Extracting dye from native resources

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William B. Keene Elementary is located in Newark, DE. Contrary to its suburban home, Keene is a title-1 school, meaning a high percentage of our population is of unstable or struggling financial means. The students come from a drastic range of lifestyles and situations. Serving grades kindergarten through fifth grade, the staff gives their all to accommodate the high student population. Averaging 650 students a year, Keene is a bustling hive of education, socialization, and culture. Each team of core classroom educators works diligently to meet the individual needs of each student. The mix of economic and cultural backgrounds proves to be stressful for students and staff alike.

As the art teacher, my time is limited to once a week due to scheduling, but I am one of the few teachers who will be actively involved with each student for the six years they are at Keene. Therefore, my class is prime grounds for deep long-term instruction and understanding. In my art class, I will never tell a class what we are making, that's just not right and it for certain isn't artistic. Instead, I teach my students about techniques, process, artists, history, cultures, and material. Once loaded with their new information for the day I set my class free to use the lesson or techniques anyway they want. I encourage experimentation and celebrate the failures equally to the successes. Everything is relevant to the artist and should be used in the creative process.

I find that the curriculum my students experience in their regular classrooms, although educational, is missing a connection to the world around us. It has become a major goal of mine, as an educator, to make that connection. In all that I teach, I aim to incorporate real-world uses, techniques and history for my students to discover. I believe that the strongest learning occurs through personal connection and experiences, which is why I use my visual arts classroom to cultivate ideas and interests in all subjects. More specifically, I focus on social studies and the sciences. The elementary core curriculum is heavily weighted in mathematics, reading, and writing. The sciences and social studies are often afterthoughts, or interwoven into the math or reading focused based lesson.

At the elementary level, science class comes in prescribes kits, literal bins with all the supplies needed for the unit within it. This is very convenient for teachers, especially with their tight schedules, but it is those schedules that often rob minutes from the science lessons. In speaking with my colleagues, I have learned that they wish there was more time for science. This is why I focus on integrating this topic, in general, it into my art curriculum.

The art classroom can be a place for deep thinking about ideas and places far away, but I also want it to be a venue for the transformation of the materials right at our back door. In the summer of 2017 a local group put in hundreds of volunteer hours to give Keene a face-lift. Volunteers painted classrooms, power washed the building and built a new garden area. Complete with flower boxes and a pergola, the new courtyard garden is now a blank canvas waiting to be used. In this unit, I discuss the extraction of natural dyes and pigments from nature. I am going to use my new knowledge to teach my students how to grow or find color in the world around them. The chemistry of the dyeing process will be explained to students to encourage experimentation and questioning.

I have always wondered about color and where it comes from? In my early art education, I learned about the primary colors, as most elementary students do. I knew that all the colors could be produced by mixing red, yellow, and blue, with the help of black and white of course. As I grew older and progressed in my artistic studies, I learned about light and how the eye sees color. In the world of light, white light is made of all the colors together. This is wildly different from the behaviors of paints. If I were to mix all the colors together on my paint pallet I would get an ugly brown. Progressing past light, I next remember learning about printing technology, CMYK standing for: cyan, magenta, yellow, and black, which are the colors used in most printers. By this time, I was well aware of the different color technologies but none of them ever answered the question of where color comes from. I've never tripped over a chunk of yellow in the woods, or have I?

After starting my research for this unit, I stumbled upon the book *Color: a natural history of the pallet,* by Victoria Finlay. In her book, Finlay travels around the world in search of colors. She discussed the cultural significance of all the colors in the context of their native setting when she finds them. For example, ochre is a type of earth and is also a pigment. In an Aboriginal territory in Australia Finlay discuss how the color has sacred uses and meaning. The book continues to discuss the different colors and their historical significance.[1]

Dye history

Color has been a part of human life as long as sight has been a sense. I mean, think about it - you see all these amazing colors in the world around you. Isn't it natural to want to surround yourself with beautiful things? – that is in the eye of the beholder of course. Humans have been using natural resources to dye fabric since the invention of textiles. 60,000–35,000 years ago the Aboriginal Australians used pieces of earth and rocks[2] they found to add color to their life. Across the globe the Picts,[3] or ancient Scottish used woad to dye their bodies blue[4] before battle. The history of dye isn't all that pretty, and the history of chemistry isn't as fancy as it is today. Raw materials couldn't be ordered from your smartphone and two days later show up at your door. Raw ingredients had to be reclaimed from substances on hand, for example, ammonia.

