Bridging "The Two Cultures" through Aesthetic Education: Considering Visual Art, Science, and Imagination

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Abstract
Art can be used to enrich the subject of science and science can be used to motivate study in art. This can stimulate new ways to regard the relationship of art and science in classrooms. Theoretical and practical examples will highlight: early and contemporary artists who developed ideas about art forms in nature; the impact an Aesthetics and Science Workshop had on university professors; and a successful science and art secondary education curriculum implemented in an East Harlem school.

Introduction

Art and science are generally considered totally separate disciplines. Science encourages objective observation, measurement, and precision through rational thinking, while the arts encourage affective engagement and participatory learning, "celebrating the life of feeling and imagination."[1] Visual art is underappreciated even in the educational community. It is often the first subject cut in a budgetary crisis. In contrast, maths and science are always thought of as necessary to strengthen an individual's capacities for competing in the employment marketplace for which education prepares them. Rational and measurable, the sciences appear to be more relevant in our assessment and accountability-driven world in which teachers find themselves. Accessing the imagination no longer seems relevant in the classroom and aesthetic experience of little or no importance, largely because it cannot be measured. The shortsighted fallacy of such thinking must be contested and educators must take a leadership role in this arena. The visual arts can significantly contribute to the enhancement of learning in many disciplines, including the sciences. As Professor of Art Education Arthur Efland wrote, "Art enables human beings to realize their spirit and their destiny in the actions and products of their imagination".[2]

[1] Arthur Efland, *A History of Art Education.* (1990). p. 263.

This paper addresses the topic of art and science as *ways of knowing* and how science and artistic expression can be enriched by each other. Art can be used to enhance the study of science and science can be used to motivate study in art. This presentation is not a comprehensive survey of either discipline; rather it is intended to stimulate new ideas relating to the status of art and science in classrooms. One part describes profiles of artists from the past and present who developed theoretical ideas about art forms in nature through scientific inquiry. The second part summarizes the impact an Aesthetic and Science Workshop had on a group of university professors. Finally, a description of an application of an interdisciplinary curriculum I was involved in as a high school visual arts teacher that sparked discoveries in science and art learning.

Questions raised in this discussion refer to the British scientist and writer C.P. Snow's most noted lectures regarding his concept of *The Two Cultures,* where he considers that the breakdown of communication between the sciences and the humanities is a major hindrance in [solving] the world's problems.[3] *What do aesthetic and scientific inquiry share in common? How can teachers build bridges between the two disciplines in ways that impact the lives of students?* Educators can benefit by considering these questions. My thesis is in agreement with Snow's perspective that, it is not about the superiority of the humanities over the sciences, or the slighting of the importance of science. Rather, that expectations of educators today must be to develop perceptual, cognitive, and expressive capabilities, useful in multi disciplinary learning and relevant to the lives of students they teach.

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[2] — Arthur Efland, (1990). p. 263.

Forms In Nature: Early Artists

"The artist uses imagery and metaphor; the scientist, numbers and mathematics." [4] Art and science were first united in the discovery of linear perspective by the sculptor and architect, Filippo Brunelleschi (1377-1446). This system is a:

> geometric procedure for projecting space onto a plane, analogous to the way the lens of a photographic camera now projects a perspective image on the film. Its central feature is the vanishing point, toward which any set of parallel lines will seem to converge.[5]

Although Brunelleschi's discovery in itself was scientific rather than artistic, it became important to Early Renaissance artists. His philosophy arises from the recognition he got from the artistic community. The Latin word *perspective* means 'seeing through'. The "percpectival" view of space transforms a picture "into a 'window' as if one were looking through a window into a space."[6]. This new approach to perspective was objective, precise, and rational. With a mathematical perspective artists were able to represent three-dimensional space on a flat surface. Even Leonardo da Vinci 's (1452-1519) work embodied this trend of art and science. Trained as a painter in Florence by Verrocchio, Leonardo worked for the duke of Milan as a military engineer, and only secondarily as architect, sculptor, and painter[7]. His altar panel *Virgin of the Rocks*, c. 1485, shows the artist, as both draftsman and keen observer of nature in his beautifully rendered water flowing around obstacles and plant life. In his later years, Leonardo devoted himself to applied science, flying machines, and waterways. His notebooks were filled with studies of flowers, birds, skeletons, cloud and water effects, and embryos in the womb.

