Mini-Grant to Support the Scholarship of Teaching and Learning at Evergreen

Approaches and Practices That Encourage Interdisciplinary Teaching

Submitted by

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&

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Name of grantees: Susan Aurand and Dr. Dharshi Bopegedera
Title of current program(s) or course(s): Light
Title of Grant/Grant Inquiry Area: **Document and describe approaches and practices that encourage interdisciplinary teaching**

Project Purpose: To share with others a highly successful pedagogical strategy for interdisciplinary teaching and learning

Description of Project:

1. In the context of a particular program or course, of all the things students might learn, what matters most to you and why? –

   The most important factor for us was to have our students learn to use science and art as tools to investigate the nature of the world. We wanted our students to be able to use their scientific understanding to enhance their creative artwork and to use their creative work to ask scientific questions.

2. What are you doing to promote that learning (e.g. the design of assignments, curricular materials, projects, activities, or learning environments)?

   We designed all activities of the Light Program to allow students to experience both a scientific and creative understanding of the concepts of light. We tackled a different aspect of light each week and investigated it using scientific and artistic approaches. In this way, we provided an avenue for students to study the same concept of light using both disciplines and helped them to make connections between them. During the first quarter of the Light Program we focused on skill building in lab sciences, art studio and library research methods. These activities continued into the second quarter, increasing in their level of sophistication as the students gained experience.

   <u>Diptychs:</u>
   To show that science and art are complementary tools for studying light, students made three diptychs on “light through a prism”, “the human eye” and “the light of a candle flame”. A diptych is a side-by-side illustration of an artistic drawing and a scientific diagram of a given subject. Scientific diagrams required that each important component be appropriately labeled and often included a visit to the library to gather information. Artistic drawings included three-dimensional art using student’s choice of medium (charcoal, pastel, paint, wood, metal, geometric optics, etc.). Students were fascinated to discover that while the artistic drawings varied greatly from person to person, the scientific diagrams were very similar to the point of being identical.

   <u>Skill Building Art Studios and Science Labs:</u>
   Each week one concept on the theme of light was explored from science and art perspectives and students were directed to make connections between them. Since technology plays a key role in the lives of artists and scientists, computers were used as a tool in every possible assignment. Students learned the techniques of drawing, painting, critiquing, and displaying art in the studios. In the laboratory, record keeping, the scientific method, use of instrumentation for data collection, proper lab techniques, lab safety, graphical representation of data, scientific analysis of data and the use of the science library were emphasized. The level of expectation for lab and art studio work was well defined and equivalent to those in other science/visual arts courses.

Skill Building Art Workshops and Science Labs in the Light Program

Art Workshops	Science Laboratory
Drawing with pencil and charcoal with a focus on line, value, texture and light	Classification of electromagnetic radiation, exploring relationships between color, wavelength, frequency, energy, wave number and speed of light
Understanding the color wheel, composition, color theory and color mixing	Understanding light sensors, band pass filters, various light sources including lasers, introduction to monochromatic light, understanding absorbance and transmittance, Beer-Lambert Law, learning to use a diode array spectrometer
Painting with oils and acrylics	Exploring the composition of primary and secondary colors using paper and thin layer chromatography, T-shirt chromatography (28)
Working with neon lights and light as an art medium	Emission spectroscopy using flame tests, making sparklers (29), emission spectrum of atomic hydrogen and the analysis of the Balmer series
Creating 3-D art with fabrics, ceramics, wood and metal	Chemistry of tie-dyeing, natural dyes and vat dyeing
Using mirrors, lenses, prisms, different light sources and lasers to create art	Investigating mirrors, lenses and prisms, reflection, interference and diffraction

Seminar discussions:

In addition to the main text (Falk, D. S.; Brill, D. R.; Stork, D. G.; *Seeing the Light: Optics in Nature, Photography, Color, vision, and Holography,* John Wiley & Sons: New York, 1986), students read several articles and books that explored the history of light in art, science, and the use of light in healing. The life and works of Albert Einstein was explored by viewing the video "Einstein Revealed" (made by NOVA) and the history of light in art was surveyed by viewing slides from various times in history. Students wrote papers in response to these readings and viewings and participated in seminar discussions. The goal of the seminar was to help students further their knowledge by articulating their understanding of the readings. The seminar book Health and Light by John Ott was selected due to students' desire to learn more about the healing properties of light. Some of these discussions continued along the corridors after the seminar sessions ended!