Ammonia is needed to make the indigo dye from woad. Do you think the Picts had some ammonia based cleaner to obtain it from? Nope, they had urine. Stale urine was their source of ammonia to make their signature body paint.[5] This wasn't the last time urine was used for chemical purposes either. "German scientist Hennig Brand (ca. 1630-1692) was convinced he could distill gold from urine. He stockpiled 60 tubs of urine in his basement laboratory and allowed it to putrefy."[6] Later I will discuss the use of rotting/fermentation to make purple and indigo dyes. The world of color is beautiful, but that is mainly on the outside. The behind the scenes science of colors, pigments, and dyes is full of disgust, poisoning, and death.

Chemistry background

Chemistry is the study of matter. Today, that matter is neatly organized into elements. The title of the father of modern chemistry is given to Dmitry Mendeleyev. He is credited with developing the first periodic table of elements.[7] Mendeleyev's work opened the flood gates for chemistry to become a science as opposed to its predecessor, alchemy, which was more of a philosophical/religious pursuit.

When I hear the word chemistry I immediately flashback to my 11^{th}-grade chemistry class. Rows of desks, a giant periodic table, black tabletops, natural gas faucets, tubing, glass, safety; it all comes back into my mental vision when I think about the scientific form of chemistry. However, as an artist, I have come to have a more intimate relationship with chemistry. Through studying the chemical compositions and recipes of ceramic glazes in my undergraduate studies, I began to finally apply some of the honors chemistry content I remember learning. Through the lens of art, chemistry is becoming real to me, and I hope to share this experience with my students.

Chemistry has always been a huge part of human life, although we as humans didn't realize it until rather recently (in the grand scheme of things). Prehistoric humans used chemistry in the form of fire. Many people think that a campfire burns wood, which isn't completely true. When a log burns in the fire, the materials in the wood are broken down by the heat and gasified. It is these gasses burning that cause the flame to sit just above the burning log. Fire altered human history and changed the way we eat. Today, there is a plethora of chemistry in the modern kitchen. The browning of meat, for example, is called the *Maillard reaction,* after the French scientist Louis Camille Maillard who in 1912 discovered that when heated, the carbohydrates and proteins in food react to produce new flavors and scents.[8]

Reactions

A chemical reaction, in the most basic definition, occurs when a chemical bond is formed or broken. "In a chemical reaction, a substance or mix of substances is changed into different substances. The substances at the start of the reaction are known as the *reactants*, and the substances left at the end are called *products*."[9] Chemical reactions, while sounding intense, are part of everyday life. Gasoline burning in your car's engine and food browning in the pan are two every-day examples of chemical reactions. There are four main types of chemical reactions: combination, decomposition, displacement, and combustion. Combination reactions occur when two or more reactants form a single product; with decomposition being the opposite. Displacement reactions occur when a more active element replaces a lesser active element; thus, discarding out the lesser active element. Finally, a combustion reaction occurs when reactants combine with oxygen and burn.[10]

Color and pigment

Color is everywhere in the world around us. As humans, we use color to send messages, change feelings, decorate, and label. Today many of those colors/pigments are synthetically made. In this unit, I am focusing on natural resources for color, but the synthetic side of color is equally fascinating. The first synthetic color is older than the periodic table itself. The ancient Egyptians, with all their scientific mastery, created a new color. Egyptian blue was created "by heating a mixture of sand, natron, and copper filings to about 1,500° F"[11]

A color or pigment

The terms pigment and color both, on some levels, mean the same thing. A color is the tone that we see when different or similar pigments are displayed. Pigments are the many different particles of a color, each of them having various chemicals that can produce certain colors. For example, the color green can be produced using copper-based pigments or chrome based pigments. Later in the unit, students will use the technique of chromatography to extract the different pigments from natural samples of color they find.

