"Light, Color and the World Around Us!

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Rationale

I have always had a fascination with two things in my life: growing plants and outer space. I love to grow and take care of plants and I love studying about things outside our world in outer space. Having both of these two hobbies in mind, I began to look for a connection when I started to write this unit. The things that I felt best connected these units were both light and color. When I started to look at the curricula I was expected to teach in my classroom, I realized that the third grade science curriculum in North Carolina offered me a chance to experiment and share both my love of space and plants with my students. I was very excited. At the third grade level, I will have the ability to do a broader unit, over two quarters, focusing on aspects of both color and light as they relate to both the study of space and plants as the backbone to address the North Carolina learning objectives in a fun, creative and meaningful way for my children and me.

I have always loved plant life. The diversity of colors, shapes and types of plants I have in both my classroom and around my home abounds. I have always considered myself a green thumb, and now I would have a chance to share my plant and flower growing experiences and my love of nature with children. In third grade, students are expected to complete a unit called “Plant Growth and Adaptations.” In that unit, five of the six North Carolina learning objectives under that specific goal are tied to “light,” as the primary source of energy growth for plants. The beautifully diverse colorations of plants and flowers is something that has developed over millions of years mainly to achieve some very basic goals: 1) photosynthesis for the production of simple sugars as food and 2) to help attract animals to allow animals to assist in pollination and dispersal of their seeds. My study of light and color directly supports these objectives.

Since about the age of five, I also have been enthralled with the stars. The vastness of the universe is something that most people have a hard time comprehending; however, if you start to talk about light and color even small children can comprehend these basic concepts when presented with an opportunity to “experiment.”

My love of the wonders of the universe began as a small child and my first exposure to the work of the astronomer Carl Sagan and the science fiction movies and television series of my childhood, such as “Star Wars, Star Trek and Battlestar Galactica.” I marveled at the idea of stars and other worlds existing in a multitude of colors, not just yellow, the color of our sun. I often wondered what colors strange new suns and worlds might be.

With NASA’s launch of the Hubble Space telescope, I was totally blown away and astonished by the color-enhanced pictures from across the universe. NASA’s two “Voyager” spacecraft have taken a multitude of pictures that have also captured my attention. It is with this in mind that I began to consider “color and light” and its relationship to the 3rd grade curriculum standards in science in “Objects in the Sky.” Considering that learning goal, my seminar research will allow me to tackle four of the six North Carolina learning objectives in ways that will also be enjoyable, imaginative, and important to my students’ learning.

In my personal unit, I will focus on teaching my third graders about the basic principles of light as they relate to reflection, refraction, absorption, transmission and scattering. I will cover the colors that make up the visible spectrum, and discuss basic principles of light and color as they relate to plant photosynthesis and to objects in the sky, through grade appropriate learning activities.

Introduction

I have taught for the past 16 years in a variety of settings. I have served both urban and suburban student populations. I also have taught every age group from Kindergarten through graduation. This has given me a very good insight into what children are expected to learn at a variety of different ages. In that time, aspects of the “light unit” always seem to come up in the curriculum in a variety of ways.

Currently, I teach general elementary science at Barringer Academic Center (BAC) a medium-sized, urban school in Charlotte, North Carolina in a laboratory setting. My school is classified as a “partial-magnet” school, which serves approximately six hundred and fifty students in total from Kindergarten through Grade Five. My school is also a “Finding Opportunities; Creating Unparalleled Success (FOCUS) School” because approximately 70% of our student population receive either free or reduced lunch. Likewise, the school has achieved “Adequate Yearly Progress” only once in the past five years.

One-third of the student population has been labeled as “Gifted and Talented” and therefore is enrolled in either the “Horizons” or the “Talent Development” (TD) program. They are bussed in daily from all over the city of Charlotte, and as well from surrounding Mecklenburg County. A majority of these students coming from other parts of the Charlotte area are from more affluent, socially upwardly mobile and culturally diverse families. The remaining two-thirds of the BAC student population are students from the surrounding neighborhoods of the “West Learning Community” (WLC) who come to Barringer Academic Center to be part of the Learning Immersion (LI) Program. Many of these students are from homes characterized as “lower socio-economic class.”

Our selection processes create an extremely diverse community of students from a variety of different racial and socio-economic backgrounds. In our school, the student population is roughly three-quarters African-American. Many families are attracted to my school because of its small class sizes and individualized learning programs. Parents feel peers will more readily accept their children, and that they will receive more one on one instruction. Each individual brings an extremely different set of experiences with him or her, creating a wonderful and sometimes challenging classroom environment.

Students attending my school are required to take science instruction three times a week for 45 minutes per session. All students come through my science lab for one of those three sessions. In the session with me, students explore the concepts they are covering in the classroom with true “hands-on” experiences. This requirement sends every student through my door, and finding a way to reach them all and keep them interested and engaged in the current unit of study is a challenge with many benefits for all. Along with the diverse population of my school, there is a staggering discrepancy in their knowledge of basic scientific concepts.

Some of the students have a strong science background, while others have had very few “hands-on” science experiences of any true measure. This occurs as the result of students being filtered in from many different schools within and from outside the district. My school is one of only about sixteen elementary schools with an actual “hands-on science lab.” The science lab compels me to teach basic scientific principles using the scientific method, making them interesting to all students, whether the concepts are review or brand new.

Objectives

I have several concepts I expect my students to master by the conclusion of my unit. I want the students to have a better understanding of the origin of color. I want them to understand how they see the various colors that they do. I want them to understand how light is involved in the process of photosynthesis in plants. I also want the students to understand how light is reflected, absorbed, transmitted, scattered, and refracted. Lastly, my students will discuss how observed colors of stars in the galaxy are related to the emission of light at various wavelengths.

This unit was designed to span two quarters and to encompass a curriculum based around a variety of “hands-on” learning activities, each 40 minutes in length. Additionally, each of the weekly learning activities has accompanying reading that will be completed for homework. The readings that are assigned become tools for students to build background knowledge of a topic before engaging in a “lab-style” learning activity and resulting discussion.

