THE HOOSIER SCIENCE TEACHER

Historic Roller Mill of Mansfield, Indiana

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IN THIS ISSUE

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The Hoosier Science Teacher

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HASTI is a non-profit corporation organized under the Statutes of the State of Indiana. The purposes of this corporation shall be the advancement, stimulation, extension, improvement, and coordination of science education in all fields of science at all educational levels.

National Science Teachers Association
Area Convention
November 4 - 6, 2004
RACING TOWARD EXCELLENCE
Indiana Convention Center
Indianapolis

ON THE FRONT COVER

The photograph on the front cover was provided by the Center for Science Education, Indiana State University. See page 51 for information.

A MESSAGE FROM THE PRESIDENT

I stated in my fall letter that the Hoosier Association of Science Teachers, Inc. (HASTI) was in the process of designing a five-year Strategic Plan. I would like to take this opportunity to share with you some of the details surrounding the creation of that document; I will also focus on some highlights of the Strategic Plan.

The HASTI founders wrote a mission statement for our organization in 1969. We continue to use that mission statement as it defines the purpose of HASTI: the purpose of HASTI is the advancement, stimulation, extension, improvement, and coordination of science education in all fields of science at all educational levels - - this led to the formation of our vision statement as the beginning of our Strategic Plan. HASTI will provide opportunities for professional development, networking of teachers, and sharing of information. HASTI will become a more proactive voice for all Indiana teachers of science.

Ken Rosenbaum, National Science Teachers Association (NSTA) Field Coordinator for Chapter Relations, led a team of HASTI representatives in the facilitation of forming the Strategic Plan. The team consisted of Ed Frazier, Executive Director; Sharon McElroy, President; Carol Chen, Past President; Stan Shimer, Past President; Monica Ellis, President Elect; and Christina Hilton, Board Member.

HASTI board members assessed our organization for strengths, weaknesses, opportunities, and trends at the November 2003 board meeting. The team used the information from the board members to develop the Strategic Plan with goals to challenge and inspire HASTI to achieve its purpose.

At this time, I would like to share the goals and some of the highlights of the Strategic Plan. Goal number one is to provide ongoing professional development for the improvement of science education at all levels. We are in the process of creating a Professional Development Committee that will provide programs and services for teachers of science at all grade levels. Goal number two is to become the voice for teachers of science. This is an exciting opportunity for HASTI to interact with the Department of Education, the Indiana Legislature, and the public regarding issues in science education. Goal number three is to improve sharing of information and networking opportunities for teachers of science. A very important component of this goal is to increase member contributions to *The Hoosier Science Teacher* and "Sci-Ed-Ogram." Goal number four is to increase HASTI membership; our plan is to double HASTI membership by 2009.

It has been an exciting process to see the ideas, hopes, and plans of HASTI translated into a written document - - the Strategic Plan. Look for the completed document with objectives and methods for facilitation to be posted on our website (http://www.hasti.org) in the near future.

Sharon McElroy

2003-2004 HASTI President

"A Message from the President" does not necessarily represent the views of HASTI or the Editorial Team.

THE FIFTH MECHANISM LEADING TO LIGHTNING INJURY OR DEATH

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We have learned a great deal about lightning since the days of Benjamin Franklin's kite experiment. The fields of meteorology, engineering, and medicine have significantly contributed to this knowledge. (See Table I.) Lightning can be lethal or cause life-long suffering to strike victims and can kill more people every year than tornadoes or hurricanes. (See Tables II and III.) Lightning is considered to be the most dangerous and frequently encountered weather hazard people experience.

Table I. General Lightning Statistics
Temperature is 30,000 - 70,000 °F or 17,000 - 39,000 °C.
Diameter is 1-2 inches or 2-5 cm.
Peak Current is 10,000 - 30,000 amperes or 30,000,000 volts.
Speed is 20,000 - 60,000 miles per second or 32,000 - 97,000 kps.
Brightness is as bright as 10 million 100-watt light bulbs for a few seconds.
Cloud-to-ground lightning usually has multiple strike points.
The common, non-severe, thunderstorm lasts for about an hour and produces an average of 150,000 miles (240,000 km) of lightning channels.
About 90% of lightning's energy is released as sound energy.
A single lightning flash can illuminate a 100-watt light bulb for up to three months.

Table II. Annual U.S. Lightning Statistics
90+ people killed
1000+ people injured
100,000,000+ total flashes
Over 20,000,000 ground strikes
1 out of 200 homes struck
Florida is the lightning capital.

Table III. Worldwide Lightning Facts
An estimated 10,000 or more people are killed annually. An estimated 50,000 to 100,000 or more people are injured annually. The global flash rate is 40 flashes per second. In an average year, there are about 1,260,000,000 flashes. Severe storms can produce flash rates in excess of one flash per second. Of all the global lightning, 85% occurs over land masses. Of all the lightning on Earth, 70% occurs in the tropical latitude band between 35° north to 35° south latitude.

Cloud-to-ground (CG) lightning injures or kills by using one of four electrical mechanisms: direct strike, indirect strike, side flash, or ground current. (See Table IV.) Mechanical injury may also occur if a person falls or is thrown by muscle contractions. It has been recognized that not all lightning injuries or deaths fall neatly into the four electrical mechanisms. Researchers have speculated for years that there may be a "fifth mechanism" of injury - - injury by an isolated upward streamer.

Table IV. Lightning Injury/Death Mechanisms
Direct Strike Lightning directly strikes the victim. Indirect Strike is when the victim is touching or is close to an object being struck (e.g., tree, pole, fence, water, electrical appliance, . . .). Side Flash is when lightning is deflected or flashes from the object initially struck to someone nearby. Ground Current is when lightning energy travels through the ground and injures a person.

The following information is intended to be used as an instructional and resource tool for teachers and their students to learn about a "fifth mechanism" of lightning injury from a case recently published in the medical literature. At this time, no information about this mechanism exists in any pre-college or college level textbooks, supplemental teaching materials, or related publications.

Although the case is a work related injury, it is not unreasonable to think that a similar injury could strike children at our schools while playing on the playground, waiting for the school bus, or during the walk to and from home. It is important for teachers to learn how to prevent lightning injury. There are Lightning Safety Guidelines that apply to both the work situation and to children that attend our schools.

Lightning Generation

Lightning discharges are initiated as irregular vertical channels in thunderstorms. These discharges are barely visible to the naked eye and jump in spurts 100-

165 feet (30-50 m) long. Discharges branch, then retreat to the source only to refill the main established channel, and branch again at the endpoint of each surge. Many "generations" of branches are produced from this channel called a step leader. This cycle repeats over and over again in a matter of microseconds. (See Figure 1.) Branching and retreating in part explains why lightning does not "always hit the tallest object." The downward step leader only "sees" a 100-165 foot (30-50 m) radius from the downward end tip of the last division.