In the eye "[t]he sensation of [color] that we experience arises from the interpretation by the brain of the signals that it receives via the optic nerve from the eye in response to stimulation by light."[12] The eye takes in signals via the rods and cones, which are the sensory cells that line the retina. These sensory cells are name for their shape. The color signals being sent to our optic nerve come from the reflected light that an object gives off. This reflection is made up of particles called photons. "A *photon* is a particle of light defined as a discrete bundle (or *quantum*) of electromagnetic (or light) energy. Photons are always in motion and, in a vacuum (a completely empty space), have a constant speed of light to all observers. Photons travel at the vacuum speed of light (more commonly just called the speed of light) ….”[13] The colors we see are actually the particles of light reflected by an object. As discussed earlier, white light is the combination of all colors of light. When an object is seen as the color red, all the other colors of light (yellow, blue, green, ultraviolet….) are absorbed by that object; thus, leaving the red light to be reflected. This phenomenon was first observed by Isaac Newton. The human eye is capable of sensing a range of color, but more on the warm end of the spectrum.[14] Warm colors are red, orange, and yellow. Cool colors are blue, green, and purple.

Chromatography

Chromatography or *chromatic separation*[15] is a separation technique where a substance is separated into its different components. Later, in the activities, students will be conducting a chromatic separation on a color sample they find. To explain the process of chromatography I am going to comment on paper chromatography, but there are several types. Many of us have seen the separation of black ink on paper. I can remember back to my elementary science teacher having us color a black dot using a washable marker on the center of a coffee filter. We then cut a section of the filter so that it would hang into a water basin. As the water was drawn up the filter paper it ran into the black dot. Being water soluble, the ink ran or was in the mobile phase of the chromatography experiment. The coffee filter continued to absorb water, pulling the black ink through it. The ink soon separated into the different pigments of which it was comprised. Once dried on the stationary phase, my-young-scientist-self could see the many different colors of the black ink, including reds, and greens. This phenomenon occurs because the molecules of different colors are carried at different speeds by the water moving up the filter paper.

Scientists use chromatography to separate substances into their constituent parts, just as I did in elementary school, to better analyze the parts of a whole. Modern chromatography is also used in forensic testing[16], food and beverage testing, and drug testing,[17] among other more specific chemical analyses uses.

Dye Terminology

Dyes or stains

What is the difference between a dye and stain? Why is it that when I spill coffee on my pants I don’t say I coffee-dyed them and instead say I coffee-stained them? I am categorizing based on two main distinctions between dyes and stains: intention and fastness. I consider a stain to be an accidental or unwanted coloration of a fabric. A dye is a more permanent, colorfast, intentional coloring of a fabric. I think that the intention aspect of this classification holds the most ground on deciphering between dyes and stains. Stains are inherently not planned and unwanted. Along with the haphazard nature of stains, is their location on the fiber. Stains sit on of the surface, changing the color to the eye only. Dyes, on the other hand, penetrate deeply, past the surface of fabrics, and bond with the fiber, remaining there for a long period of time. The fastness (a term explained below) of a dye is what makes it a good dye or not. A more formal take on the differences between the two (provided below) by The Royal Chemical Society, discusses the different properties of pigments and dyes.

> "The distinction between pigments and dyes, which is based on the differences in their solubility characteristics… Pigments are used mostly in the coloration of paints, printing inks, and plastics…. In most cases, the application of pigments involves their incorporation into a liquid medium, for example a wet paint or ink or a molten thermoplastic material, by a dispersion process in which clusters or agglomerates of pigment particles are broken down into primary particles and small aggregates. The pigmented medium is then allowed to solidify, either by solvent evaporation, physical solidification or by polymerization, and the individual pigments particles become fixed mechanically in the solid polymeric matrix. In contrast to textile dyes where the individual dye molecules are strongly attracted to the individual polymer molecules of the fibers to which they are applied, pigments are considered to have only a week affinity for their application medium, and inly at the surface where the pigment particle is in contact with the medium."[18]

Stains are really pigments laying in/on a fabric. There are many dyes that I have experimented with that seem to dye the fabric, but when exposed to sunlight they are fleeting. Ultimately are they stains or dyes? - A question that is up for debate.