The reading component of the unit is meant to range from 10-15 minutes for each activity. The readings will be obtained from children's magazines and from various Internet sites. By the conclusion of this unit on light and color, the students will have between 10-12 hours of direct and indirect contact time on the topic, between reading about topics and conducting experiments. This unit was written with third grade in mind. However, it could very easily be adapted and utilized with any elementary child.

Instructional Teaching Strategies

As in a previous unit I composed for a Yale National Initiative seminar entitled "Nutrition, Metabolism and Diabetes," there are a variety of strategies I will use to convey content information to my students. Because my school has such a diverse population, I try to teach every lab activity using a variety of methods that address the differing modalities of my learners while also taking into consideration the "scientific method" for each lesson. There are a variety of ways that I present material in order to reach each of these different learning modalities and these may include charts, review diagrams, models, integration of technology using my "Smart board," viewing "Discovery Education" videos, reading, and discussion of material. No matter how I present the original material, we always conduct hands-on experiments based upon the scientific method.

What is the Scientific Method?

The scientific method is employed in all of the hands-on "lab-style" learning activities that I teach in my science classroom. The scientific method helps to promote higher level thinking skills among the groups in my classroom. It also is a great way to format an experiment to make sure it is a fair test and is objective in nature. I try to make it a matter of practice to incorporate it on a weekly basis. Depending on the experiment, I may have to make modifications to the method; however, I try my best to remain true to form. I want my students to come away at the conclusions of my lessons with correct information on each subtopic of the unit. Because we do a yearly science fair at my school, I often have the students make reference to "sciencebuddies.org" [1] to understand the steps of the scientific method for the exact steps to follow. However for this unit, I have presented how I intend to use them in my unit on light and color. The steps in their simplest form are as follows:

Why start with a Question?

In this unit on light and color, I will have my students start off by completing a unit organizer with me as a class. First, I will have them start off by listing general questions about light and color that they may have based upon things they have already observed or experienced first hand. I think that it’s quite appropriate to start off questions with the words “How, What, When, Who, Which, Why, or Where?”

The unit organizer is a form I have used in my classroom for years that is similar in many respects to a KWL Chart. Next, I will have them list things that they know, to be followed by questions about the things that they would like to learn about. We then will make a list of questions that I want them to try to solve during the course of my unit and that they may not have thought of. To further facilitate learning, we will also make a list of all the necessary unit vocabulary that they need to research and define.

The organizer also has a loose timeline of the unit activities. Moreover, in order for the scientific method to facilitate their discovery of the answers to their questions, students will be reminded to focus questions around things they can observe and measure. Ideal questions are objective in nature and will lead to numerical and graph-able data at the conclusion of the unit.

Why is background research important?

Before the hands-on activities in my science lab, I will have my students do some background research each week for homework. I will assign them reading activities from a variety of formats such as children’s science magazine articles, websites, newspaper articles, etc. The readings that I assign them will form the basis of the overall discussion for the upcoming week’s activity. I will use their initial questions to help me decide what they need to research prior to the experiment.

I will have each class visually scan the readings to ensure we have cleared all relevant vocabulary prior to them leaving class, to ensure proper comprehension when they read at home. In addition, all reading they do needs to be followed up by a summary paragraph in their science journals. It will also give them a chance to pose more questions to me, based upon what they read, but still may not understand. Journaling is something I have them do all the time to reinforce their reading and researching skills.

How do I construct a testable hypothesis?

From our weekly science labs, as well as their experience with the science fair, my students know that a hypothesis is an educated guess, based upon their research, about how something is supposed to happen. I have taught them that a hypothesis can be written in a variety of ways, however the preferred way is using "If _____ [I/We do this] _____, then _____ [this] _____ will happen” statement. This format seems to work the best for what we do at my school.

How do I set up and conduct my experiment to test my hypothesis?

My children compose the hypothesis to prepare them to conduct an experiment that is objective in nature and will give them easily measurable data. The student's hypothesis often gives them a tentative explanation of what was tested, or it may lead to further investigation and experimentation.

When I have students who show that their original is hypothesis correct, I often ask them "What did you learn that you didn't already know from this experiment?" When they disprove their hypothesis, I often ask them "Based upon what you learned where could you take your experiment next?"

Whatever their hypothesis is, it is very important for their experiment to be a fair test. My children often have the hardest time controlling the variables in an experiment. This often results in them conducting a test that would be deemed unfair in scientific circles. The experimental phase often requires me to review their steps and planning several times before I give them an "ok" to go ahead and experiment. I often have to remind them about controls, the independent variable and dependent variable in this phase of the experiments. Changing more than one variable has proved to be disastrous to a young scientists experiment. This in turn can cause them frustration and lost time. My children have been told to repeat their experiments several times. I encourage them to conduct no less than three trials and no more than five; thus, their data is assured to be reliable and not some random fluke or accident.

How does analysis of my data lead to my final conclusions?

Once all of my students' trials are complete, I have them take their collected data and measurements and have them analyze it to see if their hypothesis is true or false. As in their yearly science fair projects, I will remind my children throughout this unit that scientists often find that their hypothesis was false. If that happens to be the case, it is appropriate to compose a new hypothesis and restart the whole process over again. Even if they have done the maximum of five trials, I often ask them if their data is valid. I also make reference to real scientists running a series of trials before something hits the consumer markets or research journals. Once the students have determined that their data is valid, I instruct them to take the collected data and show it visually in the form of a graph.

How do I share my results?

Upon completion of the experimental phases, I will have my students communicate their ideas, summarizations, and final results to me in a several different formats. Their science journals have graph paper on every other page to facilitate this. However, I would also like for groups of students to complete display boards that can be used to demonstrate what they have learned to visitors, fellow peers and parents.

When should I use visuals, models and other diagrams?