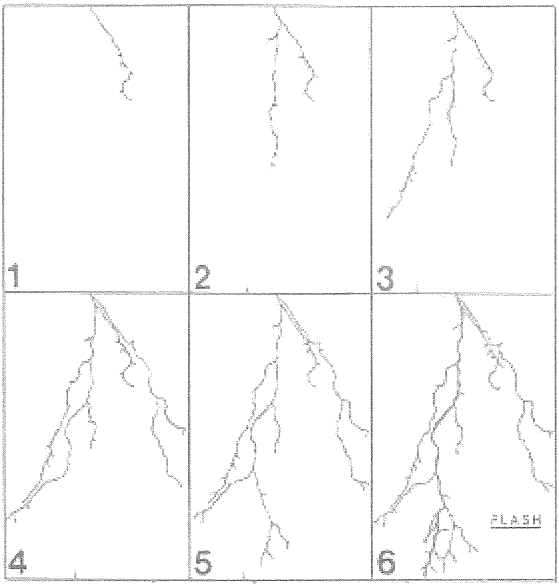

Figure 1. Diagram of a C-G lightning flash sequence occurring in less than 0.5 second

As one or more step leaders approach the ground, opposite charges are induced on the ground and in objects attached to the ground. Upward streamers of charge may arise from the tops of trees, poles, fences, animals, a blade of grass or a person. The induced static charge can cause a person's hair to stand on end. One or more of the upward streamers may connect with the downward step leader to complete the C-G channel. This process, called attachment, produces a lightning flash and results in the discharge of electrical potential.

There are often multiple upward streamers that do not form an attachment. Evidence of these appear in photographs well known to the lightning research community. It has been hypothesized that upward streamers that do not connect to the step leader may nevertheless contain enough electrical energy to cause death or disability to a person from whom they originate, leading to a "fifth mechanism" of injury.

Case Report

On September 29, 1998 an experienced five-man electric utility crew was working on a 7200 V transformer in a housing subdivision in the mountains of North Carolina. The area was surrounded by 40-50 foot (12-15 m) trees and thunder was heard in the distance. A light mist began to fall, but the crew continued working. Soon after, one of the crew felt a tingling sensation on his left side and felt the hair on his arm stand on end. At the same time two of the crew reported hearing a loud "ZZZT" sound "similar to a big, bug zapper" and one saw a white flash near the victim's head and right shoulder. When the victim was asked if he was okay, he replied, "No, no, I'm not," as he sunk backward unconscious to the ground.

Two of the crew, one an emergency medical technician, the other a combat medic, immediately started first aid. They cleared the victim's airway and began mouth-to-mouth resuscitation. Eleven minutes after dispatch, paramedics arrived finding the victim in ventricular fibrillation, a chaotic and nonfunctional heart rhythm. On attempting to ventilate the victim, the paramedics found the victim's upper dentures and a large wad of chewing tobacco far back in his throat. The paramedics administered several defibrillations, customary medications, and oxygen in an attempt to start a functional heartbeat.

By this time the light mist had turned into a violent thunderstorm. Because working on the victim on the ground at the site would have exposed the paramedics to possible lightning injury, they transported the victim while continuing emergency medical treatment. Further resuscitation in the emergency room at the hospital was unsuccessful. No effective pulse, heartbeat, or blood pressure was ever obtained, and the victim was pronounced dead by the doctor thirty-three minutes after the incident.

Investigation

After the victim's death, a detailed forensic investigation ensued. All of the victim's clothes and personal belongings, as well as the transformer equipment being repaired, were removed and stored for later inspection. Data were gathered from the work site utility crew, paramedics, resuscitating physician, forensic electrical engineer, medical examiner, autopsy photos, autopsy report, microscopic slides from wounds, National Lightning Detection Network, inspection of the scene, victim's family, and investigating safety officer for the utility company. The work crew participated in a reenactment of the incident.

During the investigation, the resuscitating physician reported that there were no obvious high voltage electrical burns on the body. However, he documented scattered, pinpoint, brownish discoloration on the skin on the left chest, left thigh, and right knee. Microscopic examination of one of the deeper brown spots revealed coagulation of tissue and cell rupture, as are commonly seen with superficial electrical burns, but are not characteristic of microscopic examination of either abrasions or

deep high voltage injury. Microscopic inspection of the discolored areas of the victim's clothing showed melting of the ends of threads that is consistent with exposure to a very brief, very high heat as seen in lightning cases.

There were no electrical marks or melting of any metal that the victim carried or that was on the transformer equipment. None of the electrical equipment, the utility vehicle, or surrounding trees at the incident site showed any type of damage from a lightning strike. In addition, there was no disruption of any of the electrical systems nor shorting out of fuses in the electrical lines in the subdivision as would be expected from an electrical malfunction or from a completed lightning strike. The surrounding trees were alive two and a half months later and exhibited no noticeable scars.

Medical Reasoning

The causes of death suspected, but excluded, in this case include high voltage electrical injury, heart attack, stroke, and/or airway obstruction. Damage from high voltage electricity, including lightning, usually shows signs of burns or metallic sheen on the body or clothes, physical damage to electrical equipment, or evidence of power interruption. None of these were present.

While a fatal disturbance of the victim's heart rhythm cannot be ruled out, the victim had no cardiac risk factors except obesity and the use of chewing tobacco. The autopsy showed minimal coronary heart disease, no thrombosis, no brain injury, or stroke. According to the victim's family, the victim had no history of hypertension, diabetes, or coronary artery disease. Immediately after the incident, the victim could speak but was gasping for air, ruling out immediate airway obstruction.

The polyester threads in the clothing showed signs of melting consistent with lightning, but no sign of melting metal in the zipper as would have been expected with a completed strike. No one, including the National Lightning Detection Network, detected C-G lightning in the immediate vicinity at the time of the injury. In addition, none of the co-workers were affected as would have been expected from a completed lighting strike. However, the tingling sensation and/or hair standing on end indicate a strong electrical field, common in lightning situations, and the brief flash of light seen are consistent with a weak upward streamer.

Discussion

Although postulated as a cause of injury, injury by upward streamers has never been proven as a mechanism. It has been stated that "An individual can be involved in an upward streamer which does not connect with the downward step leader" and that "such an event is certainly less hazardous, due to its short duration and relatively low current, than a direct strike and is a likely cause, along with ground current voltage, for the simultaneous shocking of large groups of people."[2] "In a situation where there is a lightning strike near a person in an open field, an

unsuccessful upward streamer may arise from the person's head during the last stage of the downward progression of the leader stroke. An unsuccessful streamer of this type would cause a current flow on the order of 10 to 100 amps, lasting a few tens or hundreds of microseconds, through the trunk or head of the person."[1]

According to one of the developers of the National Lightning Detection Network and also a consultant on this investigation, injury by a weak upward streamer is the most probable cause of the previously described work-related case. None of the previously accepted mechanisms of lightning injury can explain this incident. The sound described by the co-workers, as well as the flash seen by a co-worker near the victim's head, are consistent with a weak upward streamer. The weather conditions of light rain preceding a fast moving thunderstorm were ripe for producing upward streamers. The burns seen on the victim's skin were consistent with superficial electrical injury, not with what is seen with a high voltage injury, lightning, or everyday incidental trauma.

It is unknown whether this man was in immediate cardiac arrest after the incident or if he would have survived had his airway been clear. The victim, as he was collapsing, initially had an airway clear enough to make a remark to one of his co-workers. It is known that a victim of electrical injury may have enough oxygenated blood to enable that victim to speak and maintain consciousness for up to 10 or more seconds after the incident, despite the fact that that person may be in cardiac arrest. However, by the time the paramedics arrived, the airway of this victim had been obstructed by his dentures and chewing tobacco.

The Lightning Safety Guidelines codified by the Lightning Safety Group in 1998 have been published in many sources. These Guidelines address lightning safety for individuals, for children in the care of others, for small groups with short evacuation times, and for large groups with long evacuation times. The Guidelines also discuss first aid for victims. There are many reasons to believe that following the Guidelines would have saved this man's life.