Fastness

All through this unit the term/suffix -fastness will be used. There are three main types of fastness: Colorfastness, lightfastness, and washfastness. These terms are used to explain the strength or permanence of a dye. Light-fastness refers to a dyes ability to be retained and not fade when exposed to sunlight.[19] I find the terminology to be a little bit backwards in that a lightfast dye will withstand exposure to sunlight, instead of running away fast from it. Thus, lightfastness is a good quality in a dye. Colorfast and washfast are, for all intents and purposes, the same. A colorfast dye will not rinse out when washed.[20] The two terms are used interchangeably, with colorfast being predominant.

The chemical term that can be used to explain fastness is *Chemichromism*. This term is used to describe a change in color due to a chemical reaction. Chemichromism includes color changes induced by light, heat and other stimuli.[21] Natural dyes are most often affected by sunlight. To improve the lightfastness of some dyes, artisans, use what is called a mordant.

Mordents

A mordant is a substance used to help the dying process. When used, mordents help dyes to bind to the fiber by forming a chemical bridge.[22] This bridge is used to link the fiber to the mordant and the mordant to the dye, creating a permanent color. “The word “mordant” comes from the French word *mordre*, meaning to bite, or bite into”.[23] The mordant soaks into the fibers and allows the dye to bite into the fibers. Dying can be done without a mordant, a process which is called direct dyeing and is discussed below, but lightfastness and colorfastness are an issue with this method.

There are several types of mordents ranging from naturally-sourced products to isolated chemicals. Many mordents come in the form of metal salts. Commonly used mordents are potassium aluminum sulfate (alum), copper sulfate, ferrous sulfate (iron sulfate), stannous chloride (tin chloride), and wood ash. Historically chrome was used as a mordant, but due to our modern knowledge about its toxicity, we no longer use it.[24]

$KAl(SO_4)_2$, potassium aluminum sulfate, also known as alum or potash[25] is a common sulfate, and overall a common substance. Sulfate is a negatively charged ion. Salts are ionic compounds, and ionic compounds are made of positively charged ions called cations and negatively charged ion called anions. Potassium aluminum sulfate is commonly found in the minerals kalinite, alunite, and leucite.

Alum is used in culinary processes, including pickling, to preserve the crispness of the pickled food. It is used in deodorants, and those sticks you use to stop the bleeding from a shaving nick. Alum is an astringent with tightening properties. It can be found in the grocery store spice section. “When used as a mordant (binder) in dyeing, it fixes dye to cotton and other fabrics, rendering the dye insoluble.”[26] One of alum’s best qualities is it does not affect the color of the dye, causing it to be the most widely used mordant. A common practice when using alum is to also use cream of tartar in the mordant bath (8% alum, 6% cream of tartar), which enhances in its permanence.[27]

When alum is dissolved in water, the sulfate anions (or negatively charged ion) dissolve and separates from the potassium (K^+) and aluminum (Al^{3+}) cations (positively charged ions). These cations bite into the fibers. When the fibers are placed in a dye bath, the dye molecules bond with the potassium and aluminum within the fiber, causing the dye to penetrate the fabric.

The other mentioned mordents do not compare to alum in its ease of use. Copper and tin are not the healthiest things to be around, especially in their powdered form. They are considered poisonous in certain amounts. Iron, on the other hand, poses minimal health risks but it can have adverse effects on fibers and colors.[28] The choice of mordents used can influence the final color, texture, fastness, and strength of the dyed fiber. Many natural dyes produce different colors when the mordant is changed.

Natural Dyes

There are endless sources of color in the natural world; many come from vegetation, some from animal sources, and others from inorganic materials like metals, soils, rocks, and minerals. In the summer of 2017, I had the opportunity to participate in the Yale National Initiative (YNI). While at Yale University I was lucky enough to land in a seminar with two Dine women from the Navajo Nation. Dine is the name of the people who live in the Navajo Nation. After seminar I made sure to speak to them about their history, culture, and their use of natural dyes.