In the study of the color, it will be essential for me to incorporate the use of a variety of visuals, videos, diagrams, and models in my lessons. The visual learning modality is so powerful and can often convey information in a way that simple research or the experiment cannot. My lesson diversification helps meet the needs of all learners in my classroom. Visuals associated with light, color and astronomy can be found in the multitude of images in the public domain on any ".gov or .edu" website. This combination of strategies will help my students refine and extend what they are learning in their homerooms and in my science lab.

Instructional Content Background

Light

What is light? Light consists of a stream of particles called photons and can also be described as waves. The source of light (photons) is either natural (a star like our Sun) or artificial (such as a table lamp). These waves are also known as rays. As light travels, it covers vast distances in a very short period of time. Light travels at 300,000 kilometers a second (186,000 miles a second). Natural light sources, such as the sun, have the tendency to generate light waves that travel in straight lines. In the universe, the color of stars is directly related to their surface temperatures. Blue stars for example are the hottest, while red stars are the coolest. There is also a correlation to a star's luminosity. The hotter a star burns the brighter it is. Star colors range in temperature and luminosity from blue, to white, to yellow, to orange, and finally red. Even though a star's luminosity and temperature are related to their color, the size of any particular star may vary. The sun is a star of average size, luminosity and temperature. It is what most astronomers consider to be a stable star. The size of any given star may range in size from what is called a dwarf star to a giant.

Sources of artificial light, such as lamps, seem to have light waves that spread out at a variety of angles. These waves travel through some mediums (water, glass, diamonds etc.) but not all (concrete, wood, etc.)

Light can be produced in a variety of ways. It can be produced electrically, chemically, or through nuclear means, as in the case of the sun. Third graders are expected to know that light is from the visible part of the "electromagnetic spectrum." Infrared light, when it hits an object, is simply discussed as "heat" at that grade level. Light behaves primarily in three ways. It can be reflected, refracted or absorbed. If it is reflected it bounces back (like when it strikes a mirror); if it is refracted it bends (like looking at a pencil through a half a glass of water); or if it is absorbed it heats up whatever it strikes, such as the sidewalk in summer and disappears. Light cannot curve around objects. This is the reason we have shadows anywhere we have a light source.

The electromagnetic spectrum is made up of electrical and magnetic energy. The spectrum is made up of visible light and other kinds of waves, which we can't see, such as gamma rays, x-rays, ultraviolet waves, infrared waves, microwaves and radio waves. My third graders are often amazed when we talk about the electromagnetic spectrum. They have a hard time relating their concept of "visible light" to such things as microwaves we use to heat water for experiments, or the use of our citizen band 40-channel radio. What third graders do find fascinating is the use of prisms to take a beam of wild light through a cardboard slit and separate it in to the "rainbow effect" of colors they can see. When we use a prism to break down visible light we always see the same order – red, orange, yellow, green, blue and indigo. To remember the order of the colors, we use an acronym "ROY G. BIV."

Reflection and Refraction

Reflection and refraction occur every time light interacts with an object that is in the path of it. A reflection occurs when a light source's photons strike an object that they cannot get through and bounce off the object at the angle at which light strikes that item. Examples of items that reflect light are polished steel, clean new paint on a car, aluminum car rims, glass, smooth water, mirrors, etc. Light strikes the object and is bounced off at a specific angle. Refraction occurs on surfaces of transparent substances. It is the blending that occurs when light slows down as it enters a denser medium (air to glass for example.)

Scattering

Scattering on the other hand is different than reflection. Reflection has the tendency to cause light to bounce off an object in one direction, whereas scattering of light by atmospheric particles causes light to be reflected in all different directions, examples include the appearance of a blue sky or white clouds. Scattering may be caused by man-made particles of pollution or water droplets.

Absorption

Absorption of "the color white for example is when something reflects all the colors of the visible spectrum, which is why we see something that is white. The color black on the other hand absorbs all the light rays that strike it and the item appears black. When we view any other color that color is reflected to our eyes and the others are absorbed."[1]

Leaves for example make chemicals in a variety of colors, however when fall comes and photosynthesis decreases, the green color is lessened and the other colors that were masked like reds, yellows and oranges are revealed. Absorption of light waves at particular wavelengths, such as UVB or UVA can be used in the care of pet reptiles, due to the fact that the wavelength that is being given off is more in the realm of heat than luminosity. “Light has the ability to travel at 300,000 km/sec in a vacuum. However, light travels at slightly slower speeds through matter such as air, water and glass”[2] where it encounters both reflection and refraction. With the exception of clear objects, such as a wine glass, all colored objects in our world absorb some colors of light and reflect others to give the appearance of being the color our eyes perceive them as.

Opacity and Shadow

What is a shadow? Shadow has always had an air of mystery to it. As defined by Webster’s online dictionary, a shadow is “partial darkness or obscurity within a part of space from which rays from a source of light are cut off by an interposed opaque body.”[4] In layman’s terms, if light hits any object and can’t get through it, a shadow forms behind it.

In her book, “Bouncing and Bending Light,” Barbara Taylor notes “materials that block light are called opaque.”[5] The opacity of an object has a direct effect on its ability to cast a shadow. If it were transparent, light would simply pass through it unhindered. If an object was translucent, some light is allowed to pass through it, however a shadow can still be cast depending on the luminosity of the light behind the object. Shadows need to be taken into consideration when observing objects that are in the direct path of any source of light rays, whether they are natural or artificial. A tree casts a shadow in the natural light of the morning sun. A lamp on our end table, a source of artificial light, casts shadows when it is lit and shines on objects in our room. Shadows are all around us. The degree to which shadows are cast can affect the mood of the observer or the tone trying to be conveyed, especially when looking at works of art.

Shadow has been used for millennia to tell time, prior to the invention of the clock. It is theorized that ancient people, such as the makers of Stonehenge used shadows cast by sunlight to do such things as mark the growing seasons, follow astronomical cycles, mark religious celebrations, and last but not least it was also used as a sundial. Light and shadow helps to define the shape and space objects take up.

