

Imagination, Awareness, Adaptation: Art's Place in the World of Science

Robert Graham

Introduction

“Every great advance in science has issued from a new audacity of the imagination.”
-John Dewey

It is that imagination that Dewey speaks of that I aim to find, sculpt, and foster in all my students as an art educator. Science and art have forever been linked as both disciplines investigate, experiment, and constantly challenge what is before us as human beings. An artist has their studio, and a scientist, their laboratory; each place's sole purpose is to encourage the thinking ability of the people inside it. “Artists, like scientists, study—materials, people, culture, history, religion, mythology—and learn to transform information into something else. In ancient Greece, the word for art was *techne*, from which *technique* and *technology* are derived—terms that are aptly applied to both scientific and artistic practices.”¹

In the beginning, everything was art. Artists were the ones who made things, observed the world around them, and questioned it all. I cannot begin to comment on the topic without mentioning the work of da Vinci. Leonardo da Vinci is accepted as the best-known Artist/Scientist; his work will forever link the two schools of thought. Da Vinci observed the world around him and documented what he found, but did not stop there. Questioning how things worked or why they happened forced him into the realm of a scientist. The need for creative thinking and questioning is the backbone of the sciences. As Dewey stated above, the imagination is the cause for new scientific findings. If no one is asking the questions, then why look for the answers? Creative thinking is a skill necessary for today's students, teaching it is the challenge of today's educators.

As an art educator, it is my task to express all knowledge that I have collected over my entire life to my students, as well as take in the insights and ideas brought to me daily from my students. I view my position as an art educator as a quest to never stop learning and sharing my knowledge. While I continue to grow new roots in Delaware, I find myself becoming more and more interested in the environment around me.

Demographics

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.

Some of life's realities that my students are forced to live with include: managing personal hygiene alone, coming home to an empty house, living in a shelter and not having food outside of school. All of these realities come into view when my students arrive at my classroom door. Serving grades K-5, the staff gives their all to accommodate the many students. Averaging around 700 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 on student and staff alike.

Rationale

I have the exciting benefit of being the art teacher. As the art teacher, my time is limited to once a week with my students, due to scheduling. I am one of the few teachers who will be actively involved with each student for the six years they are at Keene. My classes are my chance to create an atmosphere of freedom, creative thinking, and burning curiosity for years to come. My goal is to sculpt an environment where my students will know that they are free to think and peruse their ideas. Far too often I see my students crush their own creativity or ideas because they fear criticism from their peers, when often the idea is brilliant.

I have also noticed a population struggling with "outside of the box" thinking. Students are lacking the ability to fabricate ideas and find solutions. In discussing this coincidence with several other teachers, we noticed that there is rarely a reason for students to fabricate their own ideas. In today's classrooms, students are tested and stressed to be correct or incorrect; everything is black or white. They are missing the opportunity to develop their own theories and test them out. Always having multiple choices presented to them, curiosity and creativity are in a decline. I have seen students ask questions that are easy for them to answer themselves out of habit. I account the availability of technology as a partial reason; along with the fast-paced lifestyle these children lead. There is no reason to come up with a solution when there is an already existing idea is minutes away on the Internet.

Through my research and professional development in my field, I have chosen to follow a new trend in art education: "choice". Choice based art education is manifesting itself as a valid method of instruction. The focus of my new curriculum will be on the mental process of art and creativity, as opposed to the production of art. My classroom will be open for children to choose what medium to work with and when to use it. I think it helps to view one's creativity as a muscle, instead of a mental process. Just as lifting weights makes you stronger, behaving creatively makes you more creative. This style of teaching will increase two abilities within my students: creativity and imagination. The two are very similar on the surface but I differentiate creativity from imagination. Creativity is the ability to solve problems with the resources around you. These problems can be a blank canvas, an empty book, or a scientific need. Imagination is the ability to manifest ideas and things not found in reality or the environment around you.

To these 21st century students living in a world with answers readily available, creativity and imagination are more important than ever. I have found that children are lacking in their own creative ideas because there is always a prescribed idea for them to reference. The prescribed ideas have been designed to accomplish a goal and often appear in the mind of the thinker with certain connotations. To increase the creative thinking and imaginative curiosity of my students, I want to help them build a strong mind to constantly question and seek out new ideas and answers. This year my focus will be to harbor curiosity and imaginative questioning. I aim to expose my students to the endless world of art (and sciences) through real life problems in need of a creative answer.