[3]Snow, C.P., *The Two Cultures.* (1993). Cambridge: University Press.
[4] Bülent Atalay, *Math and the Mona Lisa.* (2006) p.14.
[5] Horst W. Janson, *History of Art.* (1986) pp. 396-397.
[6] Sheldon Nodelman, "Structural Analysis in Art and Anthropology." (1966), p. 89.

Leonardo believed that the artist must know not only the rules of perspective but all the laws of nature, and to him the trained eye was the perfect instrument to gain this knowledge. He created the modern scientific illustration, an essential tool for anatomists and biologists."[8] Scientific Illustration is one of the art courses taught at the secondary level. The aim of this course is to enable students to apply skills learned in Basic Illustration class to represent specimens, under microscopes, in the zoo, aquarium, plants, rocks and minerals through observation. This will be discussed in the third part of this paper.

In 1919 Marcel Duchamp (1887-1968) penciled a mustache and goatee on a color postcard reproduction of Leonardo's *Mona Lisa*. It was inscribed with the acronym *L.H.O.O.Q.* which is meant to read phonetically as "*Elle a chaud au cul"* (She has hot pants),[9] a phrase used in a family literary publication, or (She's got a hot ass"),[10] literal translation. Why would Duchamp choose to alter this classical painting by Da Vinci? According to A. Richard Turner, Duchamp was one of the most Leonardesque of artists.[11] Both men believed mathematics were fundamentally important, and both supplemented their art by intellectual investigations. Both were interested in the process as opposed to the product, and recorded their intellectual methods in great detail. Art historian Paul Trachtman writes, "Duchamp's defacement was meant to express the Dadaists' rejection of both artistic and cultural authority [and that] Duchamp had the most success turning tools of science into art".[12] Duchamp's *Nude Descending the Staircase no. 2* (1912) was influenced by his ambivalent relationship with Cubism. He felt that Cubism lacked

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[7] —Horst W. Janson, (1986) p. 437.
[8] —Horst W. Janson, (1986) p. 449.
[9] Paul Trachtman, (2006) "Dada." Smithsonian p.68.
[10] A. Richard Turner, (1993) *Inventing Leonardo.* p. 146
[11] — A. .Richard Turner, (1993) p.146.

"movement."[13] He adopted the limited palette of Cubist paintings, yet his figure is in a state of perpetual motion—a very different effect from Pablo Picasso and George Braque's paintings. This painting was influenced by analytic early stop-action photographic studies of motion. Duchamp also built machines with spinning discs that created spiral patterns. An American photographer Man Ray (1890-1976) documented Duchamp's optical machines and manipulated his own images in the darkroom to create illusions on film.

Bauhaus teacher and photographer, László Maholy-Nagy (1895-1946) was influenced by Man Ray and the Dadaist movement, which led him to integrate industrial technology with his photographic technique. Moholy-Nagy's "free experimentation exploited the plasticity of photographs."[14] He used light in photography as "the embodiment of dynamic energy in space."[15] In *Chute (*1923) he combined airbrush and halftone reproduction with traditional artistic tools, pen and ink to create a unique image. His goal was to extend sense perception in new ways."[16] Similar goals were achieved by taking pictures through microscopes and telescopes. Bernice Abbott (1898-1991), took beautiful scientific photographs from 1939-1958 to demonstrate the law of physics. She was Man Ray's student and later his assistant. Her photograph *Transformation of Energy* is "aesthetically compelling and scientifically valid."[17] Through careful observation of form, line and composition, these photographers have "helped to open our eyes to the invisibly small and the infinitely far."[18]

[12] —Paul Trachtman, (2006) Smithsonian. p. 71.
[13] Sarane Alexandrian, (1977) *Marcel Duchamp.* p.17.
[14] Sam Hunter, (1991).*The Museum of Modern Art.* p. 484.
[15] — Horst W. Janson, *(*1986) p.779.
[16] — Horst W. Janson, *(*1986) p. 779.
[17] — Horst W. Janson, *(*1986) p. 779.
[18] — Horst W. Janson, *(*1986) p. 779.