Shadows created by natural and artificial light sources, however similar, are also very different from each other. Artificial light sources “emit light rays in a radial shape, spreading out from the light source and propagating in a divergent fashion which makes them highly distorted."[6] Natural light creates shadows as well. “The sun, our main source of natural light is so far away from the earth that the light beams are parallel in nature. This in turn causes the shadows cast to be parallel except when the Sun is in front or behind, in which the shadows fall in a line of recession.”[7] As the day progresses toward sunset, the rays of the sun are striking objects at different angles because of the sun’s relative position in the sky. This in turn causes the shadows we observe to lengthen depending on the hour of the day we observe them.

Another source of natural light is the moon. The moon's surface reflects light from the Sun like a mirror and this light in turn makes its way to Earth. Depending upon the phase of the moon, the amount of light reflected and observed from the earth's surface will vary; this also has an effect on shadows cast at night by the pale moonlight.

Opacity in contrast to shadow is the phenomenon of not permitting the passage of electromagnetic radiation through various objects, such as a brick wall, certain painted surfaces and even paper. The thicker a paper is for example the greater its opacity. This means that light has a harder time showing throw it. Glass for example has zero opacity, while the example the brick wall aforementioned has opacity of 100%, seeing light cannot penetrate it.

Human Vision

The study of human vision is taught at a very limited level at the third grade. The students I teach are expected to know at this grade level that vision is one of their primary senses, often referred to in textbooks and videos as the most important of all senses.

"The human eyes are commonly likened to the camera."[8] What this means is that the human eye works in a similar fashion to a modern camera. The eye accepts reflected light, which enters through the clear cornea, passes through the pupil and then the image is passed through the lens. The human lens then flips the image upside-down where it is projected onto the retina. If the image does not fall on the retina, but in front or behind it, corrective lenses will be needed to correct the person's vision. People who cannot see far away are deemed "near sighted" and those who cannot see close up are called "far sighted.' "A convex lens in a pair of glasses that is thicker in the middle and thinner at the edge and these lenses are utilized to treat farsightedness." [9] If someone is being treated with glasses for nearsightedness, "concave lenses are used, being thicker at the edges and thinner in the middle." [10] These terms often confuse children and adults because we often assume that the term matched the condition we are having trouble with. Instead it refers to the vision that is clearest and most in focus.

The retina has a photoreceptive layer made up of rods and cones. "Rods and cones are not distributed evenly over the retina." [11] The rods are the cells that are connected with low light vision. We use these cells at night because of their great ability to distinguish between objects that are in darkness, low light or in shadow. Rods are only able to see monochromatically, these are the cells we primarily to see in the dark. Cones on the other hand are responsible for our color vision, and are used during the daytime.

In this case, "rods in the human eye are effective only in dim light and enable us to sense differences in brightness." [12] In the case of the human eye, light enters and forms an image on the receptor cells (rods) that respond to the intensity of the light. Furthermore, rod cells in our eyes are not equally sensitive to light at various wavelengths. In the book "Color" by Hazel Rossotti, it is further suggested that "when viewed by weak moonlight, the dark green leaves of a holly tree might seem a lighter grey than the bright red berries, because rods show their greatest sensitivity to green light." [13] Because rods are responsible for low light vision in human beings, our ability to distinguish an object's color in the dark is hampered by this. Rossotti suggests, "The intensity of the light which is reflected off objects is so low that only rod vision occurs." [14] This in turn effects what we are able to see clearly in low light conditions; shadows cast by moonlight further impair our vision in that respect.

Even though the image sits inverted on the retina, the transmission of an image to the brain via the optic nerve, allows the brain to make more sense of the object by flipping it back right side up in our mind. Humans have binocular vision, meaning they have two eyes. This binocular vision also allows us to perceive not just light, dark and color, but also depth thus allowing us to see in three dimensions.

The human eye is full of photosensitive cells. These cells all contain a color; they contain pigments that absorb visible light. This is important in explaining color vision to children. Third graders need to learn that there are rods and cones in their eyes. They will learn that "the rods are effective only in dim light, while the cones are very versed in higher levels of light." [15] In my unit on light and color, we will integrate the "human eye" into conversation and general discussion. I do have a large model of the human eye and will show students what controls their vision and what parts of the eye are the most important for them to know.

Colors and the Color Wheel

What is color? Color as perceived by the human eye occurs when light is missing some energies (wavelengths) of visible light. We perceive light as being colored. Most objects don't filter out all but the color we perceive. Usually, we see the color that is complimentary to what is being absorbed. Yellow, for example, is how we see the absence of blue and violet, and the presence of green, yellow, orange and red part of the spectrum.

In nature, the sun is our main natural light source. What we see is a white light, but in reality the rays of the sun carry all the colors. When is this visible to the naked eye? When there are rainbows we see the rays of the sun passing through droplets of water in the atmosphere that act like a natural prism. This results in the bright white light being broken down into its individual colors.

When it comes to painting there are three primary colors: red, yellow, and blue. By mixing the three primary colors we can create all the secondary colors, which are orange, green, and violet. By mixing the secondary and primary we can create tertiary colors. This brings us to the color wheel, which is made of 12 colors. They are as follows, red, red-orange, orange, yellow-orange, yellow, yellow-green, green, blue-green (cyan), blue, blue-violet, violet, and red-violet (magenta).

There are also tints and shades that can be created with color. By adding white to a color you create a tint and by adding black to a color you create shades. By mixing black and white you create gray which can be used with other colors to create tones. When it comes to modern day tools/technologies, we use additive colors. For example, LED lights can use red, green, and blue to create different colors. If all three LED's are on then the light will be white. Red and green produce yellow, red and blue produce magenta, green and blue produce cyan. Varying the intensities of the red and green can create a hue of any kind and blue phosphors on a TV monitor.