Specific things that could have been done differently include:

1. Stopping work when the weather threatened and thunder was heard.

2. Seeking shelter in the utility repair vehicle which was within a few feet of the worksite.

Only a small utility work crew was involved in this incident. Many locations of school activities place students at high risk from lightning because the activities occur outside: recess on playgrounds, outdoor extracurricular activities on athletic fields, and travel to and from school. Lightning injury only causes death perhaps 10% of the time; however, the 90% that survive are at significant risk of permanent disability from brain injury as well as chronic pain syndromes and seizures.

It is important to protect students of all ages. Schools can serve an essential lightning safety role by practicing good lightning safety for students, faculty, coaches, and other staff members. School weather safety preparedness procedures should include lightning safety just as they address other severe weather.

Specific recommendations for school lightning safety include:

1. Develop a Lightning Safety Plan (LSP) for the school.

2. Maintain a National Oceanic and Atmospheric Administration (NOAA) weather radio in the school office with staff trained to monitor the radio and implement the LSP.

3. Train personnel to watch the sky and assess local weather conditions when thunderstorms are forecast.

4. Develop a procedure for notifying students that they need to seek safety in the school building immediately.

5. Conduct drills just as for fire and other weather safety plans.

6. Review and revise periodically the LSP as is indicated and as new safety information becomes available.

7. Promote the theme: "If you see it, flee it, and if you hear it, clear it."

Conclusion

The conclusion drawn at the end of the investigation was that this death was due to injury by a weak upward streamer that did not connect with a main lightning channel. This is the first witnessed and well-documented case of injury by an upward streamer. This death could have been prevented if the crew chief (who became the victim) had decided to delay the work as suggested by his crew members when they recognized the approaching thunderstorm. Death and injury to students, athletes, and faculty can also be averted by the proper implementation of the Lightning Safety Guidelines.

WWW Lightning Sites

Downloadable coloring books on various weather safety topics
<http://www.nssl.noaa.gov/edu/bm>
<http://www.srh.noaa.gov/mlb>

Lightning Safety for Children (aka Sabrina's Lightning Page)
<http://www.azstarnet.com/anubis/zaphome.htm>

National Weather Service
<http://www.LightningSafety.noaa.gov>

National Severe Storms Laboratory
<http://www.nssl.noaa.gov/researchitems/lightning.html>

Global Atmospherics, Inc. (National Lightning Detection Network)
<http://www.LightningStorm.com>

Lightning Injury Research
<http://www.uic.edu/labs/lightninginjury>

National Lightning Safety Institute
<http://www.lightningsafety.com>

USA Today
<http://www.usatoday.com/weather/wlightn0.htm>

Acknowledgements

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Jessica L. Vavrek, Cedar Lake, Indiana

Cited References

1. Darveniza, M. "Electrical Aspects of Lightning Injury and Damage." C.J. Andrews, M.A. Cooper, M. Darveniza, and D. Mackerras (Eds.). *Lightning Injuries: Electrical, Medical, and Legal Aspects*. CRC Press. Boca Raton, Florida. 1992. pp. 23-37.

2. Uman, M.A. "Physics of Lightning Phenomena." C.J. Andrews, M.A. Cooper, M. Darveniza, and D. Mackerras (Eds.). *Lightning Injuries: Electrical, Medical, and Legal Aspects*. CRC Press. Boca Raton, Florida. 1992. pp. 6-22.

Additional References

Cherington, M., J. Walker, M. Boyson, R. Glancy, R. Holle, and S. Clark. "Closing the Gap on the Actual Numbers of Lightning Casualties and Deaths." Preprint, Eleventh Conference on Applied Climatology. Dallas, Texas. American Meteorological Society. Boston, Massachusetts. January 1999. pp. 379-380.

Cooper, M.A., C.J. Andrews, R.L. Holle, and R. Lopez. "Lightning Injuries." Paul S. Auerbach (Ed.). *Wilderness Medicine: Management of Wilderness and Environmental Emergencies*. Fourth Edition. Mosby. St. Louis, Missouri. 2001. pp. 73-110.

Holle, R.L., R.E. Lopez, and R.J. Vavrek. "Accounts of Lightning in Newspapers from 1891 to 1895." *The Hoosier Science Teacher*. May 2000. 25:4 pp. 100-105.

Holle, R.L., R.J. Vavrek, and J. Allsopp. "Lightning Hazard Education." *The Hoosier Science Teacher*. May 1995. 20:4 pp. 112-118.

Krider, E.P. "Physics of Lightning." *The Earth's Electrical Environment, Studies in Geophysics*. National Academy Press. Washington, DC. 1986. pp. 30-40.

Lifschultz, B.D. and E.R. Donoghue. "Electrical and Lightning Injuries." *Spitz and Fishers Medicolegal Investigation of Death*. Third Edition. Charles C. Thomas Publisher, Ltd. Springfield, Illinois. 1993. pp. 516-527.

Mackerras, D. "Protection from Lightning." C.J. Andrews, M.A. Cooper, M. Darveniza, and D. Mackerras (Eds.). *Lightning Injuries: Electrical, Medical, and Legal Aspects*. CRC Press. Boca Raton, Florida. 1992. pp. 145-156.

Roeder, W. P., R.J. Vavrek, *et al*. "Lightning Safety for Schools." Tenth Symposium on Education. American Meteorological Society. Albuquerque, New Mexico. 2001. pp. 89-92.

Vavrek, R.J., R.L. Holle, and J. Allsopp. "Flash to Bang." *The Hoosier Science Teacher*. May 1994. 19:4 pp. 101-110.

Vavrek, R.J., R.L. Holle, and R.E. Lopez. "Updated Lightning Safety Recommendations." Preprint, Eighth Symposium on Education. American Meteorological Society. Dallas, Texas. January 1999.

BRINGING THE SOLAR SYSTEM TO THE FOOTBALL FIELD

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The Solar System Project

The solar system is a topic earth science teachers will cover during the course of the year. The project can be divided up into the three major sections of research, model construction, and the football field activity. The students will begin searching for information about the asteroid belt, Earth's moon, and the nine planets - - including information on density, atmospheric gases, surface conditions, and temperatures. Other celestial objects can be added depending on the size of the class. Textbooks, libraries, encyclopedias, and the Internet are excellent resources for gathering the information. (See <http://www.astronomynotes.com> or do a search in any major search engine.) Other interesting and useful information could be for the students to calculate their weights on each of these celestial objects, to compare the size of each to Earth, to explain what it would be like to walk on the surface of each, and to calculate how long it would take the space shuttle traveling at 25,000 mph to reach each celestial object. These are all activities to meet the state standards and proficiencies.

An added feature to this project is to let the students work in groups of two to three students and make scale size models. Letting 3,000 kilometers equal one inch is a good ratio for the models. There are two different ways to approach the collection of information by the students. The traditional way is to have each student search for information on every planet or topic. Another way is for students to work in groups, gather the information about the assigned objects, cut out and color models from paper, and then have a round robin science fair activity where the students meet in the school cafeteria, a place that already has tables set up, and move from table to table taking notes. Once the students have the information, they are ready for discussion.

Adding a Slide Show

The discussion on the solar system can have an interesting twist with a slide show. The slide shows produced could have a theme song for each planet. "Bad Bad Leroy Brown," for example, could represent Jupiter; "You've Got A Friend" for Earth; and "Candle in the Wind" for the the windiest planet, Uranus. A slide show allows

the instructor to stop the music and relay information. After students have been exposed to the discussion, they are ready to move to the football field.