Upon my questioning, they immediately responded with bounds of information. I spent some time talking with Priscilla Black and Jolene Smith who are teachers. We talked about how they make dyes from their natural resources. In our conversation, I asked what plants they use to make colors and they immediately started talking about Navajo tea. "Navajo tea is common in the timber regions on the mountain and around the edges of cultivated land at high elevations if the moisture is sufficient. It grows from one to two feet tall and its orange blossoms appear in July. The leaves, stems, and flowers are used for dye purposes and may be either fresh or dried".[29]

The women were so kind and happy to share their first-hand knowledge with me. They explained the harvesting process of a white pigment that comes from the cliffs near their home. They use this white substance to dye their shoes white, using a corn cob to apply it. It was an amazing experience to get to speak with them about their culture and to hear first-hand about things that I have only read about.

Types of Dyes

There are three main types of dyes in the natural dye realm.[30] The following are the main types used throughout history.

Direct Dyes

Direct dyes need little to be held to fabrics. Poor lightfastness is a quality or rather a shortcoming of direct dyes. Turmeric, for example, is a direct dye. From my personal experimentation, I can attest that it very successfully dyes cotton fibers. However, once exposed to the sunlight it fades very quickly. Originally a bright gold when I removed my cotton fabric from the dye pot, it faded to a pale yellow after drying out on the line with exposure to the sun. Other direct dyes in the natural realm that I have found through my experiments are red beets, certain flower pollen (especially that of Asiatic Lilies), red cabbage, onion skins, clays/earth, saffron, and red wine. The wine may technically be a mordant dye since wine contains tannins. Tannins are sulfites and are essentially mordents, but since you do not have to add in a mordant, I am classifying them as direct dyes here.

Mordant Dyes

The largest class of dyes,[31] a mordant dye requires the addition of a mordant, as discussed above. Mordant dyes need the dissolved metals to bond to as a bridge to the fiber. Yellow and red, and their variants, are the most common colors to be dyed using mordents. I ran my turmeric experiment again using alum as a mordant and found the colorfastness to be much better.

Vat Dyes

One of the oldest dyeing techniques, vat dyes use fermentation to achieve color. Traditionally madder red, Tyrian purple, woad, and indigo are produced using this technique.[32] In the ancient cities of the east, indigo vats were placed on the outskirts of the cities. The dye makers were exiled to the distant sections due to the stench that would draft from the rotting indigo vats. Similar in color to indigo is Tyrian purple. This purple color was the most expensive color to produce, and it almost caused an extinction of an entire species. Tyrian purple is made from the murex snail, specifically *Murex Brandaris* and *Murex Trunculus.*[33] This purple was produced by extracting it from the shellfish. The process could be accomplished sparing the life of the sea snail, through what is essentially milking, but that way was rather time-consuming. The faster method was to kill the snail and take the gland full of color. Thusly, the producers of Tyrian purple were sure to have a vast collection of rotting shellfish at any given time.

Dyes in natural sources

Today the dye industry is mainly synthetic, as mass production places and emphasis on reliable and highly replicable methods. In modern dye basins, the color has been chemically engineered to perfection and to always be the same exact color. This was not always the case. Below I will discuss the dye plants I will be using with my students and their qualities, but there are several other historically important dyes that are beneficial to know about.

In addition to the Tyrian purple discussed above, the color red also has a grotesque origin. The color red has connotations of power and lust, but did you know that until modern synthetics the most common form of red dye came from bugs? The cochineal bug (pictured below) lives on the leaves and fruit of the prickly pear cactus and its blood is used to make the dye. Commonly referred to as Carmine in the color and food industry, this bug juice was an ancient treasure. During the age of exploration when the Spanish landed in Central and South America, they found the native people rich with gold, of course, but also the color red. In her novel, Finlay describes the color as “one of the reddest dyes that the natural world has produced".[34] The Spanish capitalized on their new discovery, or rather stolen property, and exported cochineal/carmine/crimson (it has many names) back to Europe. Today the dye is used widely in the food and beverage industry. While you may sneer at the thought of eating bug guts with your lollipop, the common alternative to the cochineal is a coal-derived red dye. Red Dye No. 40 is made from "petroleum distillates or coal tars."[35] Cochineal red isn't just used for food dye, it has been used to dye clothing, make artist paints, and tint lipstick.[36]


[37]

Dye from Plants

Purple, as discussed above can come from the gland of a shellfish, but it can also be sourced from plants. Indigo and woad are two historic dyes made from plants. Both dyes were produced using the vat dying technique. Indigo is far superior in its color and is still produced today. Woad can be found in the Unite Stated, but the process requires the vat technique.