Mixing Pigments

Most of us have used pigments at one time or another in our lives. We may have used and mixed pigments as a child doing a work of art or in our homes during our latest home renovation efforts. Pigments are solid particles that produce colors by absorbing or reflecting light. As an artist works on a canvas, pigments that are mixed into the paint to color a neutral base cause the light waves of that pigment to be reflected and all the other ones absorbed. This allows for our eyes to perceive the pigment as blue. Elementary students in art classrooms often engage in "subtractive mixing." They combine paints of various colors to obtain new secondary or tertiary colors. In elementary science labs, students are often selectively combining colors on a pallet to make new ones. In other situations they are combining lights of various colors, such as flashlights with differing colored lenses, the effect you then get is called "additive mixing." Through a variety of learning experiences, more wavelengths of light are present, new colors are observed as the spectrum reaching our eyes becomes more complete.

Photosynthesis

Photosynthesis, the lifeblood for all plant species on earth is directly connected to light and color. "Green plants make their own food. They do this, basically by taking water and nutrients from the soil and mixing them with carbon dioxide, oxygen and sunlight to create starches and sugars." [16] Plants and animals both carry on the process of respiration; whereas lungs serve as the main engine behind respiration in animals, chloroplasts serve that function in plants. "Inside each leaf cell are tiny green structures called chloroplasts.

The green color comes from a substance called chlorophyll. Chlorophyll is a natural pigment. Chlorophyll captures the energy in sunlight."[17] When the leaves of green plants are exposed to the light from the sun, the chloroplasts utilize carbon dioxide and water to generate glucose. This glucose is used as food for the plant. Oxygen is given off as a waste by-product. That oxygen in turn is utilized by oxygen breathing animals on the land and in the sea, where the oxygen is dissolved into the water. "The atmosphere shields Earth against radiation from space; only visible light, some infrared and UV radiation, and some radio signals reach the surface"[18] making the Earths atmosphere a perfect greenhouse for plants and animal life to grow and flourish.

Classroom Activities

My children have three 45-minute sessions of science per week; they are in my classroom for one of those three sessions in my science lab. The students are expected to engage in hands-on activities that either enrich or extend what they do in their homeroom. Students engage each week in a different learning activity. In this unit, the students will complete a "pre-reading" to reinforce their background knowledge prior to the lab session. All readings will be grade appropriate and highlight key scientific vocabulary that they need to have at their grade level. As I teach this unit over quarters two and three during which I teach the "Objects in the Sky" and "Plants Growth and Adaptations," I have incorporated a series of "hands-on" learning activities that have a common theme, that of light and color. Three of these learning activities are described in detail below, while the others are presented below. It is my hope that information the students learn during the "Objects in the Sky" unit will be a connecting thread to "Plant Growth and Adaptations." I will conclude these twenty weeks with a "science day" where they will further refine and extend their background into light and color. I will make reference to my unit on color and light through both learning goals over the twenty weeks where they are appropriate. When I do any learning activity, no matter what it is, I have a white board with the steps that fit the scientific method lettered on it. As we conduct the activities, each step is completed as it applies. The children are told and then see for themselves that not everything always fits in neatly, and that some activities are demonstration, some objective experimentation and some a combination of both.

Learning Activity # 1: Duration – One Week

Shadows and Light – What time is it?
In this activity the students will create a sundial. Students will then take their sundials outside during class and with the aid of a compass they will determine the correct position to place the sundial relative to the sun and attempt to tell the time. The sundial activity has a concrete connection with the curriculum and is easy to do with third graders.
Building a Sundial:

Materials Needed:

To build a paper sundial with my students I use a paper template found at: http://www.iki.rssi.ru/mirrors/stern/stargaze/Sdial2S.htm

The sundial in the template is for 38^{o} Latitude. Charlotte North Carolina lies at approximately 35^{o} so this is a close approximation to utilize with students. It is preset with the hours and a "gnomon." A gnomon is a piece of paper that stands perpendicular to the base used to cast a shadow onto the sundials face. I have the students cut out and paste their templates to a tag-board base. This will make it more stable on the ground. I also have them cut out a tag-board gnomon to paste each of the pieces of paper to for stiffness. I give each student a small compass so they can locate "north" and place their sundial on the ground. The day they do this activity needs to be dry, relatively warm and of course sunny, for the best effects. I always remind my students that the time they see is a close approximation to the real time, however due to their limited math skills, they would be unable to use a compass to make one specifically for 35^{o} latitude.

Learning Activity # 2: Duration – Two Weeks (one to build & one to cook)

Here Comes the Sun – Catching the Sun's Rays!
In this activity, students are going to create a solar oven from a commercial sized pizza box. They will attempt to "cook" hotdogs by utilizing the sun's rays.

Building a Solar Oven:

This activity really requires days with not just ample sun but warmth. If my students do this activity in the classroom we often use a UV Bulb and large reflecting bowl, available in any pet store in the reptile section. The solar oven itself is made from unused pizza boxes that I obtain from a local restaurant supply store. I do not use used containers with them due to the unsanitary conditions of used boxes from home.

Materials Needed:

- One new pizza box
- Glue sticks
- Clean newsprint
- Tape
- "Fiskers"™
- Black construction paper
- Clear plastic wrap
- Aluminum foil
- 8 ½" x 11" paper
- A pencil or pen
- A large tongue depressor

Constructing the Solar Oven:

1) If the new pizza-box is flat and unfolded, fold it into the usual pizza box shape.

2) Use the sheet of paper as a template and a pencil/pen to trace a window that the suns rays will penetrate on the top of the box.

3) In the third step, you will need a scissors, I let my students use "Fiskers"™ due to their great cutting ability to cut two of the long sides and one of the short sides to create a flap (8 1/2x 11) that can be raised and lowered in the box lid.

4) I then have my students bring their cut flap back, without cutting that last side to make sure their lid moves easily.

5) I have my students use aluminum foil to line the underside of the flap they created and secure it with tape. The foil can over lap onto the top of the flap to make taping it down easier.

6) The flap will act as a "reflector" and send the suns or lamps rays into the box.

7) I then have my students glue down black construction paper to the entire inside of the new box. I have them use glue sticks as they are non-toxic and will not give off fumes when heated which might affect the food to be cooked.