Books Used in Seminar Discussions

Title	Author	Publisher
Art and Physics: Parallel Visions in Space, Time & Light	Leonard Shalin	Quill Publishers
Health and Light	John Ott	Ariel Press
Catching the Light	Arthur Zajonc	Oxford University Press

Mini-projects:

Students were directed to use the tools they learned to pursue independent investigations on an aspect of light of their choosing during a three-week period. Making connections between art and science, learning to present work in scientific and artistic methods, record keeping of lab work, critiquing art work, displaying art, and making science posters were expectations for this project. We found that in this first independent project, many students found it challenging to study an aspect of light using both science and art. As a result, their work leaned more towards the discipline that they were most comfortable with (either science or art).

Examples of Mini-Projects

- The Moon
- Light bulbs
- Skies
- Sundial
- Light/shadow with metal sculptures
- Exploration of inner and outer light
- Exploring the concept of light years
- Northern lights
- Bioluminescence
- Speed of light
- Stereoscopy
- Iridescence
- Electron microscopy
- Kirlian photography
- Photosynthesis
- Light in near death experiences
- Images with and without light
- Infrared light
- Light mobiles
- Big bang theory
- Telescopes
- Stain glass
- Sting theory
- Design of optics
- Infrared photography
- Color theory
- Light and mood
- Lightening
- Candlelight
- Effect of light on migrating birds
- Stage lighting
- Absorption of light by oceans
- Telescopic and microscopic visions
- Anamorphic art
- Macular degeneration

Final projects:
For their final projects, students spent 5-6 weeks exploring the science and art of an aspect of light of their choice. They were required to keep a project notebook, which was reviewed by peers and faculty regularly. At the end of the quarter, students made an oral presentation of their projects. Their art work was presented as drawings, sculptures, or other creations. Their scientific work was presented using posters. We required that this project be 50% art and 50% science and were pleased that the students met this requirement. These projects were also more sophisticated compared to their mini-projects. The breath and depth of the projects was a clear indication of the investment students made in this academic adventure. Many of these projects were done in small groups.

A List of Selected Final Projects

- Art and science of holography
- Long exposure photography
- Anamorphic art
- Photosynthesis
- Luminous tubes
- Microscopy
- Pinhole photography
- Light/shadow using metal sculptures
- Stellar evolution
- Solar power
- Bioluminescence
- Kirlian photography
- Effect of light on plants
- Sky phenomena
- Neon lights
- Diffraction of light
- Interaction of light with matter
- Quantum theory
- Visible spectrum
- Sun spots
- Black holes, supernova and stars
- Mayan astronomy
- Comparison of light and sound waves
- X-ray light to study mammography
- Light therapy
- Physics of light
- Stage lighting
- Formation of the Solar system
- Electromagnetic fields

3. What evidence do you have about the effectiveness of these practices? Or, if you are implementing new practices, how will you determine the effectiveness of these practices?

Evidence for the effectiveness of these practices was seen in the improved quality of the students' work.

- For example the initial diptych project on the human eye showed little effort on the students' part to accurately represent and document the anatomy of vision in their scientific drawings. In the later two diptych projects (prism and candle) there was a significant improvement in students' ability incorporate their scientific understanding and artistic creativity into the diptychs.
- Students were not as good in making sure that their mini-projects represented 50% art work and 50% science work. Sometimes they failed to see the connections between the art and science components. In the final projects however, all most all projects had a healthy combination of art and science and students synthesized their scientific study with studio work, making the project truly interdisciplinary.
- There was a significant improvement in the quality of their scientific presentations and art work over the course of the program.
- In seminar we saw clear evidence of improved understanding of scientific and historical theories of light as students progressively gained practical experience in labs and studios. This was further evidenced by students' interest in suggesting readings for seminar discussions. The text "Health and Light" by John Ott, was selected for seminar based on student suggestions.

4. How does this area of inquiry connect with one or more of Evergreen's priorities as articulated in the Five Foci or Expectations of an Evergreen Graduate?

- Interdisciplinary Study – From its very inception, the Light Program strove to be a truly interdisciplinary program. The students knew from the beginning that they were expected to use art and science as tools to explore light. In this way, we were able to teaching science to art students who otherwise would not get the discipline, and teach art to science students, who otherwise would have no art studio experience. The faculty taught students the value of interdisciplinary study by example. They became students of each other's discipline and completed the assignments that were required of the students. In this way, we were able to encourage students who were less at ease in the science lab or the art studio.