Navajo Tea

In my discussion with my colleagues from the Dine Nation, I learned about Navajo tea. Navajo tea is a common plant in Arizona, and grows "…in the timber regions on the mountain and around the edges of cultivated land at thigh elevations if the moisture is sufficient."[38] The plant is used to create a range of oranges. My colleague, Priscilla Black, a teacher Kayenta Middle school, described the color as "golden rod"[39] and explained the dying process to me. She stated that the tea is harvested and it can be dried or used fresh. Next, the dyer takes a clean No.10 sized can full of water and places it over the heat/fire. The Navajo tea is placed in the water and simmered. When the liquid has been reduced by half, it is topped off with fresh water and the reduction process is repeated. Once the solution has the desired potency the dyer places wool in the dye and leaves it for a few days. The amount of time determines the intensity of the color to some extent and is a personal preference of the dyer.[40]

As our conversation progressed, I shared my attempt to dye with lichens earlier that summer. I was unsuccessful, but that sparked our discussion about the water on the reservation. The Arizona water is alkaline which benefits the dyeing process. The water in Arizona has been in contact with local limestone, chemically known as calcium carbonate.[41] The calcium carbonate is picked up by the water that is poured into the No.10 can. Navajo tea can be used fresh without a mordant to yield a light olive green, but alum must be used to yield the orange to gold hues.[42]

More locally, within the state of Delaware, there are several dye producing plants. Goldenrod (pictured below), Latin name *Solidago,*[43] is a common wild-flower. A tall stem, leaves from the ground up, with a top of small golden blooms like a firework on top, can grow to about three feet high. People often claim to be allergic to goldenrod, but this is a misconception. Goldenrod is commonly mistaken as an allergen due to it having a similar appearance to ragweed. The ragweed pollen is what people are allergic to, as it is readily airborne during allergy season. The goldenrod pollen is physically too large and too heavy to become airborne to the point that it can be inhaled. Goldenrod actually has some medicinal qualities and its leaves can be used as a tea, but the flower yields a range of yellow dyes. Depending on the mordant, goldenrod can yield several different shades and colors. In the presence of alum, the color is bright yellow. When copper is used as a mordant, it yields an olive green color, while iron mordants create a drab olive.[44] Goldenrod is my plant of choice to use with my students because it is readily available around Delaware, commonly growing on the sides of roadways and in community land.

Along with its commonality, goldenrod is also a very fast grower and easily cultivated from cuttings and seed.

Strategies

Big Ideas

To challenge my students throughout the year, I use focus topics called "big ideas". A big idea is exactly as its name states; it's broad and encompassing, and it only exists as an idea or happening. I explain to my students that big ideas cannot be touched or put in your pocket and exist only in your brain. Some big ideas that we regularly discuss and create art about are identity, transformation, family, nightmares, and dreams (figurative/literal), power, beauty, nature, time, and more. These ideas are usually the focus for a month or two, and after we are done they move to a big idea bank. The big idea bank allows students to revisit any past big idea when they are so inclined. There is no due date or expiration for a piece of artwork inspired by a certain big idea, and very commonly, students' artworks span across a few big ideas.

The big idea that I will be focusing on for this unit is Transformation. In class, we will look at how artists transform materials, ideas, emotions, and viewpoints with their artwork.

Centers

New materials are introduced in a center, a home base or spot where those materials will live for the remainder of the school year. These centers can be tables, drawers, baskets, or even a binder of information. Using this organizational technique allows me to run my classroom the only way I see fit: as learner-directed. New ideas are introduced to students in a variety of ways, such as presentation, challenge days, light readings, and art criticism talks.

