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Luz: Poetry and the Physics of Light

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Introduction

Why do I want to write a curriculum that gives emphasis to physics in everyday life? I work with a population of students who are identified at risk of academic failure due to low socio-economic, cultural and linguistic reasons. The population of students in my school is over 70 % Hispanic first and second generation in the United States. Although, Hispanics in their country of origin have developed and use technology and science, this is a group that is underrepresented in the sciences in the United States. I hope that my involvement in learning about physics, developing and teaching a curriculum unit will serve as a model for further implementation of scientific inquiry at the primary grades level. In addition, as a Hispanic woman I can serve as a role model for my students to venture in science and perhaps pursue scientific endeavors as adults. As a curriculum and staff developer for a science-based program I must encourage the use of best practices for the implementation of both, scientific method and effective pedagogy. My role requires that I model teaching strategies and help teachers of English Language Learners to enhance the learning experience of their students. However, for an individual who is a researcher in Education but not a science major a seminar such as "Physics in Everyday Life" will enhance the possibility of developing a sound curriculum unit in physics.

I intend to write a curriculum unit that explores natural and artificial light in the context of the school and everyday life elsewhere. To do so I want to look at the possibilities of finding light in nature and would like to explore how does it affect my students' lives. In addition, I would like to understand the physics explanation for the phenomenon of light. Let me elaborate on this concept. I am aware that light is a phenomenon in nature and that it involves an interaction between what I am capable to see and what is present in nature or generated artificially. But am I capable to explain how this interaction occurs? This is precisely what I want to understand so I can teach my students. Furthermore, for scientific inquiry to occur students must be able to explore the phenomenon of study therefore is imperative that I feel comfortable so I can encourage exploration. Finally, as an introduction to physics this unit will have a focus on light but I will utilize poetry to introduce concepts that otherwise might be too obscure for a young mind.

The first grade curriculum covers a unit on weather that can be expanded by the study of light. Exploring light as a physics phenomenon could be a challenge for first graders yet this is not impossible. A soviet psychologist, Lev Vygotsky, has spoken of the possibility of learning from more capable peers or adults by providing scaffolds that will enhance the learning by assisting the understanding (Tharp & Gallimore, 1987). It is in this fashion that I propose that small children may learn new and difficult concepts.

Another pedagogical tool that I propose to use is the scientific method. Providing students with a structure and a common language they can make their own. Thus, they will own the behaviors and the thinking process that will allow them to make science a reality in their life.

In addition, all of my students will be exposed to this unit within a second language context therefore I intend to use poetry to bridge the gap between what they already know and the new concepts. Furthermore, poetry can serve as a scaffold for content that can be concise, deceptively simple and often highly charged with emotion (Richard-Amato, 1996).

My Students and My Community

Who are my students? They are English language learners (Ells), Spanish language learners (Slls), and balanced bilingual children whose heritage language is Spanish. The Ells are Spanish speaking children whom come from the Caribbean, North, Central, and South America. Among the Caribbean proceeding students we have children from Puerto Rico and Dominican Republic. The North Americans are my Mexican students who still have very strong ties to their heritage and their families whose main language is Spanish. From Central America we service children from Guatemala, Honduras and Panama. And finally, South American children are form Ecuador and Peru. The Slls are English speaking children some who are African American and most whose heritage language is Spanish. The Balanced bilingual students are also Hispanics with a strong background in both the English language and the Spanish Language. Almost 80% of our population receive reduced lunch fee or free lunch. Moreover, we have one of the largest percentages of limited English speaking students in the district and most of our population has at one point participated of bilingual transitional services.

We have a very strong parent group who uses the school as a vehicle to understand mainstream America. Therefore, it is my hope that the learning in the classroom will permeate to the homes of my students. Furthermore, I expect that this will provide an exchange of ideas between parent and child that will enhance and expand my students' learning.

Specifically the groups of students who will participate in this unit are enrolled in a dual language program. The dual language program has been designed to give students the opportunity to become fluent in a second language. Yet it is expected to be a rigorous program that will enhance the academic achievement of students in their first and second language (Espino Calderon & Minaya-Rowe, 2003). What's more, it is expected to provide equitable opportunities for minority students to access the curriculum and to become interested in science (Evans, 1996). In other words, my instruction must take into consideration the academic, cultural, and linguistic needs of my students (Ovando & Collier, 1996).