Imaginative questioning will be essential to address the real life problems currently taking place in Delaware's aquatic environment. I will present my students with the topics of invasive species, pollution, awareness, environmental damage, and conservation. Through art we will illustrate how these blights are changing the Delaware River and Christina River, and the life forms that call them home. We will brainstorm solutions—whether they are campaigns to raise awareness or constructed objects to counter an ongoing problem. No one ever found the answer by thinking inside the box.

I will focus on the impact man has made on species found in the Delaware River. The river has climbed to the number five spot among the nation's most polluted rivers.ⁱⁱ Students will be presented with a man-made problem that has stricken the river and challenged to imagine and design how the native species will react to it. Only factual information will be provided for students and they will use these facts to anchor their imaginative reactions. As students develop the adaptations of species they will provide an explanation for each adaptation. The final product will be a full-scale model or illustration of the effectiveness of the adaptations for various species of marine life.

Science and Art, an eternal relationship

As I stated earlier, the relationship between science and art is a historical marriage where like-minded individuals questioned the same topics. It was these individuals who investigated and sought out their own answers that solidified the relationship. One of the most famous artists that illustrate this relationship is Leonardo da Vinci. Da Vinci designed thousands of machines and inventions, like an engineer. He illegally autopsied and dissected human bodies, like a biologist, to better understand the human form. A true renaissance man, da Vinci sought to understand multiple disciplines. All this research culminating in two of the world's most precious works of art: *The Mona Lisa* and *The Last Supper*.

Later on in history the questioning shifted as the invention of photography changed the art and science worlds forever. Now there was no longer a need to recreate by hand what can be seen visually; it is as simple as photographing it. Art's direction changed completely, to one of pushing boundaries, similar to the ways modern medicine pushes the limits of what is humanly possible. The actual invention of photography was a scientific breakthrough, but it was artists and photographers like Ansel Adams who took this new scientific break-through and showed the world what it could do. Ansel Adams

(1902-1984) was an American photographer whose work photographing the American landscape laid the groundwork for landscape photography. Adams's photographs spoke volumes about the need for conservation to be a daily topic of concern. Born in San Francisco, Adams spent childhood among the dunes of the Golden Gate Bridge, developing his appreciation for nature.ⁱⁱⁱ

Art's Ability to Raise Awareness

I do not need to dwell on the idea of art's ability to raise awareness when the decades of propaganda and advertising precede me, but I do need to highlight art/artist's impact on nature, and illustrating the effect of humanity on it. Conservation and climate change are hot topics today, as they should be, and never before has art had such a key role. The propaganda of today may not be about war-torn Europe, but it is still propaganda, nonetheless. The "going green" movement that began early this century is a propaganda mission aimed to change the daily life choices of individuals. Art and advertising have been used extensively to push the idea of a need for change. Art, unlike written word, can be understood by anyone no matter the language they speak.

Adams, Ansel: Artist and Conservationist

Ansel Adams was born in San Francisco in 1902. An only child, of older parents, Adams grew up in a relatively normal childhood. He was pulled from the mainstream classroom and was home schooled for some time during his childhood. His parents gave him a Kodak Brownie (standard and common early consumer camera) and during a family vacation to Yosemite, he snapped his first pictures of the Park. Adams grew up and became known for his landscape photography, making quite the name for himself. Utilizing the dodging and burning techniques, in the darkroom, he created a style that was sought after by patrons and employers.

Adams was hired by several organizations to capture nature in his photographs, among them are: The National Park Service, Kodak, Zeiss, IBM, AT&T, Life and Fortune magazines.^{iv} As an active member of the Sierra Club, Adams accompanied the group on many trips as the club photographer.

While in the Sierra Club, Adams climbed his way up club politics. He advocated for preservation and suggested improvements for national parks. Eventually making his way to the Board of Directors of the club, Adams truly began to have a major impact on preservation, using his photography as a springboard. "Adams' images were first used for environmental purposes when the Sierra Club was seeking the creation of a national park in the Kings River region of the Sierra Nevada. Adams lobbied Congress for a Kings Canyon National Park, the Club's priority issue in the 1930's, and created an impressive, limited-edition book, *Sierra Nevada: The John Muir Trail*, which influenced both Interior Secretary Harold Ickes and President Franklin Roosevelt to embrace the Kings Canyon Park idea. The park was created in 1940."^v

A River Gone Bad

The Delaware River has run its way onto the nations most polluted rivers list. “Most of the 6.7 million pounds of toxic chemicals estimated to have been released into the Delaware in 2010 are due to the DuPont Chambers Works in Salem County, which is legally permitted to emit 5.3 million pounds of effluent into the watershed, says the report, which relies on federal Environmental Protection Agency data.”^{vi} The longest river on the eastern seaboard, the Delaware reaches eight states and provides drinking water for about 5 percent of the U.S. population.^{vii}

The pollution of the river ranges in containments from industrial to household. All of those contaminants have an effect on the organisms that call the river home. Fish and other gilled water dwellers are impacted directly by oil pollution. The oil that leeches into the Delaware from roadways and other pathways can build up on the gills of fish and slowly cause them to suffocate.