The use of centers allows students free access to all material in the classroom. I release materials in stages throughout the year as students are ready to receive them. I begin the school with the entire room being the drawing center. At every table, I stock a variety of drawing materials: markers, colored pencils, crayons, etc. Standard pencils are readily available at another location, next to sketch paper and other permanent materials. As the year progresses and student understanding and skills develop, more advanced material is released in this order: painting (cakes then liquid), collage, sculpture, printmaking, clay, weaving. Alongside materials-based centers, I also open content-based centers. Still life is a center that resides in a container; it is set up and broken down as the artist/student needs. Continuing through their mastering of the art room, students will have access to an upload center where they photograph their own artwork and submit it for publishing on the class website, as well as more information based centers where they can go to brainstorm and analyze information to craft new ideas. These information style centers often include technology and a hall pass to leave the room and venture to the library across the hall.

Choice-based Art Education

The choice-based, or learner-directed, art room is one where students oversee the designing of their own lesson. In my art class, I will never tell a class what we are making; that's just not right and it for certain isn't artistic. Instead, I teach my students about techniques, process, artists, history, cultures, and materials. Once loaded with their new information for the day, I set my class free to use the lesson or techniques in any way they choose. I encourage experimentation and celebrate the failures equally to the successes as opportunities to learn. Everything is relevant to my young artists and will be used in the creative process.

I decided to "teach" in this manner after studying the level, or lack of, creativity in my students. As the teacher in the learner-directed classroom, I look at myself as a facilitator. I am there to prep students and materials for self-directed discovery and art-making. When put in charge of a project students are not just deciding what color to paint their artwork, but rather working on a deeper level of how they want to communicate. Students in the choice based art room are thinking critically about what they want to create and how they will accomplish that. I challenge my students to think creatively about materials and techniques.

The learner-directed classroom is a place where students think critically about choices, strengthen their visualization skills, and develop collaboration techniques. Every student in my classroom must present me with their idea before a project can begin. Like a mini sales pitch, students must express how this project will be completed, what the significance is to them, and what the viewer will experience.

This upcoming school year I plan to separate each grade level into *focus years*. Each grade will focus on a different aspect of art. For example, I plan on having the fifth-grade focus on skill development. My fifth-grade students are headed into the competitive world of middle school and I want to send them there with a full arsenal of artistic skills. I'm thinking my second graders will focus on the historical context of art and its impact on human life. My third-grade students will focus on the sciences in the arts. I plan on teaching them about the properties of substances and art materials, running different artist experiments, and letting them reason their way through the artmaking process. This unit will fall within the science immersion focus year. My younger students in kindergarten and first grade will focus on sensory exploration and self-expression.

Restorative Practices

At the beginning of last school year, Keene began a new course of disciplinary action. Our first action is now to use restorative practices, instead of the outdated scolding/punishment model of discipline. The main idea of restorative practice in school is to repair the relationships harmed during a time of wrong. When an incident occurs that disrupts the classroom relationship I focus my teaching on repairing the relationship(s) between the offending/offended parties. Assuming the role of a facilitator, I bring together all students or classes involved in an incident to voice, in a safe place, how we all felt before, during, and after the incident.

The book Better Than Carrots or Sticks: Restorative Practices for Positive Classroom Management, lays out the framework for facilitating “circles”.[46] In our circles we take equal time to speak, listen, and understand how all the involved parties feel. The focus of these circles is not to decide a punishment for the offender, but to bring the victim and the offender together to come to equal terms of understanding, in order to move forward. In my classroom, I strive to create a supportive community where students feel safe enough to express themselves in any way they need. To do this I use several educational techniques including the choice-based art education philosophy mentioned above, but also self-assessment.

Activities

Color Source Rubbings

We have an amazing outdoor space at Keene including an outdoor classroom, pergola, numerous flowerbeds, and a wooded stream area. Students will venture outside the classroom to search for some natural resources of color. To start, this hunt will begin with a meeting at the outdoor classroom. Utilizing sketchbooks students will explore their environment for sources of color and document it via sample swatches.

In their sketchbooks, students will document experimental color resources into their notes by rubbing their color sources against their paper. Students will create two rubbings of each source, as they will need them for testing. Once a significant amount of color has been transferred from its source to the paper, students will document the name of the sample (if known), location found, material properties (wet, dry, scratchy, etc.), original color observed and anything else they deem important. Students will then complete at least three-color source rubbings for homework that week.