8) My students then roll up the clean newsprint and line the edges of the box and bottom.

9) Lastly, my students use plastic wrap to make a window to cover the opening created earlier by their flap. They will then cut two pieces of plastic wrap larger than the 8 ½" x 11" opening of the flap. They will use tape to secure the plastic wrap on the inside and outside of the flap. All four sides of the plastic wrap must be secured by tape. This will aid in making sure the Sun's or lamps rays are trapped inside the oven.

Using the Solar Oven

Now that my students are done constructing their "solar ovens," they will them either take them outside or place them on a table under the UV Lamps. My children then place the hotdogs inside. They then open the foil-lined flap facing the solar or UV source. Using a large tongue depressor, the flap is propped upwards to keep the rays directed inward. If the depressor is not enough, a ruler can be used. The hotdogs will be turned occasionally while cooking.

Learning Activity # 3: Duration - Two Weeks

Building Sun Catchers – Colored Film & Transparency
In this activity, my students will create their own creative cut out sun catchers. They will make 2 identical cutouts. They will then use plastic films of different colors to fill the holes. We will then hang the sun catchers on the windows of the science lab. Visitors will be able to see the catchers through the hallway and courtyard windows. When the sunlight comes through the courtyard windows, a multitude of shapes and colors will be cast onto the ground in the classroom. It will be a visually stimulating display that will be fun for all to see.

Materials Needed:

- 1 piece of colored cellophane – blue, green, red, clear
- 2 piece tag board
- 2 piece animal tracers
- "Fiskers"™
- Glue sticks
- Pencil

Directions:

1. My students will start this activity by using a pencil to trace an animal from one of the animal tracer templates. My students will trace the same animal onto two pieces of cardboard to make a mirror image.
2. My students will then use "Fiskers"™ to cut out the animals they have traced.
3. Next, the children will cut out pieces of cellophane of various colors to fill in the "holes" on the animal's body they just cut out.
4. My students will use glue sticks to glue down the cellophane to the first template.
5. Lastly, the students will line up and glue down the opposing tag board.
6. Finally, my students will use crayons to decorate the tag board.

Learning Activity # 4: Duration - One Week

Spy Periscope! – Mirrors, Light and Reflection
In this activity, students will construct a "periscope" made from same size mailing tubes. Students will place two mirrors at 45-degree angles in the inside of the mailing tubes. They will also cut opposing holes in the rolls. The angle of the two mirrors will allow light that enters one hole to be reflected onto the other mirror. They will be able to see "over" an obstruction without having to raise their heads. We will set up the periscopes up around the media center, using the bookcases as obstructions. Students will then be able to "spy" on their friends as they are in differing locations. This will be an interactive and fun activity that more than just the third graders can enjoy.

Materials needed:

- Mailing Tubes - White with End Caps. (I purchase these in a bulk set of 50 for about the same price. The sturdiness and cleanliness of the tubes is never in question. I am able to buy this for my classes out of a PTA Budget, however you could collect $2 dollar per child to cover costs; you then have a set ready for next year. Each year supplies the successive years)
- Two small 2 inch square pocket mirrors (science kits provide mirrors)
- "Fiskers"™
- Protractor
- Ruler
- Pencil
- Duct Tape
- Exacto-Style Knife
- 4"x4" manilla paper square
- Yard stick

** Due to safety issues, I will be the only one to use the "Exacto-style" knife to make cuts to student tubes.

Directions:

1. My students start this activity by removing the caps from the mailing tubes.
2. My students will then trace and use their Fiskers"™ to cut out a 1 ½ inch circle template from a piece of manila folder
3. Next, the students measure the circumference of the tube. Have them use the pencil and yard stick to draw a straight line on each side ½ of that circumference, basically giving the children a guide line to place their manilla hole templates.
4. My students will trace their holes onto their tube so I can cut them out for each student group.
5. As the teacher, I will use an Exacto-style knife to cut out a 1 1/2 in. hole about three inches from the bottom of their tube to be an "observation hole." I will need to repeat the same step on the opposite side of the tube about three inches from the top. The holes I will cut for my students are on opposite sides of the tube, however they need to be aligned to each other.
6. My students will then mark a line with a pencil and ruler about ¼ in. below each opening I made into their tubes.
7. My students will line the base of the protractor with the line they draw to determine a 45^o angle from the base of the hole. Have them mark that angle and use the ruler to draw a line they will cut to insert the two mirrors they will use.
8. The students will use "Fiskers"™ to cut slots to insert the mirrors. The mirrors need be snug so they don't fall out or are loose. The mirrors need to face each other.

9. The “Spy Periscope” is all done and will give them hours of enjoyment seeing around objects in the classroom, media center and at home.

Learning Activity # 5: Duration 1 – Week

The World in Focus – Refraction & the Microscope
In this learning activity, my students will use the refractive properties of my class set of microscopes to investigate the shape and color of everyday objects, such as comic strips and newspaper print and the shapes and colors of animals and insect cells, such as bees' wings, blood cells, etc. The students will start the investigation by identifying the parts of the microscope and their uses. They will conclude with a microscope view of their world. We have a class set of microscopes that we use to view objects of all. The children love to observe colored printed items under the scopes to discover how the image they see is really a lot of pixels. The color mixing that occurs is caused by overlapping yellow, cyan, magenta and black dots to achieve the illusion of a unified color picture.

Learning Activity # 6: Duration – Six Weeks

A Universe Full of Color
In this learning activity we will explore colors in three stages over three weeks. It is a three-part activity that will explore color and then incorporate their use of color and the universe around them.

Weeks 1-2
In stage one, my students will do a very light sketch on a premade canvas in pencil of a nature scene from a variety of animal photographs that I possess. On a separate cardboard pallet, each student will have a cup of Q-tips and a cup of paint of each primary color. On their pallet they will mix primary colors to create complimentary color. They will then use the secondary colors to mix and make the tertiary colors they will need to complete their painting. They will have a work sheet to guide them through each step of the mixing process. They will then use the palette to color their nature-based painting on a piece of simple white canvas from a canvas roll that was precut to 8 1/2 in. by 11in pieces. I will pre-tack the canvas to premade frames I will construct at home prior to instruction. This will require some extra effort on my part, but it will be worth it.