The Football Field Model

The football field is an area to utilize for a scale size model, proportions, and synthesis of the project. If the scale size for the model is 3,000 kilometers equals one inch for planet diameter, then Earth is four inches, Jupiter is approximately four feet, while the sun would be represented by two goal posts stacked on top of each other. This creates a visual for the students to gain an idea of the size comparisons. Before the students go out to the football field, the groups will need to figure out how far the planets are from the sun. The scale of one million miles equals one foot (Students may need to change this to yards for the football field.) should be used to place the planets on the specific yard lines on the football field.

Further Investigations

Once the planets are placed, there are several activities that can take place. Knowing it took the Apollo rocket around four days to travel to the moon could be used for students to calculate how long it would take the same rocket to travel to Pluto. The same could be done for the Voyager series probes that traveled past Jupiter, as well as for the current space shuttle. Calculating how old a person would be by the time that person traveled out to Pluto and back is interesting. Calculating how long it would take to go to our closest star, Alpha Centauri, amazes students and helps them realize just how vast space really is. These discussions can dovetail an investigation to space travel, metal degradation on spaceships, or even food preparation. Discussion of National Aeronautics and Space Administration (NASA) "gadgets" produced from research will also keep student interest and inquiry ongoing.

Meeting the Standards

This project could meet six of the nine earth science standards while making the learning fun. Understanding the role of technology, the Nebular Theory, manned versus unmanned spacecraft, planetary systems, Kepler's Laws, and the Big Bang Theory are all possible subjects to meet the standards for the project. The project holds student interest while using hands on activities and visuals to ensure that learning can occur. The students will be able to make their own inferences about the universe after the completion of this project. Being fun and informative, as well as fulfilling the standards, make this an exercise that all teachers could complete at any grade level. This is one experience the students will be discussing long after the class is over!

A CHANGE OF STATE PYRAMID: A HANDS-ON EXPLORATORY LEARNING AND STUDY TOOL FOR THE MIDDLE SCHOOL SCIENCE CLASSROOM

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Oftentimes, when teaching a somewhat abstract concept to middle schoolers it becomes obvious that they need a good, concrete, study tool to assist them. One of the subjects that has always frustrated my students is attempting to learn and memorize the terminology surrounding phase changes involving the three common states of matter. This problem was solved after looking at a student's paper and seeing the creative diagram he/she had drawn to help him/her remember which change of state involved which phases and had which name. The student had drawn a circular diagram with arrows pointing the way from one phase to another accompanied by the proper name of the phase change and examples of each state of matter. This simple diagram was so ingenious that after some simple modification I developed the change of state pyramid.

The change of state pyramid gives students the always sought after "hands-on" time using scissors, colored pencils, and glue. It also compels students to open their textbooks or notes to find examples of the different phases and to find help with the terminology. The pyramid also challenges the students to use their spatial sense and visual prediction abilities since the easiest way to write your information on the pyramid is to do so before it is folded. Let us look at how to make a change of state pyramid:

Step 1: Have students cut out the shape in Figure 1. The students should cut only along the dotted lines. Use the side length you feel is most appropriate. (A side length of 10 cm fits well on a standard sheet of paper.)

Step 2: Have students crease the shape along all of the solid lines. After doing this have students experiment with how the shape will fit together when done.

Step 3: Instruct the students that one side of each pyramid will be for a solid,one for a liquid, and one for a gas. (I omit plasma.) The base of each pyramid is for student name, class period, ...

Step 4: Model for the students how, on each side of the pyramid, they should include three substances that can be found in that state at room temperature and label them on that side. Each student should also draw an arrow from that side across to a connected side and label the arrow with the proper phase change name as shown in Figure 2. (You can make this more challenging by giving extra points if all writing is "right side up" when each pyramid is finished.) This step should be repeated until all three sides are complete and all six phase changes are labeled and spelled correctly.

Step 5: Have students color each side of the pyramids with colored pencils or crayons.

Step 6: Have students fold their pyramids to the finished form and glue together using the glue tabs.

This pyramid gives the students practice with phase change terminology, measuring, and spatial sense as well as meeting several Indiana Science Standards. The standards which are applicable vary for each grade level. This idea can also be modified and expanded for use with many other science concepts. For example, when studying elements in the classroom, assign each student an element and have he/she make a cube. One side of the cube is for student name, class period, ... The other five sides are used for chemical symbol, atomic number, atomic mass, element name, and five facts about the element. When finished, all of the "element cubes" can be hung easily from the ceiling to create what we call a "one-of-a-kind-search-and-find" periodic table.

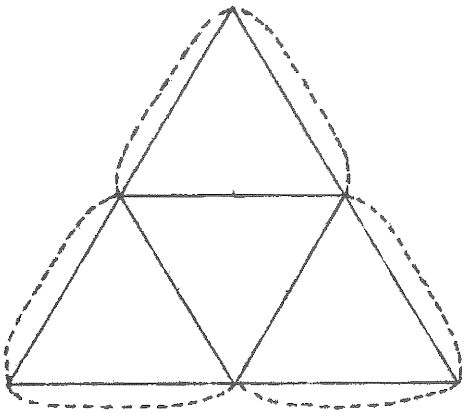

Figure 1.

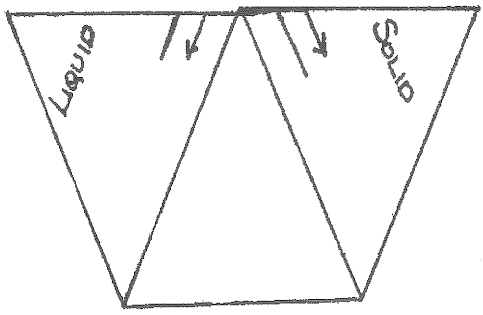

Figure 2.

NUMISMATICS AS A RESOURCE FOR SCIENCE EDUCATION

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Numismatics primarily involves the study of the elements of material culture which have served or continue to serve as the basis for economic exchange. Coins and paper money are the most obvious elements of numismatics, but primitive money, tokens, medals, and other related items also constitute sectors of the field. From the initial coinage struck in the Greek city states some 700 years B.C., the use of coins as a medium of exchange has become a worldwide characteristic of the nation states. We are now well into the third millenium of the use of coins.

The analysis of material culture in archaeology and human geography is well established in both disciplines. In archaeology, site debris (artifacts), site features (such as foundation traces or trash pits), and surviving structures serve as the primary database of the discipline; in cultural geography, the analysis of building types and other elements of the material culture of a population have also been important.

Students can be introduced easily to aspects of material culture as a part of early educational experience, and some substantive collateral learning can result. The use of contemporary world coins can be used to introduce young students to basic geographic locations. It is clear that most graduates of the existing primary and secondary curricula in the state are "lost" in space. A similar gap in the background of most undergraduates exists at most universities.

This should certainly be no surprise. The raw memorizing of geographic locations is at best tedious, and there is little motivation to memorize locations for which the students have no connections or developed interests. Traditional exercises involving lists of places, basic outline maps, colored pencils, and directions to locate and plot the places and areas on the list do not seem to have been all that effective as learning devices even when students have had those experiences.

