch-typing in Word and learn how to use Excel to make a personal budget and plan for their financial goals. The basics of inputting text and formulas as well as formatting and layout are covered in preparation for their use of Excel in the Surveying main lesson. Touch-typing continues in second term and students learn some of the finer points of Word in the process of making a resume for themselves, and they practice writing application letters for jobs. Extra practice in typing is given through completing corrections to various business letters using proofing marks. In the third term we teach some basic programming in HTML, and the students create a web page from scratch for a client (another classmate). This will provide an understanding of basic programming which can be built upon in the Class 12 Computing main lesson.

Class 10 Physics - Inside the Black Box

Students are taught in half class groups for two double lessons a week for nine weeks making 4-bit adders, using the method of Peter Wenger from Wahlwies. They work in a laboratory with access to variable DC power as well as 240 V AC power for soldering circuits. They learn some simple circuit-making with series and parallel circuits; the function of the electromagnetic relay switches; logic circuits and the use of binary numbers. They make a Half Adder as pair groups, and then combine with another group to make a Full Adder. Four Full Adders are connected to a switchboard which is wired so that 4-bit binary numbers can be added and an answer given.

Class 10 Physics - Mechanics

During the Mechanics main lesson there is opportunity during the work on motion and freefall to manage the experimental data (e.g., from a ticker tape timer) using an Excel spreadsheet. Distance/ time data can be converted to velocity using formulae and then graphed. Velocity/time data can then be graphed and acceleration calculated. In two lessons much of this can be accomplished, without losing connection with the actual physics work. The computer becomes a tool.

Class 10 Surveying Main Lesson

For many years we have taught surveying to class 10 during a two-week camp in the Flinders Ranges, north of Adelaide. (Glasby, P. and D. Millar, "Surveying in the 10th Class, a Synthesis of Archetypal and Local Curricula," *Paideia,* Issue No. 20, 1999, pp33–40) We resisted the urge to modernize the methods because we value the educational advantage of working with the more overseeable of triangulation, tacheometry and leveling. The experience with something like a field station, though very valuable for a professional surveyor, we judged too hard to penetrate for the average 10th grade student.

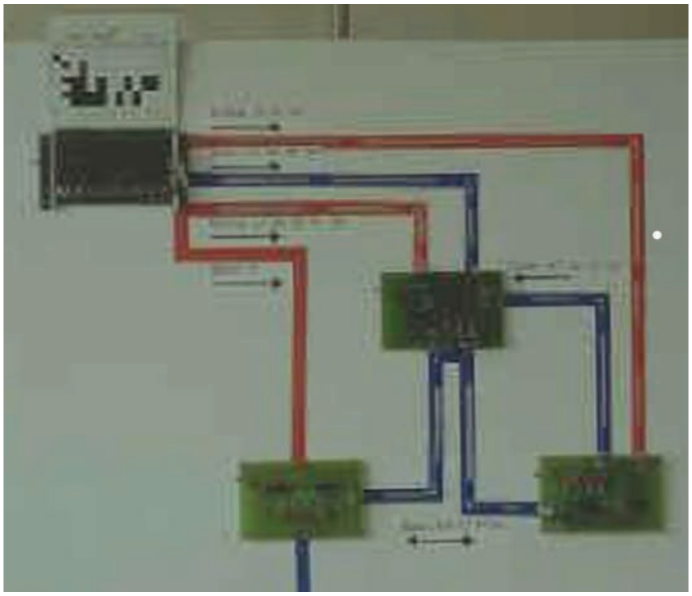
Last year we tried the following: We still used all the techniques we had always used but with the addition of hand-held GPS (Global Satellite Positioning) units and laptop computers equipped with Excel and Arcmap (a sophisticated software for drawing maps from basic coordinate data). So now, in addition to triangulating and measuring all the angles of our scaffold grid, students were also able to take very many coordinate readings for the grid points. The data generated could be analyzed using an Excel spreadsheet, prepared as a database file for Arcmap, and then converted into a shape file for including in the map.

Tacheometry drawings, prepared the traditional way, could be scanned using a scanner and then "registered" using the Arcmap software so that the image could be used to create shape files for the map. The actual map is then drawn using the software instead of being traced onto plastic film, which is what we have done in the past. There are many advantages to teaching these computing skills in this way as the students are working outside most of the time and the computing then helps in the analysis of something their bodies have already been engaged in.

Glasby P., O'Flaherty A.L. and D.V. Millar. (2005) An attempt to integrate new and emerging technologies with surveying and mapping into the Class 10 Curriculum. *Journal for Waldorf/Rudolf Steiner Teachers Produced by the Initiative Circle of the Pedagogical Section in New Zealand and Australia.* Volume 7, Number 2 (September 2005).