Just as students are taught parts of speech, to communicate verbally in more conscious ways, art teachers teach about ”visual parts of speech” or art elements. Regarding this *Language of Art* students become familiar with terms such as form, shape, space, color, line, texture, contrast, balance and emphasis. In scientific language these terms are relevant to observational studies as well as investigations of structures.

All organic and inorganic structures have forms, and structures which provide clear examples of visible shapes and organic arrangements from an aesthetic point of view. These forms can also be scientifically analyzed. For example D’Arcy Thompson (1917), in his book *Growth and Form,* investigated forms such as the growth of spiral shapes in shells and horns. His work revealed many aspects of related forms in nature. He pointed out that, “Closer analysis of natural phenomena through physical or mathematical research made their beauty even more apparent.”[19]

The Golden Ration of Nature or the Fibonacci spiral is an excellent example of this. Spirals appear in seashells, pine cones, animal horns, patterns of plant growth, galaxies, and the rendering of a DNA strand. Spiral shapes in art can be found in drawings by Leonardo including his studies for a helicopter, a design for a spiral staircase, and a pump. Another example is *The City of Destruction* an illustration based on John Bunyan’s *The Pilgrim’s Progress* which shows a visual story of a destroyed city utilizing a spiral formation. American painter Georgia O’Keefe (1887-1986), represented microscopic close-ups of organic shapes including seashells. Other environmental examples of spirals include plant growth in spiral stages, and spiral staircases.

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[19] Dolf Reiser, (1972) *Art and Science* pp. 48-49.

These patterns in nature, depicted in drawings, paintings, and architecture reflect parallels between art and the natural environment. This idea of form in nature will be revisited in the section that describes an art and environmental science collaboration at the high school level.

Art Forms In Nature: Contemporary Examples

Art and science collaborations related to nature and natural elements are rapidly becoming the hallmark of the 21st century. The ArtSci INDEX is a user friendly, online research tool with a searchable database. It has a special matching function designed to assist individuals around the world to find appropriate collaborators for projects of mutual interest. Participants range from biologists, technologists, mathematical physicists, psychologists, playwrights, visual artists, dancers, and musicians.

Founded in 1988, Art & Science Collaborations, Inc. (ASCI) is one of the few art and technology members organizations in the USA. Established primarily as a network for artists who either use or are inspired by science and technology. ASCI was instrumental in reinvigorating the art-sci-tech movement in the United States during the 1990s. ASCI also produced exhibitions of kinetic art, interactive light art, solar art, digital prints, and a Womentek exhibition.

In 2001, the University of Oxford hosted a series of experiments in the visual arts. Five artists were asked to explore the subject of science and to make meaningful connections with their own work. Susan Derges' (born 1955), work entitled *Natural Magic* was the outcome of a year-long residency in Oxford. Derges collaborated with the Museum of the History of Science. Some of the other projects concentrated on making links between artists and practicing scientists, but the Museum Director agreed that the history of science could provide an alternative and equally stimulating source of inquiry for Derges' project.

Derges' art form involved cameraless, lens-based, digital and reinvented photographic processes, and encompasses subject matter informed by the physical and biological sciences. Derges explored the Museum's 'cabinets of curiosity' using the four elements of earth, water, air and fire as a guide. She presented the organization with new ways of thinking about its collections. Members from the Museum's staff responded by selecting texts for the artist to consider. The title of the residency, *Natural Magic*, is a reference to one of these texts, a famous study of popular natural and physical science by Giambattista della Porta, first published in 1558.

A Renaissance scholar, Giambattista della Porta is renowned for the broad spread of his scientific interests - encompassing everything from cosmology, geology and optics to poisons and cookery - and for his observations. Della Porta's writings helped Derges to make the necessary leap of imagination from the Museum's holdings to the experiments in which the exhibits were originally used. The Oxford educated American cleric Reverend William Gilpin (1792) wrote, "Our eyes are only glass windows; we see with our imagination."[20] This inspired Derges to use her residency to recover the sense of imagination and wonder in science. At the outset of the project the building was undergoing refurbishment. When excavations on the foundations unearthed old chemical vessels, alongside human and animal remains, the artist reflected about the relationship between these objects to early scientific practice.