The Unit

My intent in writing this unit is to address an important and critical issue in education and in my own classroom. All of my efforts to find a way to convey and help students process information are in an attempt to help them think. When I talk about thinking I refer to Thompson's and Zeuli's (1999) definition of thinking:

> *"By "think", we mean that students must actively try to solve problems, resolve dissonance between the way they initially understand a phenomenon and new evidence that challenges that understanding, put collections of facts or observations together into patterns, make and test conjectures, and build lines of reasoning about why claims are or are not true. Such thinking is generative. It literally creates understanding in the mind of the thinker. Thinking is to student's knowledge as photosynthesis is to a plant's food. Plants don't get food from the soil they make it through photosynthesis, using nutrients and water from the soil and energy from sunlight. No photosynthesis, no food. Students do not get knowledge from teachers, or books, or experiences with hands-on materials. They make it by thinking, using information and experiences. No thinking, no learning-at least, no conceptual learning…" In Darling-Hammond and Sykes pp346.*

In the end I do not want to loose sight of the purpose of my teaching. I want my students to become learners who can think, question phenomena, and can apply their learning to everyday life.

This unit will emphasize students' performance in scientific inquiry. Through the exploration of light I intent to expose them to the scientific method. I want them to observe, pose questions, make predictions, observe some more, document their observations, and finally come up with answers. Thus, this unit focus will be on designing activities that will encourage inquiry processes as a group but also as individuals. Following you will find an outline of the unit. Immediately after I will discuss the physics background needed to help students explore each topic.

The Unit Outline

I. The scientific method
II. What is light?
III. How can we make waves?
IV. The Human Eye
V. Why are colors everywhere?
VI. Can light bounce? Reflection
VII. Can light break? Refraction
VIII. Can light bend? Optic Illusions
IX. Where is the light? Shadows
X. How do cameras work?

XI. What is energy? Light and electricity
XII. What is physics?

Through literature I want to introduce the use of drawings and poetry for students to express their observations. At this level this is an ambitious endeavor but a possible and exciting twist to the study of physics. After reviewing available literature to introduce this topic I realized that the non-fiction materials would serve as explanation but not as the hook to get my students attention. What I intend to do is to expose them to a book of poetry about light called "Flicker Flash" written by Nancy Davis and illustrated by Joan B. Graham. This book takes the children in a journey to explore light in nature and man made light through poetry. I see it as a great opportunity not only to enhance my students' scientific development but at the same time I can enhance their literacy skills. My final project will be to create a class book of poems about light from my students' observations of the various hands-on experiments we will conduct in this unit.

In trying to form my idea, I want to introduce the concept of light as a phenomenon. I must introduce to my students the concept of physics as a science that explains how things work. I would like to make this a hands-on unit in which my students can explore through simple experiments. In the exploration process the students will be able to learn the concept and about the scientific vocabulary related to it.

Prior to starting the study of light I want to teach them about the scientific method. I want them to learn more about posing questions and setting up experiments to answer those questions. Likewise, I want them to understand the importance of structured observations that have a specific objective. In addition, I want them to learn to make predictions and to purposely inquire to find out if they were accurate. Moreover, it is my hope that they will be able to understand that to err in predictions is not to fail but that it is part of the learning process. Furthermore, I would like to see them understand how they can apply conclusions to their everyday life (i. e. seeing light as a valuable resource for humans, animals, and plants). Finally, I want them to observe, hypothesize, test and study results while they are having fun; playing but in fact experimenting (Ransford, 1997).

The concept of light may be abstract for six and seven year old children to understand. The intent of this unit is to provide the necessary scaffolds to help students understand some of the characteristics of light as a physics phenomenon and to promote my students interest in science.

The Physics Background

To implement this curriculum it is imperative to understand the physics concepts explored by the unit. In an attempt to understand this concepts I have written concise explanations about each of the topics in the unit. In addition, I will include any other concepts that may be needed to understand the concepts introduced.

Light (Department of Energy, 2003; Taylor, 1992).

Light is a wave of energy that does not need a medium to travel. It can travel as fast as 186,000 miles per second. It is a combination of electrical and magnetic energy that seems to travel faster than anything else does in the universe In fact light is so fast that even though the sun is so far from Earth it only takes solar light eight minutes to reach us. One interesting fact about light is that it slows down when traveling through substances such as glass, water, etc. There are several ways to think of light. The classical description says light is an electro-magnetic wave. This means that it is a varying electric and magnetic field, which spreads out or propagates from one place to another. It is not a physical substance. The modern quantum mechanical description says that light can also be considered to be particles called photons. These carry energy and momentum but have no mass. In both descriptions, the light energy is carried by a very real and observable mechanism Light can bounce, bend, refracts into many colors. It helps us see. Man has found ways to produce light but it is a phenomenon that is present in nature. The sun, our own star is an important source of light.