Class 11

In Class 11, the indication from Rudolf Steiner is to teach the latest about Electricity. Following a 3- to 4-week block which includes an exploration of electric fields, induction, capacitance, magnetic fields and coils, oscillating circuits, electromagnetic radio wave transmission, high voltage discharge in partially evacuated gas tubes (alpha, beta and gamma ray phenomena), the laboratory lessons involve largely the making of crystal radio transmitters and receivers. However, time can be used to deepen the work on computing with the newly-gained electronic background. The following apparatus developed by Peter Wenger is, in fact, a programmable computer which can be hung on the blackboard and programmed with black and white cards which gives the students a challenging further understanding of the digital logic basis of computing.



Computer-Teaching Apparatus
Link: http://www.wenger-lehrmittel.de/print.php?reporeid_print=44

This computer-teaching equipment is intended to close the gap between the digital (Full Adder) and the computer. It is designed as a demonstration unit and is so large that it can be seen by the entire class. It can be hung on the blackboard or wall. It functions as a simple central processing unit (CPU). It allows the teacher to step through simple programs, with each step displayed.

The program and data are entered on a cardboard strip marked with felt-tip pen (black mark = 1, white = 0). This allows independent programming by the students. For example, they can design and mark their own programs onto the strips of cardboard.

Equipment:
• 4 integrated circuit board with mounts
• ribbon cable, plugs, sockets
• instruction book
• baseboard, 5V DC source

Class 12 – Computing Main Lesson
Getting behind the computer and exploring its relationship to society and human identity.

In grade 12, one main lesson is devoted to computing. The 12th grade main lesson subjects should touch on themes that are of universal human significance, not be just lessons about technology. This has been a tendency, sometimes, for us.

Following workshops given by Dr. Michael Schrefel at our school, we would very much like to take up the approach he suggests for the 12th grade main lesson. It is an approach that explores the thought process behind software development. This approach allows the students to explore ideas about artificial intelligence and their possible validity, a theme we deem worthy of class 12.

This main lesson has two main aims: (1) to integrate students' existing understandings of how computers work and what they can be used for and round it out into a coherent picture, and (2) to extend their thinking about technology into the philosophical realm. Thus, although they have learned some of the principles of computer hardware in physics, they now learn how hardware interacts with software. Students have also done some basic programming in HTML in class 10, but in this main lesson they extend their understanding of the principles behind programming more broadly and discuss its advantages and limitations.

At the same time the development of information technology can be viewed in historical perspective beginning with the technology of writing and then of print, as an introduction to questions such as: How do technologies affect human thinking? What is the difference between human and artificial intelligence? What, indeed, is intelligence?

These philosophical themes are approached through a three-step process whereby the students first experience something of the question to grab their attention and give them something solid to work with. Then they characterize and work with it in exercises and activities, and finally they address it directly and reflectively with their intelligence. By the end of the main lesson, students should have a good understanding and recall of the architecture of computers, have practiced for themselves and understood the principles behind programming, and have explored their own understandings of the philosophical questions which arise from this material.

All Waldorf Science Kits Currently in Stock

Purchase your kits for next year now!

These AWSNA kits, with the instructions included, have been developed to assist the teaching of science blocks in a Waldorf school. It is hoped that the guidance provided will help the teacher develop other phenomenological experiments. Some of the kits are for demonstration purposes while others can be obtained in bulk to provide the students with a hands-on learning experiences. We have found new, less expensive suppliers and pass the low prices on to you, while they last.

Kit #1 – Static Electricity, Grade 6
This is a complete kit with fur, rods, and other materials, a bag of shredded tissue paper, balloons, a bag of crinkle confetti, and pith balls. Included are instructions and a sample lesson plan. Sold as a single item.

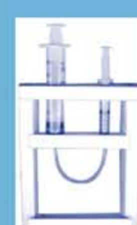
Kit #2 – Magnetism, Grade 6
This kit contains two Alnico bar magnets, a sample of lodestone, a base for observing magnetic fields, 8 small Alnico magnets, and a bottle of iron filings. Included are instructions, sample lesson plans, and several experiments. Sold as a single item.

Kit #3 – Acoustics, Grades 6/7
This kit contains a Chladni plate. Included are instructions and sample lesson plans. Sold as a single item.

Kit #4 – Heat, Grades 6/7
This kit contains three experiments, a five-metal star, a bimetallic strip, and a brass ball and ring. Included are instructions for experiments and sample lesson plans. Sold as a single item.

Kit #5 – Optics, Grades 6/7
This kit contains a set of optic cards, five polished glass prisms, and a set of falling gray-scale cards. Included are instructions for several experiments and sample lesson plans. Sold in kits for 10 students.