- Personal engagement with learning – Before long, students actively participated in their own investigations of light. They suggested books to read in seminar, selected their own topics for independent projects, and eagerly participated in a "Cross Cultural Celebrations of Light" to celebrate the winter solstice. Working in small groups, students investigated how light have been used in cultural celebrations outside the main stream. They chose to study a wide variety of cultures including Native American, Australian, ancient Egypt, Mayan, ancient European, Jewish, Indonesian, Buddhist, Caribbean and ancient Chinese cultures. Each group made a 30-minute presentation summarizing their research that included a participatory aspect by the audience. This celebration of the winter solstice was managed entirely by the students and the only task required of the faculty was to schedule the needed space and to "enjoy the show".

- Linking theory and practice – The way our students linked theory (what they studied in the studios, labs and classrooms) and practice was by doing their independent projects. Some students brought their own desire to study a certain aspect of light into the program while others found new interests while taking the program. Many of our students proceeded to study light after the program was over, both at and outside The Evergreen State College.

- Articulate and assume responsibility for your own education – Students learned the techniques of drawing, painting, critiquing, and displaying art in the studios. In the laboratory, record keeping, the scientific method, use of instrumentation for data collection, proper lab techniques, lab safety, graphical representation of data, scientific analysis of data and the use of the science library were emphasized. The level of expectation for lab and art studio work was well defined and equivalent to those in other science/visual arts programs. In fact, the final lab Light Program students did studying the atomic spectrum of hydrogen is a standard lab conducted by general chemistry students.

  Many of the students had a history of using pigments without a clear understanding of their toxicity. They had often used toxic and environmentally harmful solvents to clean paintbrushes and paint covered fingers and had disposed them down the drain! Learning the true nature of these toxic materials and their proper disposal methods was one of the most useful things students learned in the Light Program. It was quite entertaining to see some of the students wearing paint smeared lab coats in the art studios for several quarters following the Light Program!

- Participate collaboratively and responsibly in our diverse society & the ability to communicate effectively – Student participation in the "Cross-Cultural Celebrations of Light", collaborative group projects when assigned to do independent work, understanding how the study of light was supported by many cultures across the world, and participation in labs and workshops where students always worked in teams are examples to illustrate the level of collaboration, communication, and cross-cultural understanding that we required of our students.

For collaborative proposals: Provide a clear strategy for how individual reflections by each team member will be presented within the context of the collaborative work.

> Both instructors were present at all class meetings and became students of the other's discipline. This faculty role of being a model student was an important part of the program design. Students who had little or no exposure to the sciences were far more willing to venture into challenging (sometimes unnerving) tasks such as graphing, mathematical manipulation of data, working with scientific instrumentation, when a faculty co-learner provided leadership by example. On the other hand, in the art studio the students had the upper hand compared to the science instructor. This provided and environment of close interaction and trust building between students and instructors, one that encouraged academic risk taking leading to intellectual growth. It was also an excellent faculty development opportunity for both instructors.
>
> Included are our excerpts from our self-evaluations that document our cross-disciplinary work.

Excepts from the self-evaluation of Dharshi Bopegedera:

"Teaching with Susan Aurand was a lot of fun. She is a committed teacher and a wonderful colleague. She always did her share and contributed good ideas. She worked well with students and often went beyond the call of duty. I was delighted that she attended and completed all the science labs. It was great to see a faculty member taking such an interest in learning a different discipline. Her commitment was a good example to the students.

Even though the students did not have much background in science, they were willing to learn. Their mathematical skills were poor and most had not used mathematics for many years. I had to be quite inventive in my methods of explanations and teaching, but it was worth the effort because the students were really eager to learn. I found out that if I went slow and explained things in detail with many examples, students were able to grasp the concepts. Hands-on work was instrumental in helping students learn. I do not believe I converted any students to be scientists but I do believe that I took the fear of science out from them. Most of them left the program knowing that if they wanted to learn science, they could. All they needed was to put in the effort. Not very different from painting a picture!

One of the things I enjoyed about this program was having the opportunity to become an art student. I attended Susan's art studio workshops and became an active participant. I learned to draw with charcoal and pastels. Finally I also learned how to paint. I am certainly not going to be an artist, but I discovered that I could draw if I put the effort into it. It was an eye opener for me to understand the effort it took to make one finished drawing. I have a new respect for artists as a result of this program. Also I fully understand what it takes to be an art faculty member at TESC.