Weeks 3-4
In stage two of the activity, students will again be given a pallet and Q-tips. We will look at the colors of the rainbow. We will discuss “warm colors” and “cool colors.” We will talk about the warmth and coolness of stars that we learned about previously. We will also talk about the reading and research they will do on stars and constellations. I will have the students create a “space mural” for the hall. We will relate the cool and warm colors to the colors of stars in the galaxy. They would use black bulletin board paper to represent space. We will be studying various stars and constellations. They will paint the

constellations and nearby stars on the black back ground. I will have them with up cards on each constellation, the stars that compose it, their color, size and temperature on a large index card and affix it next to what was painted.

Week 5 & 6
In stage three of the activity, students will explore creating the tint, tone and shades of a given color. The will do this on a cardboard pallet. They will use these tints, tones and shades to paint a Paper Mache planet in the solar system.

Materials:
1. Balloons of various sizes to represent the planets.
2. Strips of newsprint.
3. Liquid starch, water, and large white bowls.
4. Table clothes
5. Smocks
6. Paint, Pallets, and Brushes
7. Color photographs of the planets of the solar system.

Learning Activity # 6: Duration - 2 Weeks
Cameras – Bringing the World into Focus

Week One
In this activity, students will use a disposable camera. Students will take their disposable cameras with them outside and conduct a nature walk and photograph real life objects over a class period. I will have the film developed and blown up at a local photo lab. We will then display our photographs for the school to see on a display board in the hallway.

Materials:
1. Disposable cameras.

Week Two
For this activity, I am having a guest photographer come in to the class to demonstrate some of the various techniques he uses with light, color and shadow when taking professional photographs. He will explain the principles and workings of the cameras used to my children.

Materials:
1. Samples of guest's photographs

Learning Activity # 7: Duration – Several Weeks
Living Light – Light and Photosynthesis

In this learning activity, I will explore how light effects the growth of plants. This will be a great precursor to the third grade unit on plants and soil that we are doing this year. As a class, we will explore the parts of a plant, we will look at green leaves and we will talk about photosynthesis. We will discuss the process where leaves utilize chlorophyll to create simple sugars they need to live. The Department of Energy's "Ask a Scientist" website suggests using the chemical "acetone" to extract the chlorophyll. We have all seen the green chlorophyll of leaves and grass when we have gotten grass stains on our pants. However to be more scientific, "we will extract chlorophyll from the plant leaves by exposing leaves that are cut up into small pieces in glass bowls outside to the chemical acetone. The experiment must be done outdoors due to the nature of acetone, which when it evaporates gives off a bad odor. We will pour off the green chlorophyll/acetone mixture that will be extracted from the leaves onto white paper towels. When the acetone evaporates from the paper towels, we will be left with the chemical chlorophyll residue on the dry paper towels." [19] We will then observe the chlorophyll under the microscope. Lastly, the class will then conduct some hands on experiments with living plants and grass to demonstrate a plants need for light. We will box up or cover up some plants and grass samples I have growing in the lab. The students will track the growth progress over several weeks and compare and contrast plants that are fed all the light they need and those that are light deprived. We discuss our final findings for this activity when we are doing the plant unit.

Unit Wrap-up Project:

One of the things I do each year is to have a science day, similar to a Science Olympiad at each grade level. Students from each classroom spend the afternoon travelling from room to room on their grade level team completing a variety of activities. I organize the science day each year around a "theme." Based upon this unit, I would like to have the science day revolve around both color and light. The science day would be a series of extension activities for the students. It would help to enrich their background knowledge. I would like to have the children go to each room and experience something related to light and color that was not presented as a learning activity in the unit. I would like one room to experience the process of chromatography. (See Teacher Resources) I would like them to see what color dyes are used to make the colors of their Crayola™ Markers. I would like the second classroom on the team to experience the dying of cotton, a natural fiber, by taking a 100% white cotton t-shirt and tie-dying it. (See Teacher Resources) The students would be provided with a variety of the 16 different RIT™ liquid dyes, choosing colors for their experiment based upon previous learning. For each station, they will need to write a brief description of each activity in the science journal as a form of assessment. They will be expected to list the objective for each activity, the steps needed to complete each activity in their own words, and lastly they will need to summarize the results of each experiment completed on the science day.

Notes

[1] www.sciencebuddies.org

[2] Atwater,Mary et al.,. Sound and Light. Science Turns on Minds. New York, NY: Macmillian/McGraw Hill, 1995., 54.

[3]Atwater,Mary et al.,. A System in the Sky. Science Turns on Minds. New York, NY: Macmillian/McGraw Hill, 1995., 309.

[4] www.merriam-webster.com

[5] Taylor, Barbara. Bouncing and Bending Light. New York, NY: Franklin Watts, Inc., 1990., 6.

[6]Asuncion,Josep. Light and Color. The Painter's Corner. Hauppauge, NY: Barrons, 2004., 40.

[7]Asuncion,Josep. Light and Color. The Painter's Corner. Hauppauge, NY: Barrons, 2004., 40.

[8] Rossotti, Hazel. Color: Why the World Isn't Grey. Princeton,NJ: Princeton Press, 1983., 109.

[9] Proujan, Carl, et al.,. Science Saurus. Wilmington, MA: Houghton Mifflin, 2005., 314.

[10] Proujan, Carl, et al.,. Science Saurus. Wilmington, MA: Houghton Mifflin, 2005., 314.

[11] Rossotti, Hazel. Color: Why the World Isn't Grey. Princeton,NJ: Princeton Press, 1983., 112.

[12] Rossotti, Hazel. Color: Why the World Isn't Grey. Princeton,NJ: Princeton Press, 1983., 112.