Sources of light (Kerrod & Holgate, 2002).

Light is present in many forms in nature from insects to our own star, the sun, we can see light all around us. Throughout history the humans have cherished light, first by worshiping it and later on by making light our selves. From striking stones to rubbing wood and later on striking metals. Friction is then a source of light that whether it is caused by nature of by humans the sparks that result from it can be use as a source of illumination. It is true that we not only have use light for illumination we also needed to keep warm. Our main source of light, the sun, it is perhaps one of the most important resources for life as we know it. It not only sheds light but it is a source of energy. Furthermore, many ancient civilizations worshiped the sun. But we find light in other natural sources such as: other stars and some plants and animals can make their own light. An interesting occurrence of light in nature is a flame that results from methane gas bubbles from rotting plants that rises to the ground surface and interacts with phosphine another gas from rotting animals. This chemical interaction produces a quickly moving flame when it interacts with air.

Due to its presence in nature and their need of energy and illumination, humans made the study and development of technology related to light a scientific endeavor. In ancient civilizations oil of different kinds were used to make lamps, torches, matches, and beeswax candles were invented. More recently, the incandescent light utilizes electricity and a filament to produce light. The interaction of atoms of a gas produces light in florescent light. In conclusion, this electromagnetic wave composed of tiny particles of energy called photons is an important resource.

Natural and artificial light, have much in common. Similar chemical reactions must be present for light to be produced. For example, the sun and an incandescent light bulb produce light when atoms are heated and release some of their thermal vibration as electromagnetic radiation. The difference is that one is present in nature and the other was invented and made by humans.

How can we make waves? (Smith, 1996).

A wave can be described as a disturbance that travels through a medium from one location to another location. One can observe how waves are form on water by applying disturbances such as throwing a pebble in a bucket; the rings formed in the water are waves. Such a demonstration may be useful in presenting this concept to students.

The Human Eye - Receptors

Our anatomy has equipped us to see light. Our vision requires an anatomical structure to perceive light. Although we can't in fact see light as it is due to its speed we posses the capacity to see some of it. Visible light is a complex phenomenon that needs to be explained taking into consideration both anatomy and physics. The fact is that light bounces and our eyes are capable to perceive that bouncing of a speedy phenomenon. Another fact is that for us to see the spectrum of light waves we need technology. Diffraction glasses, prisms, water and other materials or technology that slow down light allows us to see a truer picture of what light looks like.

Light and color (Burton & Taylor, 1998).

Light is similar to other electrical and magnetic energy or electromagnetic waves in that it has different wavelength. For example white light appears colorless but in fact it is composed of colors that have different wavelengths. When it travels fast it appears as white but when slow down one can see the different colors in it. A good demonstration of this would be to send a beam of white light through a prism one can see a spectrum of colors present in white light. This demonstration is present in nature when sunlight beams pass through drops of rain it forms a rainbow.

Reflection, light can bounce! (Burnie, 1992).

Because light bounces when it encounters an opaque surface we can control it and directed towards objects that allow it to bounce such as mirrors and other objects. Minerals such as metals create a reflection. This can be seen in the moon and how it reflects the sunlight. The reflection produce by the bouncing light makes object appear shiny.

Can light break? Refraction (Burnie, 1992).

It does not break in fact it bends, which is called refraction. Light travels through space very fast in a straight line but when it encounters transparent materials through which it can travel it slows down. Apparently light goes through transparent materials but as it slows down it bends; bending depends on the characteristics of the material through which the light ray travels. Another interesting way of slowing light is by introducing air at different temperatures. The speed difference bends light rays. Depending on the temperature the light is bent by different amounts making it more visible. Perhaps you can remember when traveling in a highway how we can see it shimmering as if it was wet. What you see is a sunlight mirage cause by the difference in temperature. It works like this: the dark asphalt absorbs heat from sunlight and heats the air directly above it. Warm air directly above the road and cooler air above that form two layers of different temperature. Warm air is less dense than cold air and light travels faster in the thinner air, therefore light travels differently.

Lenses (Burnie, 1992; Glover, 2001).