Prescription drugs have flowed their way into our water system via the sewer line. Lots of Americans are taking antidepressants and other mood altering drugs, which are expelled, often unchanged chemically, in our urine. The body uses what it can from the prescribed meds, and sends the rest into the toilet. The flush eventually finds its way to the rivers and bays where fish swim through a cocktail of various chemicals. The effect of antidepressants on fish is a topic of recent study. In a lab study, male flathead minnows exposed to minor amounts of antidepressant drugs began to ignore female minnows.^{viii} These changes in male behavior will reduce reproduction, this could lead to a devastating collapse in the food chain, as the minnow is essential as both a predator and as prey.

The Delaware River’s pollution problem has taken a toll on the organisms that call it home. “The watershed came when environmental laws led to a Delaware River revival. In 1961, Pennsylvania Governor David Lawrence convinced a reluctant JFK to sign the law forming the Delaware River Basin Commission between Delaware, New Jersey, New York, and Pennsylvania, the first ever Federal-state watershed compact. In 1968, the DRBC was the first agency to impose load allocations on river dischargers, holding them to standards more stringent than the United States Environmental Protection Agency (USEPA) issued years later. In 1972, Congress led by George McGovern overrode Nixon’s veto and passed the Clean Water Act, a law that invested \$1.5 billion in new wastewater plants along the Delaware River. Phosphate detergent bans by New York in 1973 and Pennsylvania in 1990, along with a 1994 halt on manufacture prompted phosphorus declines by over 25 percent in many rivers.”^{ix}

Delaware River Dwellers

The Delaware River is home to thousands of organisms, aquatic and non-aquatic, each fitting into their own place in the ecosystem. The New Jersey Division of Fish and Wildlife has an extensive list on its web page about the organisms that call the river home. I would like to focus on a few groups of organisms. Vertebrates, organisms with vertebra bones/spinal cord, such as fish (walleye, shad, striped bass, short nose sturgeon, carp, etc.), bog turtles, and several frogs are some of the larger more predatory aquatic-dwelling organisms of the Delaware.

Other inhabitants are invertebrates, or organisms without vertebrae. This group includes a diverse range of shelled organisms (mussels, clams, snails, etc.), crayfish, marsh crabs, horseshoe crabs, and insects. Many aquatic invertebrates are often first to experience the effects of pollution due to the way they process the water for oxygen and food.

Many aquatic dwelling organisms have gills to process oxygen from the water around them. Gills are similar to our lungs in that they are full of blood vessels and thin walls to allow oxygen to pass from the environment into the bloodstream. Gills are also made up of many layers and folds to increase surface area and have as much contact with the water as possible (an adaptation). Due to the gill's increased contact with polluted water and the thin-walled blood vessels, many other dissolved pollutants can and are absorbed into the blood stream of the water-breathing organisms. This is one of the most common interactions between human pollution and aquatic organisms.

Adaptations

The animals you see today have gone through generations of evolution. Each organism has adapted to fit its environment, or niche. A niche is the specific job, ability, or process that an organism plays in its environment. There are two types of niches: fundamental and realized. The fundamental niche is where a living organism can exist and what it needs to do to survive. The second is the realized niche; this is what the organism achieves after experiencing all the things in the environment that challenge it (such as a competitor) and prevent it from fulfilling its fundamental niche. To create and meet these niches, organisms needed to adapt. One example of this is adaption radiation, where one species exhibits multiple different and individual adaptations to fill empty niches in an environment.

An adaptation is a change within an organism that increases its ability to thrive in its environment. Many adaptations begin as mutations, and mutations occur on the genetic level. There are three types of adaptations: morphological, physiological, and behavioral. Morphological adaptations are changes in the body itself. Physiological adaptations are chemical or metabolic. Behavioral adaptations are how the organism acts, and responds. For an example, let us look at the rattlesnake. The rattlesnake has multiple adaptations; on the morphological side it has rattles, hollow fangs, and environment specific camouflage. Physiologically the snake has slow digestion and the ability to produce venom. Behaviorally the snake clusters, strikes, and lives on the ground. These are just a few of the multiple adaptations the rattlesnake has; there are even more adaptations between rattle snakes from different regions.