Kit #6 – Hydraulics, Grade 8
This kit contains an apparatus for observing the advantage of hydraulic force. Included are instructions and sample lesson plans. Sold as a single item.



Kit #7 – Botany, Grades 5–11
This root plant observation kit contains a vessel for growing plants and observing root growth and instructions. Sold as a single item.

Kit #8 – Optics, Grades 6–12
This kit contains a large, sealed, clear prism for holding water and throwing a rainbow image on the classroom wall. Sold as a single item.

Kit #9 – Optics, Grades 6–12
This kit contains a bent lucite rod used to show how light follows a bent path by multiple internal reflections. Sold as a single item.

Kit #10 – Optics, Grades 7/8
This kit contains material for an optics bench, allowing your class to study the properties and laws of lenses. Sold as a single item.

Kit #11 – Optics, Grades 7/8
This kit contains four mirrors with stands and experiments for reflection, shadows, and refraction. Sold as a single item.

Kit #12 – Electricity, Grades 7/8
This kit contains all the components and instructions for children to build an electric motor.
Sold as a single item: suggest one kit for 2–4 students.

Kit #13 – Acoustics, Grades 7/8
With this monochord, the teacher can create experiments on the mathematical relationship of sound. Sold as a single item.

Kit #14 – Chemistry, Grades 8/9
This kit contains different materials for fiber experimentation. Included are instructions and student lab sheets. Sold as a set for 10 students.

The following three kits were developed to be used in conjunction with Michael D'Aleo's and Stephen Edelglass's book *Sensible Physics Teaching* – AWSNA Publications

Kit #15 – Physics, Grade 6
Kit #16 – Physics, Grade 7
Kit #17 – Physics, Grade 8

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Of the many subjects taught in the eight-year cycle of a class teacher, few are more challenging than the science main lessons of the 6th, 7th, and 8th grades. These main lessons arise at a time when pupils are developing a much stronger ability to perceive the world as being separate from themselves; this capacity is crucial for scientific inquiry.

To help cultivate in their pupils these powers of perception in a healthy way, Waldorf teachers approach science by means of a method different from what is typically used in more traditional schools. Said simply, this method is "phenomena-centered" rather than based on the testing and application of theories. While most Waldorf teachers will have heard of this approach, few will have experienced this method themselves as school children, and many may have made only fleeting acquaintance with this approach during their teacher training. As a result, teaching science in Waldorf grade school classes is not always sufficiently strong or rigorous to satisfy the needs of young adolescents.

Once again a part-time course—entitled "Teaching Sensible Science"—will be offered during this coming school year to help teachers develop a deeper understanding and experience of phenomena-based science so that they can feel more confident using this method in their own classrooms. The course will consist of:

- Workshops and discussions on the foundations of a phenomenological approach to science (primarily the physical sciences)
- Practical sessions with experienced class teachers who will demonstrate these methods and help participants prepare class experiments and demonstrations for use in their own classrooms
- Artistic classes: drawing for the main lesson book, eurythmy
- Daily question and answer sessions to review the day's work

The intention of this course is to give the teacher a living connection to science so that this same enthusiasm, understanding, and interest can be shared when the teacher is working with the students in the classroom. All practicing grade school teachers or those who are slated to teach upper grade school science are strongly encouraged to attend this program.

For descriptions of "phenomena-centered science" see Michael D'Aleo's "What Is Phenomenology?" and David Mitchell's "The Teaching of Science" at www.waldorflibrary.org. For a more detailed description of this course, see the articles by Bob Amis and Michael D'Aleo in the Research Bulletin (Volumes XII & XIII) or at www.waldorfresearchinstitute.org.

Comments from participants in the most recent cycle of this course:

“The Teaching Sensible Science course has revolutionized my consciousness of how the world reveals itself to my senses, and this in turn has thoroughly enlivened my work in the classroom as well as my personal development. …As with all quality courses in teaching, this course gives both practical tools and methods for the classroom and stimulating food for our own inner growth and education.”