A much less formal approach to developing basic spatial knowledge in early elementary students may be more effective. In the early grades, the students are curious and often interested in novel objects which can be handled. The new state quarters have generated a renewed interest in coin collecting, and most youngsters are becoming familiar with these quarters. More broadly, world coins are diverse and often have attractive designs, which can be the basis for discussion. The kangaroo on the Australian penny, the beaver on the Canadian nickle, the "strange symbols" on

the Chinese cash coins, and the variety of coins from the "new" African states are just a few examples.

Once early elementary students learn the names of other countries, it is a natural progression to wonder where they are. The where issue can be faced with some reason to pursue it. The teaching materials needed to develop this approach are very modest.

First, a supply of foreign coins is required. Many coin dealers have a "junk box" of foreign coins. The box most often contains coins from a variety of countries, offered at a set price per coin. It is usually possible to obtain a sizeable sample for a few dollars. Lacking an area dealer, the weekly coin newspapers, *Coin World* and *Numismatic News*, contain advertisements from dealers offering foreign coins at a few dollars a pound.

Most foreign coins are labeled clearly, and with some guidance a student with a basic reading knowledge can identify the country for which the coin was struck. Doing a few coins at a time, a class can easily develop a basis for discussion of a number of countries including the issue of where they are located.

The materials needed to address the location problem area also inexpensive. Basically, a globe and an atlas are sufficient. From the globe several geographic basics can be introduced. These include the concepts of: 1) the planet Earth; 2) its axis of rotation; 3) the geographic poles; 4) and direction on the Earth (north and south from the poles, and the conventions of east and west).

In addition, the existence and names of the continents can be suggested easily. From that background, an atlas can be used to locate the countries of interest. If the students are familiar with the alphabet, the index could be used. If that is too complex for the group of students, projection of continental maps with national boundaries and names would permit the students to find the locations of the countries of interest. Instead of drudgery, identifying the locations of countries becomes a game of discovery. Discussion can then center on where a nation is in the context of a continent, who are the neighbors, and any other aspects of the place the teacher wishes to emphasize.

The suggested educational goals are to introduce early elementary students to: 1) the names and basic locations of a sample of countries; 2) the basic location concepts of the Earth's reference points and directions on the Earth; 3) the use of globes and maps; and 4) the "fun" of such learning.

More broadly, the approach would provide a first orientation to the spatial thinking that is fundamental to so many of the physical and social sciences. On a longer range basis, an early introduction to basic numismatics may result in a youngster becoming a collector with a lifelong hobby to pursue. While collecting coins minted in the United States may be too expensive for younger children, most can

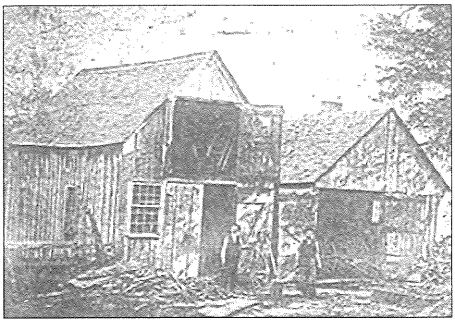
pursue an interest in foreign material. Also, foreign currency is affordable. As students mature, more specialized collecting of foreign and United States coinage can become feasible. The *Standard Catalog of World Coins* by Krause and Mischler and Yeoman's *Redbook* on United States coins make it possible for the young collector to identify and price coins from about 1700 A.D. to the present. Local and school libraries could provide these references.

Further, local coin clubs normally welcome "juniors," and coin clubs can be established in the schools if none exist in the area. As one pursues the hobby, historical and geographic learning necessarily follows, which can lead far beyond the sometimes arcane numismatics focus.

MANSFIELD MILL

The historic, state-owned, Mill is located on Big Raccoon Creek near Mansfield, Indiana in Parke County. The Mill, constructed in the 1820s, remains in working condition even today. A turbine provides the power for grinding grain into flour.

The original Mill was merely a 30 x 30 foot log structure. For grinding, glacial stones from a farm nearby were used. As the population and the needs of the Mansfield community increased, a saw mill and a carding mill were added to the grist mill. In time, the Mansfield Mill became a three story structure; the third story was added to house the additional equipment that was needed. After many years of successful operation and three owners, a new building was constructed north of the original one; this new structure, 24 x 36 feet, is a part of the present day Mill. In 1886, the Mill was converted from stone to roller milling. The Mill prospered until the late 1920s.



In 1926, the Mill was sold for back taxes at an auction. The Mill operated as a feed mill until 1968. After several owners, in 1991, the Mill was donated to the state; today, the Mill is part of the Indiana State Museum System. Mansfield Mill is a superb example of historic roller milling in Indiana; all three floors of machinery are intact and the water-powered turbine is in working order.

Group tours are available; for more information call 1-765-344-0741 or visit <http://www.mansfieldcoveredbridge.com>. Contact the Mill at least one week in advance. Operation of the Mansfield Mill varies by season.

KEEPING THE BIOLOGY CLASSROOM CURRENT: REJECTING HAECKEL'S EMBRYOS

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Biology textbooks will often include in their units on evidences for evolution diagrams showing the similarities in the embryological stages of vertebrate species.[1,8,10,11,12,13] Some authors will use photographs of embryos, sketches from photographs, or Haeckel's original set of sketches.[10] Students are told by their teachers or by the authors of texts that these "embryos show our evolutionary history."[11] This claim, sometimes referred to as the recapitulation theory, is the idea that the evolutionary development of a species is repeated in its embryological stages. According to this theory, one should be able to find in the stages of development of an embryo, characteristics that its ancestors possessed at some point in evolutionary history. This idea was expressed by the statement, ". . . the developing embryo takes a microscopic trip through evolutionary time," although the biogenetic law as formulated by Haeckel was rejected.[9] Called by Gould the apostle of evolution in Germany, Haeckel formulated the biogenetic law as "The rapid and brief ontogeny is a condensed synopsis of the long and slow history of the stem (phylogeny)."[4] He believed new features of a species were added to the end of the embryological development, and by a process called condensation, room was made for the additions by deleting some of the earlier stages.

Darwin believed that the leading facts of embryology were important to his theory. Not being an embryologist, he depended on other biologists for information. Two prominent scientists of his era, Karl Ernst Von Baer (1792-1876) and Ernst Haeckel (1834-1919), provided a choice for him. Von Baer, referred to as a preeminent observer and foe of unsupported speculation, acknowledged but rejected the idea of recapitulation.[5] Haeckel, the Lamarckian German biologist, formulated an entirely different view of embryological development from Von Baer. Darwin viewed Haeckel's ideas and sketches as powerful evidence for his theory; Darwin stated "Thus it seems to me, the leading facts in embryology, which are second to none in importance, are explained on this principle of variations in the many descendants from some one ancient progenitor."[2]

The impact of Haeckel's recapitulation theory cannot be underestimated. Not only was it used by biologists, but it played a primary role in other disciplines. In *Ontogeny and Phylogeny*, there is a chapter on the pervasive influence of this theory; Haeckel's ideas strongly influenced essays on criminal anthropology, racism, child

development, primary education, and psychoanalysis of the late 1800s. By the end of that century there was a shifting of the scientific community away from the biogenetic law.[3] That shift is covered in the chapter entitled "Decline, Fall and Generalization;" Haeckel's law "fell only when it became unfashionable in approach (due to the rise of experimental embryology) and finally untenable in theory (when the establishment of Mendelian genetics converted previous exceptions into new expectations)."[5] "When Mendelian geneticists discarded the inheritance of acquired characteristics, Mendelians also rejected the most promising theoretical basis for the biogenetic law."[7] E.W. MacBride stated in 1914, "In these days this law is regarded with disfavor by many zoologists, so that to rank oneself as a supporter of it is to be regarded as out-of-date."[6]

Serious doubt regarding the validity of Haeckel's ideas accumulated over the past century. Many recognized authorities (besides Gould) rejected the recapitulation theory as originally proposed and presented by Haeckel and his drawings. When this topic is covered in biology courses, teachers must be careful to present the most current information; and, this information may not come from the textbook.