In order to adapt, a species must reproduce and contribute to the gene pool of that species/environment. Gene pool is the term used to describe the collective genetic information available for reproduction in an environment. Larger environments with many organisms of the same species have a very large gene pool, therefore there is more opportunity for adaptations to occur. Smaller environments with slimmer numbers of

organisms have a smaller gene pool. The smaller the gene pool the more common a trait may be. This smaller gene pool can lead to some interesting trends. A trend called the Founder Effect is when one small genetic variant takes over an environment. The Founder Effect is visible in the New England area. Cats of the New England region are more likely to have six toes per paw due to the trait being passed on in a smaller gene pool than in other populations across the U.S. Felines from other parts of the country may sometimes exhibit this trait, but the chances of it happening are far slimmer than that of a New England cat.

Selection: Natural, Kin, Sexual, and Artificial.

Natural selection is one of the most basic ways evolution occurs. It is the phenomenon in which certain organisms prevail over other organisms of similar species or niche. When a genetic mutation occurs that benefits an individual, that mutation allows for a better chance of survival, and ultimately that mutation being genetically passed on to kin. Under natural selection there are several other types of selection: kin, sexual, and artificial.

Kin Selection is the term used to describe the will of a parent or relative to protect its offspring. It is biologically predetermined that a mother/father will put their livelihood in danger in order to protect their offspring. This would not occur with two random organisms, and the degree of sacrifice decreases each step the relative genetic distance between two organisms increases. The term “blood is thicker than water” can be used to describe kin selection. Siblings share 50 percent of their DNA, cousins share 25 percent, and so on. Kin selection also holds true when discussing non-relatives. To use a human example, people are more likely to protect each other the more intimate the relationship is. Family being the closest relation followed by village, town, city, etc. The scarcer a personal relationship is the less likely any individual is to compromise their livelihood to save another. This may go without saying, but it is a genetic predisposition.

Sexual selection is rather simple; you choose who you reproduce with. Not all organisms exhibit sexual selection, such as oysters, who reproduce openly in the tide. Organisms that exhibit sexual selection are looking for attractive qualities in their mates. Many species have certain rituals or requirements for mating. The male bower bird of Australia goes to extreme lengths to impress the female population. He constructs elaborate dens with decorations to attract mates. The female will choose to mate with the male with the most attractive display.

Artificial selection is the result of humans controlling who mates with whom among a desired species. Modern agriculture is the poster child for artificial selection. A farmer will breed his dairy cows for certain characteristics, like fattier milk or leaner milk, based on whether he is selling the fatty cream or producing drinking milk. Agriculture has artificially selected the progression of pigs, breeding them from the natural small size to today’s 500 pound pigs. Artificial selection is how different breeds of dogs were engineered. By breeding like individuals, or combining traits, breeders were able to produce a litter with the desired traits.

Activities

I believe in a choice based, student driven learning path in the art room. The following activities are ideas to help students guide their problem solving. In each activity there should be as much opportunity to for open-ended investigation. I am challenging my students to solve the problem of awareness in regards to the Delaware River pollution problem. I ask my students how will they make other people aware of the pollution? What is the strongest way art can send a message? How can an artist's interpretation impact a viewer?

Mutation Mask

Masks are used to hide identities, change expressions, and portray characters. Throughout history, the mask has been an essential part of celebrations, performances, and deception. Students who choose to construct a mutation mask will examine the idea of what a mask can do to the wearer and how it changes the experience of the viewer.

Students who select to complete the mutation mask will choose a resident aquatic organism in the Delaware River, and illustrate a potential mutation caused by the pollution. For example, a student may choose to illustrate the drastic/exaggerated effects of excessive amounts of oil in the water system. What would this do to aquatic life if they can initially survive the toxins? What will their skin look like? Their gills? How will they see, if at all, through the murky water? Mutations should be as drastic as possible to cause concern and raise awareness.

Students will first sketch out their organism and adapt its shape and profile to a mask. Next students will select a pollutant, such as litter, agricultural run-off, or sewage, and brainstorm what effects it would have on their organism in a drastic way. To push the idea of awareness, students should stretch the mutations to the extreme ends. Once sketched, the student may begin construction.

Construction of the masks will be done in paper mache. The technique is well suited for mask making due to its endless possibilities and it is lightweight. To begin making a mask the artist (student) must crumple up newspaper sheets until they have a ball about the size and shape of their head. Use masking tape to hold the ball together; it is not necessary to cover the entire surface with tape. This ball will be the basic form. Once complete the loose newspaper can be ripped away from the mask through the back. Artists should cover the form with one layer of paper mache.