Lenses are a way that inventors and physicist have manipulated refraction to utilize it in everyday life as well as in experimentation. Lenses are curved pieces of transparent materials that can refract light in a particular way. Lenses have been use to correct vision by changing the direction of the light rays; with concave lenses objects appear reduced. On the other hand you can see how the lens utilized in a lighthouse gives a strong beam of light because is a convex shaped piece of glass or clear plastic. In microscopes and telescopes, lenses collect light and focus it into the eye.

Light can bend, Optic Illusions (Kerrod & Holgate, 2002; Nature News Service / Macmillan Magazines Ltd 2002).

This bending effect can create optical illusions. The truth is that it is our brain that interprets what we see. Perception plays an important role in creating optical illusions. Utilizing color and lines we can create multiple illusions that will fool our brains into believing what we see even if it's not true. Illusions are then created by our brain as a coping mechanism to make sense of an image that is not fully understood. Einstein suggested that the force of gravity could bend light so that the gravity of planets and stars make them act as big lenses in the sky. In other words solid bodies in the space can in fact distort light waves. Recently a team of researchers, Sergei Kopeikin of the University of Missouri in Columbia and his colleague Edward Fomalont of the US National Radio Astronomy Observatory in Charlottesville, Virginia, used a network of radio telescopes in the United States and Germany to test this phenomenon. While looking at a quassar (a strong source of waves in the universe) near Jupiter they saw how the light appeared to come from another point in the space, thus showing that in fact the gravity of planets can make them act as lenses that bend light.

Shadows where is the light? (Richards, 1999).

Shadows are the silhouette of an object that is blocking the path of light. The shadows stretch away from the object and in opposite direction from the light. An object that does not allow light to travel through is called opaque. Examples of these objects are wood, rock, or our own bodies. Eclipses are the result of a shadow created either by the moon or the Earth blocking the sunlight. One very interesting phenomenon is how shadows could be use to tell time. From simple sighting to creating sundials the shadow and positioning of the sun in our sky can help us tell time.

How do cameras work? (Smith, 1996; Taylor, 1992).

Our eyes allow light to pass through an opening called pupil, the image then is projected inverted. A nerve called the optic nerve connects the retina with the brain. The camera is a light proof box that has a shutter, which prevent light from entering into the film chamber. Photographic cameras work with a photo sensitive (sensitive to light) film that allows for a picture to be imprinted. Other cameras like television cameras or camcorders allow the image to be processed in such a way that they can be projected similar to the eyes. Photography works by allowing light into the camera. Once the image is imprinted in the film we can then print them on paper.

What is energy? Light and electricity (Burnie, 1992; Kerrod & Holgate, 2002).

Lightning is a very interesting way of seeing the light that is produced by electricity in nature. A spark is produced by water and ice particles colliding and becoming charged by electricity. This amazing source of light is produced when an electric spark in the clouds makes the air ionized or so hot that it glows. Thus, lightning is a good example of a source of light due to heat. Another amazing process is the energy that plants absorb from the sunlight on a daily basis. Solar energy can also be used to power cars, telephones, calculators, water heaters, etc. Solar energy can be used as heat or by converting it to electricity.

What is physics?

Physics is the study of the nature of basic things such as motion, forces, energy, matter, heat, sound, and light. Physicists study a wide range of things. Black holes, atoms, engines, elevators, and baseballs all obey the laws of physics. Physics is about finding things out and understanding what lies behind every-day phenomena like rainbows, red sunsets and blue skies as well as the more revolutionary concepts of quantum theory, relativity, and cosmology. One of the key ideas in physics is that, behind the complexity of the world around us, there is an underlying simplicity and harmony in nature. Thus, physicists study nature to understand and manipulate the laws that govern it.

In conclusion the study of light is complex but extremely interesting. The explorations that this unit will bring about should not only teach my students science. In addition, it should allow for me to comprehend the processes necessary for me to teach such an abstract concept.

Lessons

First Lesson

The objective of this lesson is to review the scientific method. Through center activities the students will apply scientific process including observing, recording, sorting, classifying, measuring, predicting, collecting, and interpreting data. I will provide each student with a folder for recording information from all the centers. Students will be recording all throughout the activities provided.

The observing center will require the students to look at pictures of the sky (night and day) and to make their own picture of the sky. The night sky will have stars and the day will have the sun. This will be in an attempt to get the students to observe these sources of natural light and record it in their drawings. The question to be answered in this center is what do you see?