[13] Rossotti, Hazel. Color: Why the World Isn't Grey. Princeton,NJ: Princeton Press, 1983., 112.

[14] Rossotti, Hazel. Color: Why the World Isn't Grey. Princeton,NJ: Princeton Press, 1983., 121.

[15] Rossotti, Hazel. Color: Why the World Isn't Grey. Princeton,NJ: Princeton Press, 1983., 112.

[16] Siepak, K, L., Light & Color: Bending and Reflecting Light Shadows Color Pigments Eyes and Visual Tricks. Greensboro, NC.: Carson-Dellosa Publishing Company, Inc. 1994, 5.

[17] Atwater,Mary et al.,. A System in the Sky. Science Turns on Minds. New York, NY: Macmillian/McGraw Hill, 1995., 80.

[18] Atwater,Mary et al.,. A System in the Sky. Science Turns on Minds. New York, NY: Macmillian/McGraw Hill, 1995., 118.

[19] http://www.newton.dep.anl.gov/aas.htm

Bibliography

Asuncion,Josep. Light and Color. The Painter's Corner. Hauppauge, NY: Barrons, 2004. Very interesting book on color.

Atwater,Mary et al.,. Sound and Light. Science Turns on Minds. New York, NY: Macmillian/McGraw Hill, 1995. Elementary Book on sound and light.

Atwater,Mary et al.,. A System in the Sky. Science Turns on Minds. New York, NY: Macmillian/McGraw Hill, 1995. A good book on astronomy for kids.

Cohen,Paul, et al.,. Achieving Competence in Science. AMSCO School Publications. New York, NY: AMSCO School Publications, 1993. Interesting Article.

Lebofsky,Arthur. Heat and Light Energy. RED ed. Delta Content Science Readers. Delta Education Staff. Nashua, NH: Delta Science , 2009. Easy read.

Lowery, Lawrence. The Everyday Science Sourcebook: Ideas in Teaching in the Elementary and Middle School. New York, NY: Dale Seymour Publications, 1985. Great Science Resource.

Proujan, Carl, et al.,. Science Saurus. Wilmington, MA: Houghton Mifflin, 2005. Great Science Resource. Great resource for elementary science.

Rossotti, Hazel. Color: Why the World Isn't Grey. Princeton,NJ: Princeton Press, 1983. Interesting study on color.

Scott, Carole, and Twist, Clint. 1,001 Facts About Space. New York, NY: DK Publishing , 2002. Interactive book on outer space.

Taylor, Barbara. Bouncing and Bending Light. New York, NY: Franklin Watts, Inc., 1990. Nice light resource.

Teacher Resources

Teacher Websites

- http://www.learnnc.org/lp/pages/3369
  - Great site to get a simple sundial activity to complete with your students.

- http://www.iki.rssi.ru/mirrors/stern/stargaze/Sdial2S.htm
  - Another great resource to extend your background on sundial
- http://www.fi.edu/time/Journey/Sundials/aboutsd.htm
  - Fun little site with other sundial activities.
- http://www.packsecure.com/servlet/the-307/tube%2C-cardboard%2C-white%2C-white/Detail
  - This is a great resource for the packing tubes I use in my class.
- http://www.sciencebuddies.org/science-fair-projects/teacher_resources.shtml?From=Tab
  - This is a wonderful website.
- http://www.oneminuteastronomer.com/wp-content/uploads/2009/01/hrdiagram.jpg
  - Great diagram of solar colors, size, luminosity and temperatures.

Student Resources

Student Reading List

DiSpezio, Michael. Awsome Experiments in Light and Sound. New York, NY: Sterling Publishing Co., Inc., 1999.

Student Websites
http://www.pioneerthinking.com/naturaldyes.html
Great site for homemade dyes.

http://www.kathimitchell.com/light.htm
This is a great website for kids full of links related to light.

http://whatscookingamerica.net/Eggs/EasterEggDye.htm
Great site to learn how to dye eggs.

Discovery Education's Website has some terrific videos on color and light.

http://player.discoveryeducation.com/index.cfm?guidAssetId=7405C85E-837F-4CEC-B0E4-5F351127698A&blnFromSearch=1&productcode=US

Great site for exploring the "Basics of Physics: Exploring Light and Color"

http://player.discoveryeducation.com/index.cfm?guidAssetId=E2A9E804-5F5E-465F-83BA-AE30DB1A2B74&blnFromSearch=1&productcode=US

Great site for exploring the connection between the color of stars and their temperatures.

http://player.discoveryeducation.com/index.cfm?guidAssetId=0D2CCF17-8C4E-4101-A1FF-D11305F6878C&blnFromSearch=1&productcode=DSCE

Another great site related to light and the electromagnetic spectrum.

Appendix 1

North Carolina's Grade 3 Science Content Standards

Goal 1

The learner will conduct investigations and build an understanding of plant growth and adaptations.

Objective 1.01

Observe and measure how the quantities and qualities of nutrients, light, and water in the environment affect plant growth.

Objective 1.02

Observe and describe how environmental conditions (light) determine how well plants survive and grow in a particular environment.

Objective 1.03

Investigate and describe how plants pass through distinct stages in their life cycle including.

- Growth.

Objective 1.04

Explain why the number of seeds a plant produces depends on variables such as light, water, nutrients, and pollination.

Goal 3

The learner will make observations and use appropriate technology to build an understanding of the earth/moon/sun system.

Objective 3.01

Observe that light travels in a straight line until it strikes an object and is reflected and/or absorbed.

Objective 3.02

Observe that objects in the sky have patterns of movement including:

- Sun.
- Moon.
- Stars.

Objective 3.03

Using shadows, follow and record the apparent movement of the sun in the sky during the day.

Objective 3.04

Use appropriate tools to make observations of the moon.

Objective 3.05

Observe and record the change in the apparent shape of the moon from day to day over several months and describe the pattern of changes.

Objective 3.06

Observe that patterns of stars in the sky stay the same, although they appear to move across the sky nightly.