— Tim Morrissey, Olympia Waldorf School (former engineer, now class teacher)

“The course has been meaningful to me in terms of how I teach, yet more importantly, how I perceive the world around me. Although I consider what I have gained thus far to be a life-long practice, I have on many occasions enjoyed the keen insights that have come to me, and the lack of assumptions I would normally create in my less-than-awake thinking. I have thoroughly enjoyed working with fellow colleagues from many regions of the country, as we grappled with new ways of seeing the world, as well as growing in our other sense faculties. …I highly recommend this course for those seeking to expand their awareness of the world around them, and hoping to facilitate the same level of growth and awareness in their students.” — Gail Lescher, Live Oak Waldorf School (class teacher)

The course will be divided into three week-long sessions:

SESSION 1: **Baltimore: Thursday eve. 14 February – Wednesday noon 20 February 2013**
Seattle: Sunday eve. March 31 – Saturday noon, April 6, 2013

SESSION 2: **(B) Tuesday eve. 18 June – Monday noon 24 June 2013**
(S) Sunday eve. August 18 – Saturday noon, August 24, 2013

SESSION 3: **(B) Thursday eve. 10 October – Tuesday noon 15 October 2013**
(Columbus Day weekend in the U.S. and Thanksgiving in Canada)
(S) Sunday eve. December 29, 2012 – Saturday noon, Jan. 4, 2014

Presenters:

Lylli Anthon has been a grades teacher at the Halton Waldorf School near Toronto, Canada, for over 20 years. She has taken one class from grades 1 to 8, but now concentrates on grades 6, 7, and 8, having graduated three such groups. She continues as a class teacher to this age group, offering chemistry blocks in grades 7 and 8. Lylli’s professional interest is focused on the art of teaching, especially in mathematics and the sciences.

Gary Banks worked as a research engineer on the NASA Space Station project before entering teaching. He took a class through eight grades at the Denver Waldorf School, then worked as high school science teacher at High Mowing and class teacher at Pine Hill Waldorf School before moving to Michigan, where he teaches chemistry and biology at the Rudolf Steiner School of Ann Arbor.

Michael D’Aleo left a career in engineering to become an upper grades class teacher before helping to found the high school at the Waldorf School of Saratoga Springs, where he teaches physics. Co-author of Sensible Physics Teaching, a guide for teaching physics in the 6th, 7th, and 8th grades, Michael is Director of Research at the Saratoga Experiential Natural Science Research Institute (SENSRI); he is also on the faculty of The Center for Anthroposophy’s Waldorf High School Teacher Education Program.

Barbara Richardson, who specializes in eurythmy in the workplace, has led artistic classes for many different adult professionals including chemists, doctors, nurses, farmers, and teachers. Formerly at Arcturus Rudolf Steiner Education Program, Barbara is now teacher and Coordinator of Foundation Studies at The Center for Anthroposophy.

Registration

Prompt registration is crucial since sign-up for this course will be limited to 25 people to ensure sufficient individual attention.

Cost

Registration fee for entire three weeks of the program (payable to "Research Institute for Waldorf Education")		$ 1650
(non-refundable deposit of $250 due with application) (*late registration fee of $300 added after 15 December 2012*)		
Housing (shared room)	w/ breakfast: 17 nights @ $30 per night	$ 425
Housing (private room)	w/ breakfast: 17 nights @ $40 per night	$ 680
Lunch/Snacks (Participants will be on their own for dinner.)		$ 225

Limited financial aid is available to those who send letter of request before the registration deadline.

For further information or to register, contact:

Michael D'Aleo
SENSRI
23 Hutchins Street
Saratoga Springs
NY 12866-2601
Phone: (518) 587-0457 e-mail: *spalight@verizon.net*

To register, complete the form below and submit it with $250 deposit, payable to "Research Institute for Waldorf Education," to the address above before December 15, 2012.

Your name: ____

Your school: ____

Home address: ____

Home phone number: ____________________ E-mail address: ___________________________

Housing Request:

Shared room _________ Private room _______ None needed ___________

Meals:

Lunch/Snacks (circle one) Yes No Special dietary needs _______________________

Index of Past Issues

Waldorf Science Newsletter
edited by David Mitchell

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

AWSNA Publications
E-mail: publications@awsna.org
458 Harold Meyers Road
Earlton, NY 12058
fax: 518/ 634-2597
phone: 518/ 634-2222

available on-line at: http://www.whywaldorfworks.org/books_sciencenews.htm

Volume 1, #1
Partial contents – Acoustics in Grade 6; Teaching about Alcohol in Grade 8 Chemistry; The Chemistry Curriculum: The Debate over Teacher Demonstration vs. Student Experimentation; Spiritual Aspects of 20th Century Science; Overview of the Waldorf Science Curriculum; Water; Characteristics of the Major Sugars; Goethe's Meditation on Granite; Book Reviews; Humor; Poetry; Conferences; and Sample Experiments

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Volume 2, #3
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Volume 2, #4
Partial contents – Current Research; Strange Theories; Science Education and Wonder; The Human Earth; Steiner's Counterspace Examined; The Cow; Language and the Book of Nature; Book Reviews; Humor; Poetry; Conferences; and Sample Experiment

Volume 3, #5
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Volume 5, #10
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