The sorting center will have a set of pictures or objects that the students must sort as natural light or man made light. This center requires an adult to help the students sustain a conversation while sorting. In order for the students to agree on the type of source they must identify what makes it natural or artificial. The questions to be answered in this center should be what is natural light and what is artificial light, and how are they different? Once the students are able to sort the different sources of light they write the two lists of sorted objects on their recording folder.

An interesting center will be the classifying center where the students will be talking to their peers about how different light sensitive objects and battery operated objects may work. For example, I have a "bird" I purchased in Chinatown many years ago that is light sensitive. When the light enters the bird box we can hear it singing. I can also use calculators that use light to function, among other objects. The recording for this center will require adult assistance. The question posed will be: "How do you think this works?" The importance of this center is the students trying to explain how the light may affect the object to make it work. The classifying stage of this center will be on whether the object uses light or another source of energy to work.

I want students to create a sundial at the measuring center. Although they would not be doing the measuring in the classroom they will have the opportunity to see a model of a sundial and create their own. The sundial will be used outside at different times of the day so they can measure the daily movement of the Earth. To help them determine the accuracy of their sundial the students will compare their own findings with those of their peers. In addition, they will write the time as measure by the school clock and compare to their own.

I will conduct an instructional conversation with the students with the topic: What is the scientific method? My intent in this conversation would be to help the students debrief on the centers they have visited in order to understand the process of inquiry and the importance of posing questions, predicting, observing, recording and so forth.

All of these activities will take place in an hour and a half period. This will require 15 minutes per activity and allowing 15 extra minutes for rotating and any other management needs. The debriefing can be a whole group activity or a small group activity. I have chosen an instructional conversation for the debriefing to use it as an assessment tool. This lesson is preliminary so I can determine my students needs before I start with the unit. In addition, it will help me establish classroom rules and to start developing a rapport with the students. The following day we are going outside to use our sundials. Once we establish that we can tell time using sunlight, then I can generate a discussion on the uses of light.

Second Lesson

The objective of this lesson is to allow the students to measure solar position and to compare to time as measured by a clock. Utilizing the sundials we go outside to mark the sunlight on each of our measuring dials. We will be outside twenty minutes in the morning, after lunch, and in the afternoon. The teacher, assistant, tutor, and I will assist the students in utilizing the sundial. All students will have an opportunity to debrief and record their observations and conclusions.

Third Lesson

The objective of this lesson is to produce sentences describing light. Utilizing the language experience approach I will allow for my students to experience light and then produce vocabulary and eventually sentences to make up poems. First I will make some demonstrations with different sources of light, such as: flash light, candle, etc. Then the group will generate vocabulary, describing light (adjectives). Demonstrations will include light traveling in a straight line. This demonstration can be done by making dime size holes in the center of index cards, turning on a flashlight, and turning off the classroom lights. I can also demonstrate how light can slowed down by the density of substances. Utilizing a glass half full of water and a pen I can show my students how a pencil appears to bend when it enters the water. A prism can help me show how white light contains a spectrum of color. For this to work one has to use a very narrow beam of light. All of these demonstrations should allow for the students to become better familiarized with the concept of light.

Fourth Lesson

My objective is to introduce the concept of light through one of the poems in the book "Flicker Flash". The first poem refers to light as stretched, bend back, flicker and flash, near and far, lamps and stars, tiny and wide as day. This poem will allow the students to explore vocabulary at the same time they are learning some more information about light. I want to do some drama with this poem, get the kids to act out the words and pretend they are light. This will allow them to increase their experience with the vocabulary and will enhance their ability to comprehend and to write their own poems.

Fifth lesson

The objective is to further understand the characteristics of light. During this session we are going to centers again. We are going to explore some of the characteristics of light. We are going to make waves in a tub of water in the classifying center. The students all must observe and record how many waves they each make. Then they can classify their peers in order of who had the most waves to who had the least or vice versa. In the sorting center they are going to make candles (with the help of the teacher assistant) they must sort the materials and make sure that every student has the necessary parts to make the candle. In the measuring center the students will be measuring the beam of a flashlight. The predicting center will involve making a circle divided into triangles and predicting how would it look when they spin it (this center will be with help from the teacher). The interpreting data center will be looking at light through a prism and trying to explain how is it that they can see the spectrum of light. This will be an instructional conversation with me and the question will be: "The light is one color. How do you think we can see many colors ?" In addition, I have diffraction glasses that we can integrate in one of the centers for the students to see the spectrum of light. All of the center activities will include a question that will require analysis and interaction with their peer to answer it.