My best work in the Light program was my labs. I decided early that I was going to use labs to teach every concept. I used lectures and workshops only to provide the background for the labs. Students learned concepts by doing labs and analyzing the data they obtained. It took several weeks to develop each lab, not including the time required to test it and make the necessary adjustments. However, I really enjoyed developing them.

Labs in the Light program were conducted in the same way I conduct labs in other science programs. I kept my expectations high and the students knew it. Only difference was that I gave more time for these students to learn a given concept. I also used many visual teaching techniques that I had not used before. Group discussions and group work were encouraged since this helped students in their learning.

I presented the work I did in this program at the annual Washington College Chemistry Teachers Association Conference in April 1999. The title of my presentation was "LIGHT"- AN INTERDISCIPLINARY APPROACH TO TEACHING SCIENCE". This was well received by the audience.

It is my conclusion that the Light program was a very successful way to teach science to non-science students. It was also successful in cross-disciplinary education of faculty. Most importantly it is the program that I had the most fun in my teaching career at TESC."

Excerpts from Self-Evaluation of Susan Aurand:

The program had no art pre-requisites, so the students entered having a wide range of skills. To accommodate their varied skills, I taught two workshops in the fall (a drawing workshop and an advanced art workshop) and one in winter (painting).

<u>Fall- Advanced Art workshop:</u> In the advanced art workshop, I focused on development of imagery, concepts and composition through a series of thematic assignments that could be interpreted in a wide range of ways, for example: shadows (optical, psychological, mythic) or double vision (optical, vision as understanding, inner vision), etc. The students worked in media of their choice and the critiques focused on helping them see ways to develop their work both technically and conceptually. The workshop went fairly well, though some of the students in this group really would have benefited more from very structured drawing assignments.

<u>Fall- Drawing workshop</u>: This was a very straightforward basic drawing workshop to help the students develop skills and familiarity with dry media, and I fell it went well. I was delighted

that Dharshi participated in this workshop; she was not only delighted to have the chance to learn some art skills, but her participation greatly encouraged the more hesitant students.

Winter Workshops – Painting and Neon: In winter, to accommodate student interest, I taught an introduction to painting workshop and arranged to have Doug Hitch teach a beginning neon class. Both went well. In painting, I introduced students to color with pastels, then acrylics and oils.

Projects:

In addition to the workshops, we assigned the students three visual projects in fall quarter, which were art/science diptychs on the eye, the prism, and the candle (perceived light, the spectrum, and light as heat). The students created paired images, one a scientific diagram illustrating, for example, how a prism splits white light; the companion image then was an expressive interpretation of the phenomenon. I ran the critiques of these projects and was very pleased with how they stimulated students to examine light from two perspectives simultaneously.

In fall, students working in groups also presented a "Celebration of Light." Each group researched how light was understood and celebrated in a particular culture and gave a 20 minute presentation that had to include a food item, an interactive activity, and a 10 minute talk. I was very busy giving technical support to the students… The projects were wonderful, however.

In winter quarter, the students took on individual research projects, which were to be half creative work and half research in scientific literature. Again, it took a lot of time to work with each individual student on his/her creative work since the projects were tremendously diverse. There was lots of problem solving, for example, helping one student figure out how to make paintings using colored light, helping another construct a camera obscura, and so on. …. I was exhausted by the end, but really felt that the program epitomized the best of what can happen in a truly interdisciplinary program.

Lectures:

In both fall and winter, I gave lectures on how light has been understood by artists through human history. … These lectures were fairly informal slide talks, but, since we were reading *Art and Physics*, which recounted the major movements in art history, I feel they served their purpose well enough by simply giving students the opportunity to see lots of images of artworks. The lecture I was happiest about was one I developed on the use of light as an art medium among contemporary artists. I found some impressive information and images that inspired the students as they were working on their own projects.

Co-Learning: I put a good deal of time and effort into being a good co-learner with the student, to encourage and support the students who were science phobic. I felt that if I didn't, the students who came from art backgrounds would feel justified in holding back in the science work. So I participated fully in the chemistry labs, doing the work and the lab reports along with the students. Generally I was able to catch on quickly enough that I could both do the lab and help other students who were having difficulty. I enjoyed this part of the program, though doing it on top of my own teaching preparations proved exhausting!

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