Conclusion

It does not matter how authoritatively one may present arguments for hypotheses or theories. Speaking with authority does not create truth nor does it make something more or less correct. If inaccuracies are identified in the evidence from embryology, the high standard of integrity among scientists should force them to eliminate or update such references as many conscientious textbook editors have done. If we overlook errors or inaccuracies in our field of study, we must allow experts in other fields to overlook errors and inaccuracies as well. I do not think we want to head down that road.

The very nature of science demands accuracy and self-correction based on the latest research. Scientists must discard that which does not stand up to the scrutiny of discriminating minds. The truth concerning Haeckel's embryos is that he was wrong, and it is scientifically unjustified to perpetuate those wrong ideas.

References

1. Arms, Karen and Pamela Camp. *Biology*. Fourth Edition. Harcourt Brace. New York, New York. 1995. p. 362.

2. Darwin, Charles. *Origin of Species*. Second Printing. A Mentor Book, New American Library. New York, New York. 1958. p. 418.

3. Gould, Stephen Jay. *Ontogeny and Phylogeny*. The Belknap Press of Harvard University Press. Cambridge, Massachusetts. 1977. pp. 53-55.

4. *Ibid.*, p. 81.

5. *Ibid.*, p. 168.

6. *Ibid.*, p. 186.

7. *Ibid.*, p. 203.

8. Mader, Sylvia. *Biology*. Seventh Edition. McGraw-Hill. New York, New York. 2001. p.296

9. Miller, Kenneth. "What Does it Mean to Be One of Us." *Life*. Chicago, Illinois. November 1996. 19:3 pp. 38-53.

10. Miller, Kenneth and Joesph Levine. *Biology - Discovering Life*. Second Edition. D. C. Heath. Lexington, Massachusetts. 1994. p. 162.

11. Raven, Peter and George Johnson. *Biology*. Fourth Edition. William C. Brown. Chicago, Illinois. 1996. p. 487.

12. Starr, Cecie. *Biology - Concepts and Application*. Fifth Edition. Brooks/Cole. Belmont, California. 2003. p. 283.

13. Starr, Cecie and Ralph Taggart. *The Unity and Diversity of Life*. Tenth Edition. Brooks/Cole. Belmont, California. 2004. p. 315.

HAVE YOU CONTRIBUTED TO *THE HOOSIER SCIENCE TEACHER* THIS YEAR?

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GENDER DISCRIMINATION IN SCIENCE

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Since the Sex Discrimination Act of 1975, groups supporting equal rights, women's liberation, and affirmative action have been actively trying to level the field for all individuals. (Some efforts were made in the nineteenth century.) The reason for the efforts have come from the unequal distribution of power and privilege of males in society even though the female population outnumbers the male population.[17] Sociologists study the sexes to determine how gender differences, masculinity and femininity, are formed within a society. (In education, Title IX of the Educational Amendments of 1972 has had an impact.) Researchers have extended these studies to explain why males and females perform differently in the classroom and what impact gender stereotypes have on attitudes in school.

Does society have an impact on how males and females perform in the classroom? Is there a correlation of gender expectations related to male and female performance? Are there correlations between how society views the roles of men and women and how females view science? Males and females show the same interest in science at the primary level but differences in interest appear once in secondary school.[5] It has been illustrated that males have consistently demonstrated a more positive attitude toward science than girls.[26] A decline in female science achievement is associated with a change in a female's opinion of her role in society as she grows older and with the effect of parental actions concerning a female's sex role in socialization.[3] What impact does this gender disparity have on student performance and attitude toward science?

Sources of Gender Discrimination

There is evidence to illustrate how gender stereotypes are acquired and what male and female attitudes result from the exposure. Sociologists have shown that stereotypes are learned starting from the day that males and females are born. Parents' behaviors steer their children toward masculinity and femininity skills.[11] Parental behavior is demonstrated through the kind of attention that is given to males over females. Males are exposed more than females to science and technology-related experiences such as through trips and visits to museums. Males have more experiences with toys involving the use of science and tinkering skills, while females are not encouraged to play with these "mechanical" type toys.[13,20]

Once children begin their formal education, males and females are exposed to a new source of behavior patterns, teachers. Females have fewer experiences in science activities than males and this parallels females' negative views of science.[20]

Science teachers tend to elaborate more on a male's response to a question than a female's response. If given a wrong answer, teachers challenge males to seek a correct answer and offer only sympathy to females.[1] In addition, teachers usually ask males more often to help with demonstrations.[19]

While in school, males and females also reinforce stereotyping through their behaviors and attitudes toward one another. It is typical to have males dominate and females to sit back and watch when doing activities, such as conducting an experiment.[10] Females who discuss in debate-like formats feel ignored by males. Males perceive that a question asked by a female will only address her lack of knowledge instead of being of an inquisitive nature. Males dominate instructional conversations, while females are good listeners.[14] From a two year study, several findings were apparent concerning gender disparity. Males were more aggressive in whole-class and small group discussions and debated more than the females. When females did participate and debate the issues, the males dismissed the females, thus reinforcing the intimidation and the lack of self-confidence found in females. The other striking result was seen in how teachers and students perceive gender disparity. Though a teacher did not report gender disparity, females were quick to report male dominance in discussion; males tended not to realize any gender disparities.[14]

While verbal communication plays an influential part in the development of attitudes, non-verbal communication can reinforce the stereotypes. The science classroom atmosphere sends a message about gender dominance when observing the number of males and females represented in displays. It has been observed that 93% of science classroom displays that included humans depicted males.[19] Another source for reinforcing stereotyping is the science textbook. Studies have shown a slight improvement in this area.[5] Early science textbooks were written and reviewed by males, portrayed males as "doing" and females only "posing," and included more male interests (e.g., automobiles) within the textbook.[16] Since textbooks influence what teachers teach and what students learn, gender disparity needs to be addressed in order to create a science education for all students.[6]

Effects on Gender Attitudes Toward Science

With all of these learned influences, one can determine gender attitudes toward science through the activity "Draw a Scientist."[8] In this activity, each student is told to draw a picture of a scientist. From the picture, indicators are identified for the standard image of a scientist. Indicators include the presence of a lab coat, eyeglasses, facial hair, symbols of research, symbols of technology, male, pencils/pen in a pocket, and unkempt appearance. Using these indicators to illustrate stereotyping, a study using middle-school students found that males' drawings illustrated more male stereotypic features than females' drawings.[18] In another study, comparing the views of high school students with those of grades K-8 provided insights to students' images of scientists. From this study, an average of 69% of students from grades K-8 and an average of 65% from grades 9-12 illustrated male gender scientists.[4] Yet another study found similar results using Hong Kong Chinese students. Sixty-two percent of the respondents (grades 2-12) illustrated a scientist as being

male.[12] Another measure of recognizing stereotyping and discrimination is whether students can name or recognize female scientists. A study documented that students could name only Marie Curie as a female scientist who made any significant contribution.[15] It was noted by one female student that if she could not name a female scientist, then maybe she should not go into science. By not highlighting female scientists, the masculinity of science prevails.