These are some examples of how one may cover the topics explored by this unit. A final project will include a written collection of poems produced by the students. Following there is a discussion on the historical and theoretical pedagogical framework of this unit.

Historical and Theoretical Framework

In light of the No Child Left Behind education act (NCLB) all instructional services provided to children must be of excellent quality. Well-trained professionals must teach children challenging curricula. The Guiding Principles of No Child Left Behind are the following. 1) Accountability for results - all states must implement statewide accountability systems that will set academic standards in every subject and identify strengths and weaknesses in the educational system. 2) Focus on what works - the federal government will invest in educational practices that have proven effective in increasing student performance and expect local educational and state agencies to do the same. 3) Reduce bureaucracy and increase flexibility- state and local officials will have the flexibility to find local solutions for local problems; principals and administrators will spend less time dealing with federal red tape, and more on student achievement; and

parents and guardians are empowered to make sure that their children received the best education. They will be informed about the quality of their child's education and school, and can take action based on a school's performance (NCLB, 2002).

The National Science Standards

The standards for content in science are critical in designing and implementing this curriculum. Starting in the earliest grades, students should develop the abilities of doing science by exposure to experiences that enhance their opportunities and engagement in the active construction of ideas and explanations. Inquiry-based science teaching will provide me with the opportunity to develop my student's abilities and understanding of science. In addition, my students should do science in ways that are developmentally appropriate according to their capabilities. In order to accomplish this I have taken into consideration the science content standards appropriate for students in grades K-4. The standards for content in science were issued by the National Academy of Science, seven areas of instruction are identified as important science as inquiry, physical science, life science, earth and space science, science and technology, science in personal and social perspectives, and history and nature of science. This unit will focus on the first standard - science as inquiry and will briefly attempt to address standards B, and D - physical science, and earth and space science.

Science as inquiry based requires that students plan and conduct simple investigations. In addition, it should allow students to employ simple equipment and tools to gather data and extend the senses. Furthermore students must be given the opportunity to use data to construct a reasonable explanation. Finally they must be able to communicate their investigations and explanations to others.

I am also going to include information that will allow my students to explore physical science. As a result of the activities my students should develop an understanding of some of the following concepts: properties of objects and materials, position and motion of objects, light, heat, and electricity. According to the National Academy of Science, physical science in grades K-4 includes topics that give students a chance to increase their understanding of the characteristics of objects and materials that they encounter daily. They content that through the observation, manipulation, and classification of common objects, children reflect on the similarities and differences of the objects. As a result, their initial sketches and single-word descriptions lead to increasingly more detailed drawings and richer verbal descriptions. By experimenting with light students may begin to understand that phenomena can be observed, measured, and controlled in various ways.

I will also address earth and space science and as a result my students should develop an understanding of properties of earth materials, objects in the sky, and changes in earth and sky. During the first years of school, they should be encouraged to observe closely the objects and materials in their environment, note their properties, distinguish one from another and develop their own explanations of how things become the way they are. As children become more familiar with their world, they can be guided to observe changes, including cyclic changes, such as night and day and the seasons; predictable trends, such as growth and decay, and less consistent changes, such as weather or the appearance of meteors.

The Standards for Effective Pedagogy

The Center for Research in Education, Diversity, and Excellence (CREDE) researchers have provided the educational community with a consensus for practice that is comprehensive and therefore allows for flexibility in its implementation. The array of techniques that are available to teachers can be overwhelming due to its complexity; CREDE has streamlined the possibilities. Standard-based instruction would be incomplete if we only looked at student performance standards without considering the importance of pedagogical standards. Since 1999 I have used and promoted the use of the Five Standards for Effective Pedagogy (5STEP) issued by CREDE. These standards are issued as a result of the work done by educational researchers associated with CREDE. Teachers have used these standards across time and program boundaries. Separately these standards may be useful but as a unit composed of five important dimensions in teaching they are indispensable if we are to help every child reach their potential. Specifically, the standards are joint productive activity, language across the curriculum, contextualization, challenging activities, and instructional conversations (IC).

Stoll Dalton (1998), as well as many other practitioners and researchers propose that pedagogy in fact occupies a central place in accomplishing all student learning. In addition, many contend that pedagogy that is supported by a strong learning theory can in fact enhance the teachers' abilities to reach every student.