On the Derges Guide Website http://www.m.hs.ox.uk?derges/ , the artist described how the materials found in the basement:

> . . .had once formed part of an ancient scientific laboratory. The objects provided a potent reminder of an era of science when there was less separation of disciplines, when anatomy would have been practiced alongside chemistry or celestial observation, and when imagination and subjectivity were inseparable from scientific enquiry.[21]

In the exhibition four large images representing the four elements are set alongside smaller back-lit light boxes which narrate the creation of aqua vitae. The Public Manager at the National Portrait Gallery, comments on Derges work:

> Too often, science is depicted as a detached and objective undertaking. Art, by contrast, is acknowledged to be about feelings, connections and instinct. By using the four elements as an organizing principle, Susan Derges helps us to see the objects and history of science through imaginative eyes and reveals unexpected affinities between scientific and artistic ways of making sense of the world.[22]

***Icy Bodies:* A Contemporary Science And Art Collaborative**

The New York Hall of Science is New York City's hands-on science and technology center[23]. Exhibits include sound, light motion, microscopic organisms, optics and other science concepts. Shawn Lani (born 1967) is an American artist who has worked collectively with material

[20] William Gilpin (1792) from the website http.//www.mhs.ox.ac.uk/derges/guide.htm
[21] http.//www.mhs.ox.ac.uk/derges/guide.htm

scientists Drs. Sidney Nagel and Heinrich Jaeger. Their work *Icy Bodies* (See Figure 1) is featured on the main floor of the New York Hall of Science. *Icy Bodies* focuses on complex pattern formation and emergent behaviors in physics. According to Lani "these continuing collaborations expand upon the concept of Science as a dynamic, at times aesthetic, at times cultural endeavor."[24]

What Is *Icy Bodies?*

According to the website's description of *Icy Bodies,* "Intricate shrouds of spinning mist trail fragments of dry ice as they skim across the surface of this dark basin. Reminiscent of comets, the ice shards sublimate large amounts of gas that propel them in unexpected directions."[25] Dry ice drops from a conveyer belt onto a pool of blue water in a basin, creating moving patterns that are unique to each cycle.

Focusing on *Icy Bodies,* Education Professor Artie Salz and Lincoln Center Institutes' Education Assistant, Holly Fairbank led a group of college professors through the process of aesthetic inquiry. I was part of the planning session for the workshop with Salz and Fairbank. Some questions that helped guide our plan were:

How does what you know inform what you perceive?

How does what you notice inform what you know?
How important is comfort with the unknown (and indefinable-as with

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[22] http.//www.mhs.ox.ac.uk/derges/guide.htm
[23] See <www.nyscience.org>
[24] http//shawn lani.com retreived 2/1/06 pg. 1
[25] http://shawnlani.com/WORKS/ICY%20BODIES/ICY_BODIES.html Retrieved 2/1/06

aesthetic inquiry) in scientific discovery? Teaching? Learning?

The process described here is a non-linear approach to explore a work of art. A series of brainstorming activities and inquiry took place in order to develop personal connections to aspects of *Icy Bodies*. Faculty members who participated in the Aesthetic Education workshop reflected on what they noticed in this piece. A few described it as:

> *Action made visible by the blue water, container, and chemical reaction.*

Others noted:

> *Ice particles look like a dance.*
>
> *Fascinating and beautiful piece. Interesting to observe multiple concepts from physics (material phases, liquids, solids, gases, speed, floating) in such an aesthetically pleasing way (colors, lighting, viewing angles).*

Questions raised by the participants based on the *Icy Bodies* encounter include:

> *Is this science or art?*
>
> *Where can I get one for my living room?*
>
> *What does sublime mean in science?*
>
> *How does that relate to the psychological meaning of sublimation?*
>
> *Why blue water?*

These observations indicate a careful viewing of the work that resulted from conversations augmented by questions that lead to deep noticing, description, analysis and interpretation.

Philosopher, Maxine Greene (2001) writes "Aesthetic education is education for more discriminating appreciation and understanding of the arts. It includes ways of developing a more active sensibility and awareness in our students."[26] The workshop led the participants to reflect on the integration of art and science in meaningful ways in their own classrooms.

[26].Greene, Maxine. *Variations on a Blue Guitar*. (2001) p. .8.