Gender Equity Proposals

Recognizing that gender discrimination can influence attitudes for males and females, efforts can be focused on changing behavior patterns to reach gender equity. Even if parents are not strong in science, they should praise girls for their skills, ideals, and successes. Parents should provide a positive attitude and have high expectations for their children. Parents should encourage females to take mathematics, science, and technology classes in school, while providing more related activities at home.[14,25]

Teachers can achieve gender equity by developing programs to alter students' negative attitudes and stereotypic images of science and scientists.[24] It was found that when a teacher believed that girls could be high achievers, the teacher then treated males and females equally.[15] The students were aware of this treatment and the females tended to perform better than males. In addition, teachers should provide role models and mentors for girls.[7] By developing investigation based, cooperative learning strategies, and a closer connection of physical science to daily lives, a teacher can enhance success and attitudes toward science.[13] One example of a teaching strategy that provides positive response by female students is the learning cycle because of its group orientation and hands-on instruction.[22] The curriculum becomes more meaningful when depth in content, practical applications, and hands-on instruction are utilized. Teaching science thematically and using more cooperative and less competitive strategies to teach science should be used. In addition, teachers can combat girls' declining self-esteem by demonstrating encouragement and reassurance. Encouragement should come not only in pushing science studies but also in academic performance and expectations.[15] Teachers can ensure girls equal opportunities to participate successfully even if it means single-sex learning situations.[14] At middle and high school, more female educators should be teaching the higher-end courses.[21]

Pre-service training should include strategies that are gender equitable in methods courses. Teachers should be trained in basic science investigative processes to help students formulate and implement early student research efforts. Teacher training programs must include science content training in physical and earth science as well as in life science.[13,21]

Effects of Gender Equitable Methodology

One way to measure if gender discrimination is still influencing female science attitudes is in the number of females pursuing science majors in college and as

a career. In a study that focused on a 30 year period (1970s through the 1990s), the number of bachelor's degrees received by women in biological and agricultural sciences doubled and the number increased more than ten fold in engineering. In this time frame, the number of degrees earned by men reflected closely the pattern for women until the 1990s. During this period, women climbed faster in the number of degrees earned than men. This study also documented that women are on a par with men in selecting biology as a field of study.[23]

Even though females have made strides in the field of life science, physical science is still deemed to be masculine. Although female participation in science competition has increased, females are less likely to do projects in physical science.[13] Progress has also been seen in increased enrollment in high school chemistry courses by females.

Summary

Research compared males' and females' perceptions of their abilities in science. Females tended to believe that their lower perceived ability is due to the stereotypic belief that science is a masculine domain.[9] Ideas for reform in science education can equalize achievement and participation of males and females as seen in Project 2061.[2] Utilizing thematic units, incorporating history, and integrating technology and mathematics are strategies presented in Project 2061 to help eliminate barriers for minority groups.[2] Teachers need to assess their influence on students and start by conducting pre- and post-Draw a Scientist Tests to measure effectiveness in altering perceptions to science.[24]

Within society itself, the belief that a scientist is unfeminine, impersonal, and only logical in investigation skills is a major barrier that must be dispelled in order for females to be accepted in science.[21] Understanding the role of society in gender discrimination is a complex issue. One has to start from birth to tackle barriers both inside and outside of academia and at all grade levels, K through post-graduate.

References

1. Alper Study (cited in 13. Greenfield, 1995).

2. American Association for the Advancement of Science. *Science for All Americans. A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology.* Washington, D.C. 1998.

3. American Association of University Women Study (cited in 21. Kennedy and Parks, 2000).

4. Barman, C.R. "Completing the Study: High School Students' Views of Scientists and Science." *Science and Children.* April 1999. 37:7 pp. 16-21.

5. Bazler, J.A., and D.A. Simonis. "Are Women out of the Picture?" *The Science Teacher*. December 1990. 57:9 pp. 24-26.

6. Bianchini, J. "The High School Biology Textbook: A Changing Mosaic of Gender, Science, and Purpose." Annual meeting of the American Educational Research Association. Atlanta, Georgia. April 1993.

7. Brickhouse, Carter, and Scantlebury Study (cited in 21. Kennedy and Parks, 2000).

8. Chambers Study (cited in 24. Mason, Kahle, and Gardner, 1991).

9. Debacker, T.K. and R.M. Nelson. "Motivation to Learn Science: Differences Related to Gender, Class Type and Ability." *Journal of Educational Research*. March/April 2000. 93:4 pp. 245-255.

10. Duru-Bellat, M. "Women and Science Breaking Through." *UNESCO Sources*. August 1998. 102:4 pp. 10-12.

11. Forrest, G. "Gender Differences in School Science Examinations." *Studies in Science Education*. June 1992. 20:1 pp. 87-122.

12. Fung, Y.Y.H. "A Comparative Study of Primary and Secondary School Students' Images of Scientists." *Research in Science and Technological Education*. December 2002. 20:2 pp. 199-213.

13. Greenfield, T.A. "An Exploration of Gender Participation Patterns in Science Competitions." *Journal of Research in Science Teaching*. September 1995. 32:7 pp. 735-748.

14. Guzzetti, B.J. and W.O. Williams. "Changing the Pattern of Gendered Discussion: Lessons from Science Classrooms." *Journal of Adolescent and Adult Literacy*. September 1996. 40:1 pp. 38-48.

15. Hatchell, H. "Girls' Entry into Higher Secondary Sciences." *Gender and Education*. December 1998. 10:4 pp. 375-387.

16. Heikkinen's Study (cited in 6. Bianchini, 1993).

17. Henslin, J.M. *Social Problems*. Pearson Education, Inc. Upper Saddle River, New Jersey. 2003.

18. Huber, R.A. and G.M. Burton. "What Do Students Think Scientists Look Like?" *School Science and Mathematics*. November 1995. 95:7 pp. 371-376.

19. Jones, M.G. and J. Wheatley. "Gender Influences in Classroom Displays and Student-Teacher Behaviors." *Science Education*. September 1989. 73:5 pp. 535-545.

20. Kahle, J.B. and M.K. Lakes. "The Myth of Equality in Science Classrooms." *Journal of Research in Science Teaching*. February 1983. 20:2 pp. 131-140.

21. Kennedy, H.L. and J. Parks. "Society Cannot Continue to Exclude Women from the Fields of Science and Mathematics." *Education*. Spring 2000. 120:3 pp. 529-538.

22. Lee, V.E. and D.T. Burkam. "Gender Differences in Middle Grade Science Achievement: Subject Domain, Ability Level, and Course Emphasis." *Science Education*. November 1996. 80:6 pp. 613-650.

23. Luckenbill-Edds, L. "The Educational Pipeline for Women in Biology: No Longer Leaking?" *Bioscience*. June 2002. 52:6 pp. 513-522.

24. Mason, C.L., J.B. Kahle, and A.L. Gardner. "Draw-A-Scientist Test: Future Implications." *School Science and Mathematics*. May/June 1991. 91:15 pp. 193-197.

25. Samuels, L.S. *Girls Can Succeed in Science*. Corwin Press, Inc. Thousand Oaks, California. 1999.

26. Weinburgh, M. "Gender Differences in Student Attitudes Toward Science: A Meta-analysis of the Literature from 1970 to 1991." *Journal of Research in Science Teaching*. April 1995. 32:4 pp. 387-398.