Before the official outing to source color from our natural setting I will front load students with information about Native Americans and their resources of color. Students will be questioned during their harvesting to promote critical thinking about what makes a good pigment.

Colorfast Test

As a group, we will share our color source findings and notes with each other to compare and contrast. Then, students will begin to test their rubbings as potential dyes. The test and analysis of the color samples will follow the scientific method, as a tie-in with the Next Generation Science Standards. Students will first make predictions about which sample will be the strongest after testing. These predictions will be written in their sketchbooks, along with any other notes they take during testing.

Each sample will be subjected to washing and sunlight to test its fastness. Students will use a light soap to attempt to wash half of the sample off of the page. The other sample will be left open to be exposed to light for several days.

After the fastness tests, students will review their samples and draw conclusions of which of their found color sources would make the best dye and why. This activity is designed as an introduction to the idea of natural dyes and found colors. Until now, students may have only experienced pigment as a color source through art supplies. By looking for new sources of colors students will begin to think about non-traditional sources of color.

Once students have selected their strongest samples, we, as a class, will choose one of the samples to test on some fabric or yarn. The test will be a raw fiber versus a fiber that has been soaked in an alum mordant. This test will illustrate possibilities or necessity of a mordant in the dyeing process.

Chromatography

Once students have identified their strongest sample they will conduct a chromatographic dispersion. Referencing their notes, students will venture back out to their collection sources to collect a sample of their strongest pigment. The pigment will then be transferred to filter paper in order to conduct the experiment. After the dispersion, students will analyze the colors extracted and reference the color wheel. While talking about what colors came out of our samples, we will draw some conclusions of color theory and discuss the similarities and differences of our samples.

Artist Statement

An artist statement is an essential part of the artistic process. The artist statement is and artist's chance to label a work as finished, explain their ideas and processes, create a frame of reference, and ask the viewer to experience the art in a specific manner. As young artists, students will go through *Artist Statement Boot Camp.* A two-class lesson on what makes a great artist statement. On day one, students will participate in a guided notetaking activity to define how a great artist statement answers the basic questions of who, what, when, where, why, and how. On the second day, students will receive a poster of a famous work of art. Pretending to be the original artist, each pair of students will draft an artist statement based off of what they can observe from the reproduced print. Students will create an artist statement to explain their findings and results of the natural color project. Students who elect to turn their natural dye into colored fiber and ultimately into a work of art, will explain the process from start to finish. As a class, we will publish our results for the color, wash, and mordent test in an artist statement.

Implementing District Standards

Delaware Visual Art Standards

Anchor Standard 2: Organize and develop artistic ideas and work.

The unit will address this standard through the experimentation and development of not just an artwork, but also some of the materials needed to complete it. In sourcing their own dyes, students will be developing their ideas about what resources can be used to make art with and how.

Anchor Standard 10: Synthesize and relate knowledge and personal experiences to make art.

The unit will meet Anchor Standard 10 by requiring students to experiment to gain personal experience with their natural artmaking materials. Students will be going to the outdoor classroom to gain first-hand knowledge of the artistic resources around them.

Anchor Standard 11: Relate artistic ideas and works with societal, cultural, and historical context to deepen understanding.

In out discussion about the Navajo and other Native American people, students will be drawing conclusions and asking questions about what resources might have been available before Europeans came to Delaware.

Next Generation Science Standards

5-PS1-4 Matter and Its Interactions: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Students will be conducting investigations and experiments during their color sourcing and dye testing. When the class experiments with adding a mordent to the dyeing equation they will be experimenting with the addition of a new substance to a tested solution.

3-5-ETS1-3 Engineering Design: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

In their field books, students will be collecting samples and testing them for lightfastness and washfastness. These tests will be analyzed through note taking and conversation amongst students. The results of the experiment will be documented in sketchbooks and later used in an artist statement.

Common Core

CCSS.ELA-LITERACY.W.3.3: Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

Students will be writing artist statements, which are essentially descriptive narratives about a work of art by the artist. Their artist statements will explain their creative process, scientific process, and results, along with their goal for the artwork. These statements will be directly relating to, and describe, describe their personal works of art or their perceived experience as a pretend famous artist.

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