Five months after the workshop, I had the opportunity to ask some professors and the Assistant Dean of Education what new insights were gained related to the connections between art and science. They wrote:

> *This workshop got us to think about relationships between art and science and compare aspects of art (aesthetics) and science in meaningful ways. I now believe that it is, at least interesting.*

> *Confirmed that science is beautiful!*

> *The brainstorming and questions set the tone which created an environment of exploration and possibilities. The hands-on activity clearly connected the science and art in new and exciting ways.*

When participants were asked about ideas that may have been incorporated into their teaching, the responses were all affirmative and enthusiastic.

Some comments were,

> *The role of aesthetic education, which is new for me, is a means to present science in an "absorbable" way as opposed to a dry presentation of facts. Presenting "dry" facts, no matter how interesting they are per se, does not serve science education.*

> *The notions and beliefs I have about art and science and aesthetic education have informed my practice indirectly. I observed a student teacher in a Geology class. We discussed her lesson about rock formations. I presented her with the idea of looking at the rocks from an aesthetic point of view. The conversation impacted on her so strongly that the next time we met she described how her students now study the patterns on rocks and how they evolved. This*

indicated to me that she was clearly able to find connections between the artistic elements and the physical evolution of the rocks.

At least for these professors, the Hall of Science experience seemed to have had a significant impact.

A Visual Art And Science Curriculum At Urban Peace Academy

Urban Peace Academy High School (U.P.A.H.S.) is an alternative public high school located in East Harlem, New York. The school is designed to offer an intimate setting with a varied curriculum to adolescents who are not succeeding in their regular high schools. UPAHS has a population of 400 adolescents with a 15:1 student/teacher ratio. While I was teaching visual art classes there three UPAHS ninth grade classes transformed a classroom into an ocean ecosystem model. This project was part of an Environmental Studies Seminar, written by classroom teachers, Susan Elliott, Alex Newmark, and myself, and was team taught by four subject teachers: visual art, science, social studies, and language arts. The course utilized basic modes of inquiry as discovery learning and focused on three essential questions: 1) What do living things need to survive?; 2) How are living things in the environment interdependent? and 3) In what ways do humans impact on the environment? Fifty students were assigned to one of two sections of the seminar. In both sections, students selected a creature and worked with others who chose the same one. Students discovered the broad meaning of *environment* through observation, drawing, and studying aspects of diverse ecosystems and the Pacific Kelp Forest. Included in the exhibition were written and oral presentations about the process of their research and their art work, field trip sketch books, and formal scientific investigations. Completed sculptures were hung from the ceiling and transformed the classroom into a *Kelp Forest*. This seminar encouraged and supported collaboration between students, while developing intellectual individuality. The Environmental Studies Seminar was an opportunity for teachers to implement a project driven interdisciplinary component into the curriculum. Topics in the Language Arts class covered steps involved for the research paper and oral presentation, including research skills, note taking, writing techniques, reading comprehension and appreciation. Applying a scientific method, students were able to test hypotheses and learn about the importance of the food chain and water cycles. By studying an ocean ecosystem in Social Studies class students were able to form a base of knowledge from which they examined public policies, historical trends, related to the ocean environment; and such current events as the Exxon-Valdez incident and its impact on the marine organisms and our own lives. Symmetry and pattern were explored through constructing mobiles. Form and scale were analyzed in order to assemble three dimensional life size sculptures of the creatures they drew.

Preparation

Class began with a discussion of the essential questions followed by a viewing of the video, *Seasons in The Sea* (1990), which was part of the Public Broadcasting System *Nature* series. The video shows life within the Kelp Forest. Sketching sea creatures from the video and writing their reactions to what they saw helped students become familiar with ocean life. Students selected which creature they wanted to study and drew as many sea creatures from the video as they could remember.

Symmetry And Kinetic Sculpture

Students noticed some of the lower animals and plant drawings displayed structural symmetrical patterns. This was apparent in the drawings of the starfish and the repetitive shapes in the structures of kelp. We discussed the repetition of pattern in the scales covering the bodies of fish and the striped and spotted patterns on some of the fish and sea urchins. The class raised the question of the function of these patterns which we discussed. Examples of Japanese ink and color silk paintings from the Edo Period (1757-1767) by Itō Jakuchū's *Fish and Octopus*, and Fuiji Shorin's (1824-1894) *Carp* were carefully studied for the delicate forms, colors and shapes. Dolf Reiser's book *Art and Science* provided photographs of a coral skeleton and sea urchins. The theme of repetitive patterns and symmetrical shapes was used in a mobile project. I introduced the class to the notion of kinetic sculpture and mobiles through a reproduction of Alexander Calder's (1898-1976) *Big Red* (1959) and reminded them that all parts had to be balanced and planned so that they moved freely. In groups of three, using wire, thread, cardboard and paint, the class constructed a variety of mobiles of different shapes and sizes to represent sea horses, coral, sea otters, star fish, sharks, and seals.