"The standards for effective pedagogy are based on the socio-cultural theory, a theory of development that is ideally suited to the study of education. It provides a flexible, inclusive integrative lingua franca for social science's plethora of mini-theories and hypothesis, preserving the close fit between disciplinary theories and inquiries but uniting them into an overarching intellectual architecture (Tharp & Gallimore in, Estrada, Stoll Dalton, Tharp, Yamauchi, Page 9, 2000)."

Resources for Teachers

American Astronomical Society (2003). Speed of gravity and light equal: Einstein's theory of general relativity passes quasar test. http://www.nature.com/nsu/030106/030106-8.html. This is an article that can serve as an interesting source of professional discussion among colleagues.

Ask the physics van http://van.hep.uiuc.edu/van/about.htm This is a web site publish by the University of Illinois Physics Department as part of an outreach project. Physics students are available to answer question posed by kids, parents, or any other who is interested in getting good and simple explanations of physics concepts.

Cassidy, J. (1991). *Explorabook: A kids science museum in a book.* Klutz Press: PaloAlto, CA. A simple and clever book that answers questions by exposing children to an exploration of several topics such as: magnetism, light waves, illusions, and many others.

DiGiovanna, J. (1996). *Space jam: Eye illusions.* Modern Publishing: New York. This is a book of incredible optic illusions. Lines and color play a trick on your eyes and you can see depth where there is a flat surface.

DiSpezio, M. (1999). *Awesome experiments in light and sound.* Sterling Publishing: New York. An extensive book on light and sound with student-friendly experiments. This book poses a question for each topic covered and then proceeds to recommend exploration to answer the question.

Engelbert, P. & Dupuis, D. L. (1998). *The handy book of Space.* Visible Ink Press: Canton, MI. This book is extensive. It poses questions for which it provides brief explanations. It has relevant photographs and illustration all in black and white.

Espino Calderon, M. & Minaya-Rowe, L. (2003). *Designing and implementing two-way bilingual programs: A step by step guide for administrators, teachers, and parents.* Corwin Press, Inc.: Thousand Oaks, California. This is a practical book that will help the reader guide the selection of materials and pedagogical strategies for the dual language classroom.

International Reading Asociation (2002). *Second language literacy: A position statement of the International reading association.* Describes the position that the association has in respect to literacy instruction for second language learners.

Kerrod, R. (2002). *How science works: Discover the secrets of science with exciting, accessible experiments.* Dorling Kindersley Ltd.: New York. An excellent background book with scientific information, historical connections and sample experiments that will help any adult enhance children's understanding of science. In addition, the pictures and information are up to date and it looks very attractive.

Klutz Press Editors. (1996). *Shadow games: A book of hand and puppet shadows.* Klutz Press: Palo Alto, California. This is a book that can be lots of fun. The authors recommend to turn down the lights, turn on the flashlights, and bring on the show.

Knapp, B. (1991). *How Things Work.* Grolier Ltd.: New York. A good and practical book with great drawings geared to clarifying concepts of physics and mechanics. Very good for children and for adults seeking a visual tool for clarifying these type of concepts for children.

Macaulay, D. (1998). *The New Way Things Work.* Dorling Kindersley: Toronto. This is a book and CD in which you can find many answers as to how things work. The CD has sound and is very simple to operate by adults as well as by children.

National Research Council (1996). National science education standards. www.nap.edu/readingroom/books/nses/html3.html This is a description and explanation of the national standards for science education including the science teaching standards. These standards are similar to state standards and your district's framework may be structured differently but similar to these.

Ovand, C. J. & Collier, V. P. (1998). *Bilingual and ESL classrooms: Teaching in multicultural contexts.* McGraw Hill Publishers: New York. This is an academic book on general knowledge about bilingual classrooms.

Paraquin, C. H. (1987). *The world's best illusions.* Sterling Publishing Co.: New York. This a black and white book with plenty of illustrations that show optical illusions created by straight contoured lines.

Richard-Amato, P. A. (1996). *Making it happen: Interaction in the second language classroom, from theory to practice.* Addison Wesley Publishing: White Plains, New York. This is a great book, it contains good ideas to promote interaction among students in the second language acquisition classroom.

Science Made Simple Educational Magazine www.siencemadesimple.com This is a website that is very good for teachers to find answers to simple questions and also full units can be view. The units take a specific question and build a unit using scaffolds that build the understanding of the scientific concept behind it.

Smith, A. (1996). *El gran libro de los experimentos.* Usborne Publishing: London.

This book is a translation of a book written by Smith in English. It is extremely simple with step-by-step experiments and explanations. The illustrations are magnificent and motivating for young scientist.