SCIENCE NIGHT: A FEW WORDS FROM A CONVINCED TEACHER

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Last year in the spring, the North Putnam Middle School science teachers held our first science night. It was a night we had designated to teach third graders in our corporation the wonders of science. The event would last a whole two hours. That is not a lot of time when you consider the amount of planning that we teachers did. We were anxious during the whole planning phase. Would science night be a tremendous success or a resounding failure? Our hope lay somewhere in the middle, hopefully toward the top end of the spectrum.

Our hopes were answered when we had a very successful night. We teachers were pleased at the way things went. We did not receive the turnout that we had hoped for - - not as many students came as compared to our expectations. This actually turned out to be a blessing. It allowed us more time to spend with individual students and to obtain a truer assessment of what was going on by allowing us to move around among the students. The entire history aside, why would I say that I am sold on this event?

Science night allowed us an opportunity to let students experience science in a non-threatening way. There was not a test hanging above their heads. The students were not intimidated by the threat of a poor grade in case they missed the fact. They were allowed to immerse themselves into the science. They could ask questions and manipulate science equipment. The students were allowed to enjoy science. They made small things that they could keep. There were door prizes. It is no wonder the students got such a kick out of the night.

Parents also derived pleasure at the event. Some were just as astounded at some of the experiments and equipment as the children were. Some parents had the chance to utilize knowledge that was stored in their brains just waiting to come out. It was neat to see the parents' sense of pride as their child did a nifty experiment or if they themselves answered a question correctly. I believe the night was just as enjoyable for the parents as it was for the children.

I gained enjoyment and satisfaction by watching the parents and students. It was rewarding to see the looks of wonder on the students' faces and then to glance at the parents to see the pride beaming. It renewed the sense of excitement that science always gave me as I learned something new. The event was not only giving out the joy of science to many but was becoming a great public relations tool for all. The night was very successful in my mind.

I want to share some of the ideas that I think helped make the night a success. The planning took awhile, but as I pointed out, it was well worth it. First, we decided to start small. We invited only one grade level. We did this so we could work out the kinks of the program. We also did that so if things did go wrong, we could save the program because it was on a limited scale. We looked to professional journals for ideas and adapted them to suit our needs.

These are the ideas that we kept in mind as we planned the event. We first wanted to make our guests very welcome in our building. We passed out nametags so that we were not total strangers. We then went quickly over the night's schedule and gave a brief tour of the rooms we would be in. We handed out stickers and paper so participants could record which experiments were attended. The children loved this - - there is just something about kids and stickers. Then we allowed the students to go to the rooms. Without as many students as we had planned for, we did not have to enforce time limits like we thought we would.

The experiments we chose consisted of mostly hands-on activities. We basically picked our favorite ones so that the participants could see the enthusiasm on our faces. We also picked the activities according to the ability of the students being able to make things to take home. The students loved this part, too. We had middle school students man the stations; these students had as much fun as the participants did.

We called the local papers and had reporters present. Pictures of some of the students and teachers appeared in the paper, as well as a great write-up. We all know how well schools can use positive reports in this day and age of extreme scrutiny. Public relations turned out to be one of the key benefits of this event.

The end of the night pulled all the participants back together for refreshments and door prizes. The main part of this ending was to get some feedback from the participants. We distributed small evaluation forms to help us plan for next year.

The event was terrific. The responses were overwhelmingly positive. The event sold me on the importance of science night. I hope that I have convinced you of the potential this event could have for your science program. This is a great way to build an interest in science and great public relations all at the same time. Good luck on your program if you try it. It is definitely a great night of fun.

SCIENCE EDUCATION

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Teaching science has been a low priority in many elementary classrooms. I believe that this is partially because science was not being tested on the Indiana Statewide Testing for Educational Progress (ISTEP). I have attended several meetings for primary teachers where language arts was emphasized and teachers were told to skip mathematics if necessary, but to teach students to read and write. When math scores on the tests were low, teachers were told to teach reading, writing, and math, and not to worry about the rest; we could use the rest as "fill-in."

After the decision was made to test social studies and science during off-year testing, teachers were told that the subject of the meetings in the future would be teaching social studies and science in the language arts block of time. Of course, I believe that a student needs a solid foundation of two or three years of study before he/she can do well on the test and so teachers must begin in kindergarten by providing quality instruction in all subject areas being related to each other in thematic units.

All students must have an understanding of the science and technology behind any social issue which affects their lives. The primary grades are a critical time for capturing the interests of children and providing direct applications to their lives. Children must be encouraged to follow their curiosity about the natural world.

Standards are an established framework for what students should know and be able to do when they reach given grade levels. Schools should have high expectations and challenging curricula for students. School corporations are making changes to reach these standards, including developing curriculum frameworks, improving assessment, and revising teacher certification and licensure requirements. Perhaps time and money would be better spent in professional development by giving teachers the books and materials, but then by adding training in how to use them as well as the new technology.

Most money has been poured into teaching language arts with lots of books and manipulatives for making words. More and more companies are publishing big books written for the math and science areas, but very little money has been spent on purchasing these items.

Many teachers have cleaned out closets and found boxes of unused science equipment because teachers either do not know how to use it or because there was no money to buy the consumable parts of kits. In my school corporation, the teachers' manuals were bought for each teacher, but no student workbooks were

purchased for either math or science. One big flip chart for science and one flip chart for math for three teachers to share were purchased. Of course, the charts are never in your room when you want them, and they are damaged as a result of being moved all of the time, so they usually are used by just one teacher or not at all. Three years after the science series was adopted, the teachers received a CD with songs on it that were written on the charts and a book of worksheets that could be reproduced. During that same time we received a set of cassette tapes with songs that go along with our math series.

It is difficult for teachers to buy consumables for the science kits because teachers often do not know where to buy the consumables or do not need the large quantities that companies offer. And of course, there is no fund for teachers to use so they usually have to spend their own money. Once a year teachers are asked to give a "wish" list to our principal, but we never know exactly how much money is available and therefore, what items each teacher will receive. In addition, teachers do not receive the items until the next school year.

Many teachers feel inadequate to teach science because it has been some time since they were in a science class. When you do not use something like science terminology for long time periods, you tend to forget it. This does not mean that you are incapable of learning or teaching it, but that you might need to refresh your knowledge and skills. Teachers with adequate materials, enough time, and good classroom and science experiment management skills can provide students with an excellent science education with inquiry teaching methods. We teach by using investigation, critical thinking, imagination, intuition, playfulness, and thinking on your feet and with your hands in other subject areas as well as science. As teachers become involved in real science experiments in the classrooms, teachers will seek additional science content knowledge. The information we seek will be directly related to our needs as science teachers and so it will be useful and it will be remembered.

In the field of technology, money has been spent to buy one or two computers for each classroom and some site licenses or pieces of software, but there has been very little money spent on professional development. Our school has had a few five to ten minute training meetings for teachers. These meetings are "taught" by the technology person (usually going through training himself/herself) who does not know much more than the people being trained. Teachers are trained to use the computer, often from the back of a group of "trainees" gathered around the machine. We need the time to work with the machine while the trainer is still there to help and answer questions. Training sessions need to be given by a thoroughly trained person in a computer lab with enough time to go through the whole program and then have time for the people to practice and become familiar with the program or equipment.

Today's teachers need the time and money for hands-on learning activities so that teachers and students can learn from each other in the fields of science and technology.

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