Field Trips

Out of classroom excursions were an integral aspect of the Environmental Studies class. The first trip was to The New York Aquarium in Coney Island, Brooklyn. It provided the perfect setting for students to study and draw Garibaldi fish (See Figure 2) dolphins, sea otters, seals, sharks, whales and sting-rays closely. At the aquarium students had an opportunity to consider the first two essential questions: 1) What do living things need to survive? and 2) How are living things in the environment interdependent?

The beach provided the perfect setting to explore the third essential question: 3) In what ways do humans impact on the environment? Lead by educators from The Council on the Environment of New York City, students planned and publicized their second trip, to Orchard Beach in City Island, the Bronx. A beach clean-up was organized and students kept a beach log which included a list of things they found, observations, and interactions with the beach environment. The class discussed the impact of rusted cans, plastic bottles, broken glass and other debris they saw, and its effect on the environment.

Student Field Guides

Completed research papers were combined with art work for a field guide. By using computer scanned images of their initial sketches a *Field Guide to The Kelp Forest* was produced. Both the common and scientific names of each creature was listed along with a physical description, modes of behavior, habitat, and its relation to the kelp forest. Students made oral presentations of their findings and described how the sculptures were constructed.

Sea Sculptures

Based on the research gathered pertaining to the dimensions and physical characteristics of the creatures, students worked on scale drawings. They found correct body part measurements of the creature including the head, fins or arms, mouth, and tail. Working from sketches that included the basic line, shape, value, color and skin texture, students transferred their two dimensional images into a three dimensional replica. Materials used for this project included: HB drawing pencils, colored pencils, sketch pads, green and brown construction paper, scissors, green yarn, pen and ink, Cray-Pas® crayon pastels, chicken wire, wire cutters, pipe cleaners, twine, plaster gauze, cardboard, tempera paint, felt, polyester fiber fill, needle and thread, brushes, newspaper, buckets and screens, paper towels, and aprons. Some students worked on their creatures alone while others worked collectively in small groups of two or three. A number of boys in the class preferred to work with fabric and designed soft sculptures of starfish, jellyfish, and stingrays with felt, polyester filling, needles and thread. Many of the girls in the class designed whales, sea otters, sea urchins and sharks using plaster and chicken wire based on initial sketches (See Figure 3). Others preferred the soft sculpture approach and created jellyfish, starfish and Garibaldi fish. The kelp was made by studying its various shapes. Students outlined these shapes onto pieces of green and brown construction paper that were connected to yarn, and hung from the light fixtures. When they were finished, the room was set-up to look like a kelp forest by hanging the sculptures and the kelp with monofilament (fishing line). The original drawings were mounted and displayed around the room.

Results

Class members developed communication and writing skills through public speaking and research as well as a deeper understanding of an ocean ecosystem and its impact on our lives. They explored the elements of design through drawing and painting, and learned how to transform two dimensional designs into sculptural forms using scale renderings, measurement, and cut forms for armatures. They worked collaboratively in teams to create three dimensional creatures. With plaster, felt and paint, the creatures began to take on life-like qualities and students shared their knowledge about the work of art in oral presentations. Groups were evaluated based on evidence that learning took place through various phases described above. Students completed self-evaluation forms and all the subject teachers graded the students, the grades were averaged to discern a final exhibition grade. On the day of the Exhibition, the principal, the Deputy Superintendent of Schools, the Director of Curriculum and Instruction, parents, teachers, and other classes were invited to see and hear what the students had worked so hard to create. There was a very enthusiastic reaction from the audience, especially when the students discussed the reproductive lives of the creatures.