Thompson, C. L. & Zeuli, J. S. (1999). The frame and the tapestry: Standard-based reform and professional development. In *Teaching as the learning profession: Handbook of policy and practice.* L. Darling-Hamond & G. Sykes, Editors. Jossey-Bass Inc.: San Francisco. This is an excellent book for best pedagogical and staff development practice.

VanCleave, J. P. (1991). *Janice VanCleave's physics for every kid: 101 easy experiments in motion, heat, light, machines, and sound.* John Wiley and Sons: New York. This is a practical book with good experiments and some explanations. It has few illustrations but is very good for teachers to design experiential activities.

York, P. *Experiment cards.* Dorling Kindersley Ltd.: London. This is a book of illustrated and step by step direction for quick and easy experiments.

Reading List for Students

Branley, F. (1986). *What makes day and night?* HarperCollins Publishers: New York. This book has very simple text good illustrations and some photographs. It is very good to for kids to read some background information on the Earth and Sun. It also has some simple suggestions for exploring.

Bransfield Graham, J. (1999). *Flicker flash.* Houghton Mifflin Co.: New York. This is a beautifully illustrated book of poems for children. This book has poetry inspired by sources of light including those present in nature and artificial life. The poems are simple, concrete and fun.

Burnie, D. (1992). *Light: Eyewitness science.* Dorling Kindersley Ltd.: London. This is one of the best resources I have found for kids with assistance. It has good short explanations and good illustrations about the sources of light. It includes history as well.

Burton, J. & Taylor, K. (1998). *The nature and science of color.* Gareth Stevens Publishing: Milwaukee, Wisconsin. This is a book with good photographs of colors in nature. The text is good and simple but first graders would need assistance with it.

Cobb, V. (2002). *I see my self.* Harper Collins: Scranton, PA. This is a children non-fiction book that explores reflections on mirrors, nature, and shiny man made objects. It is a pretty book that presents a non-fiction topic with beautiful drawings appropriate for young children.

Cooper, J. (1993). *Light: Secrets of science.* The Rourke Coporation Inc.: Vero Beach, Florida. This is a non- fiction book that is available both in English and Spanish. The photographs are magnificent and the text is simple but challenging.

Ehlert, L. (1992). *Moon rope.* Harcourt Brace & Co.: New York. This book is an adaptation of a Peruvian legend called "The Fox and The Mole". It is a story about these two animals fascination with the moon. The illustrations are made so they look like pre-Columbian designs, this could be a great inspiration for children to create geometrical designs.

Glover, David (2002). *Sound and light: young discoverers science facts and experiments.* Houghton Mifflin Co.: New York. This is an interesting book that can help both teacher and students with simple explanations and some hands-on activities. Helping young discoverers learn science facts and experiments about light and sound. The text and illustrations are simple and attractive. It is recommended for young readers, ages 4 to 8.

Palazzo-Craig, J. (1996). *How night came to be: A story from Brazil.* Troll Communications: New York. This is another mythological story of the daily passage of daylight to darkness came to be.

Palazzo-Craig, J. (1996). *When sun ruled the land: A story from Cuba.* Troll Communications: New York. This is a legend from Cuba. Its simiple text retells a story about creation and how day and night came to be.

Richards, J. (1999). *Science factory: Light & sight.* Aladdin books Ltd.: New York. This book examines the basic aspects of light and more complex and practical uses. The projects included are design to expand the scientific knowledge of the reader and to help them understand the subject better.

Taylor, B. (1992). *Focus on light.* Aladdin books Ltd.: New York. This book brings the reader to a closer look to light through art, science, history, geography, literature, math, and the natural world. It includes fascinating facts and practical projects that are fun and easy to do.

Tichnor, R. & Smith, J. (1994). *A spark in the dark.* Dawn Publications: Nevada City California. This is a mythical book about the sun. Completely non-fiction offers a new perspective for how the sun came to be.

Wood, R. (1999). *The McGraw Hill big book on Science activities: Fun and easy experiments for kids.* McGraw Hill Publishers, New York. It helps children to understand the wonders of nature and advances in science through activities.

Resources for Manipulative Materials

Educational Innovations, Inc. (2002). Educational Innovations, Inc.: The master teacher's source for science workshop supplies and super, wow, neat science products! Available: www.teachersource.com This catalog can be also order by phone at 888-912-7474. It includes a light kit that has a variety of color lenses. Also there are other products such as prisms and mirrors that are fun and safe for exploration in the classroom.