There are several recipes for paper mache, as well as ready-made products and plaster cloth strips. My favorite recipe for paper mache is one-part flour to one-part water; it's that simple. Stir the mixture until it forms a thick, glue-like paste. While stirring make sure to break up any clumps of flour. Next dip one-inch wide strips of newspaper into the solution and squeegee off the excess paste between two fingers. Place the strip over your form and smooth down. Once the initial base layer is completed, let it dry completely before adding another layer. Continue this process layering strips, no more than four

layers thick. After the base layer has dried the artist should map out the features for the mask. At this point students should begin to form the features of the mask with more crumpled newspaper. Build up areas with newspaper and masking tape to create features and designs. After the basic features have been taped down, use more strips and paste mixture to permanently attach them to the base form. As the artist builds up strips of paper mache, sculpt and form the details. The artist may add as many layers as needed to achieve the desired rigidity.

When the mask is finished the artist should smooth out all unwanted folds and bumps before the mask dries. After it dries, unwanted marks can be sanded with sandpaper. To remove the initial form of loose newspaper, begin to pull pieces from the back of the mask and discard. The artist should pull as much loose newspaper from the inside of the mask as possible. To finish construction of the mask, coat the inside with one layer of paper mache. Finalize the design with acrylic paint.

The final step to any mask is, of course, to wear it. The artist should put on the mask and assume the character of it. How does this aquatic organism move, behave, and function?

Design a Fish

This activity is similar to the mutation mask, but it calls more toward the designer-minded students rather than the maker-type students. If a student chooses to answer the awareness problem with the “design a fish” artwork, they will be challenged with creating a totally new species. This species of fish will have adapted from a current Delaware River dweller. After learning about adaptations and what causes them, how the effect the organisms chances for success and survival, students should brainstorm what types of adaptations an organism must develop in order to thrive in the polluted river system. What challenges will the organism face? How will the organism eat and breathe? What new dangers are caused by pollution? What can be taken advantage of?

All of these considerations should be compiled into a brainstorm session. Students will produce a quality scientific style illustration of their newly created creature. The final product will need to include a quality drawing or illustration, explanations of adaptations, and how they affect the animal’s essential functions: eating and reproduction. The artist should sketch out their organism several times to figure out the best-suited adaptations for the polluted environment.

Now and Soon Poster

In propaganda/advertisement style poster students will illustrate the Delaware River as it stands today, a crippled system in recovery, as well as a projection of what the river will look like if no further action is taken to halt pollution and slow deterioration. This artwork may be complete in any two-dimensional medium(s) that the artist sees fitting.

Final posters should be 18 x 24 inches or larger. The size of the poster is necessary for visual impact. It is up to the artist to decide how they want to arrange the illustration. The design should be arranged for maximum impact on the viewer. A brief artist statement should accompany the finished poster to explain the arrangement, design and process.

Traditionally handmade posters were inked with pigments and very liquid paints. Students should use clean crisp lines in their drawing. To finalize poster design, the artist may choose to embellish their poster with a text statement to promote action.

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- ⁱ Eskridge
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 - ^{iv} United States
 - ^v History: Ansel Adams
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 - ^{vii} What We Do to Protect the Delaware River Watershed
 - ^{viii} Fish on Prozac
 - ^{ix} Kauffman

Curriculum Unit
Title

Imagination, Awareness, Adaptation: Art's place in the world of

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KEY LEARNING, ENDURING UNDERSTANDING, ETC.

This unit focuses on some of the connections between the Arts and Sciences. Students who participate in this unit will discover the many ways that visual art has played a role in science and how they can use art to communicate scientific idea. The unit highlights environmental awareness, conservation, activism, propaganda, and pollution.

ESSENTIAL QUESTION(S) for the UNIT

In what ways are the sciences and the arts connected? How do artists communicate their ideas? What role does art play in environmental awareness? What do images say that words can not? How can an imagination be beneficial?

CONCEPT A

Adaptation

CONCEPT B

Awareness

CONCEPT C

The Relationship of Art and Science

ESSENTIAL QUESTIONS A

What is adaptation?
In what ways do organisms adapt?
Why is adaptation important?
What does adaptation do to future organisms?

ESSENTIAL QUESTIONS B

How can I raise awareness?
What does being aware mean?
How does awareness affect people?

ESSENTIAL QUESTIONS C

How are the arts and sciences related?
In what ways can an artist be a scientist?
In what ways can a scientist be an artist?
Why do the arts and sciences overlap?

VOCABULARY A

Adaptation, organism, selection, niche, genetic, DNA,

VOCABULARY B

Awareness, conservations, pollution, environment

VOCABULARY C

Leonardo DaVinci, Ansel Adams, photography, observation, critical, creativity

ADDITIONAL INFORMATION/MATERIAL/TEXT/FILM/RESOURCES

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