Personal Reflections

A course like this requires cooperation amongst the teachers, careful planning, and time for teachers to meet on a regular basis. Planning sessions did not happen as frequently as we would have liked. The class continues with a new group of teachers. One of the former teachers from the Seminar observes, participates and responds to these new teachers weekly. She acts as the overseer and supports the work that is being done. Fridays from 3:00 - 4:00PM the teachers meet to evaluate and plan for the next class. Ninth graders at UPAHS will continue to transform their classroom into an ocean ecosystem. Such a course offers an opportunity for teachers to implement an interdisciplinary component with visual art and science as the main focus into the curriculum. Perhaps even more important is that it offers students a chance to make connections between what living things need to survive, how living things in the environment are interdependent, and ways that humans impact on the environment. As an added bonus, the rewards of artistic and scientific experiences are made pleasurable and meaningful. This project is not limited to the urban classroom; it can easily be adapted to any learning environment.

Conclusion

Building a bridge between the visual arts and science that is grounded in traditions of making art and scientific discoveries can be seen as a viable way to empower teachers with the kind of understanding that has the capacity to change the way these separate content areas are taught. Turner notes "Different though they are, art and science are [like] opposite ends of the [piano] keyboard of human experience, but the same keyboard nonetheless, in whose playing are revealed the harmonies of the universe."[27] With this understanding teachers can impact on changing the ways in which young people discover the world around them and participate in it. In many situations where artists and scientists collaborate, science is not viewed merely as a rationalistic endeavor or art as only an expressive activity.

C.P. Snow wrote,

> What is wanted is not to force potential physicists to read a bit of Dickens and potential literary critics to mug up some basic theorems. Rather, we need to encourage the growth of the intellectual equivalent of bilingualism, a capacity not only to exercise the language of our respective specialisms, but also to attend to, learn from, and eventually contribute to, wider cultural conversations." [28]

I have experienced a power in making connections between the art room and the science lab,

[27] — A.. Richard Turner (1993). p.209.

encouraging channels of communication between those primarily interested in seeing through a microscope or telescope, and those who see a landscape as a potential setting for a painting. The artists, scientists and educators mentioned in this paper are working beyond limited definitions of disciplinary boundaries, and are guided by questions, issues, and abstractions where new knowledge is seen as a function of creating and critiquing human experience.

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[28] —Snow, C.P. (1993). p. lvii

Figures

Figure 1.
Icy Bodies by Shawn Lani

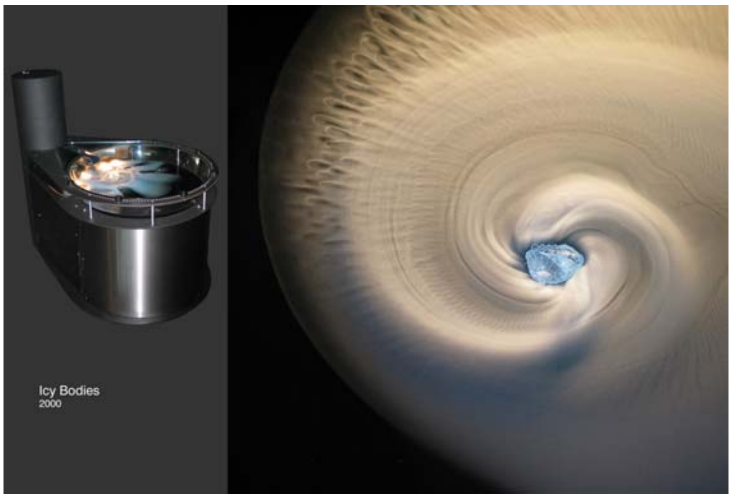

Photo Courtesy of Shawn Lani, Used here with permission

Figure 2. *Garibaldi goldfish*, student drawing, colored pencils on paper.

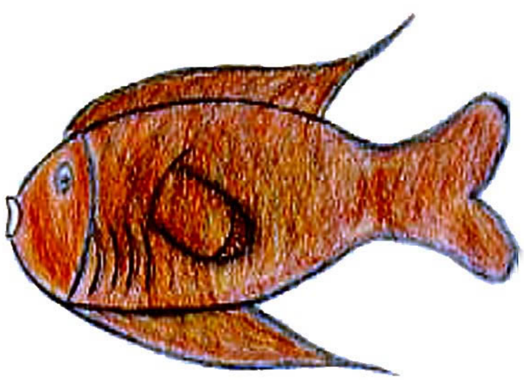

Figure 3

Blue whale, student drawing, colored pencils on paper.