Artventures In Engineering At Arizona State University

Shawna L. Fletcher¹ and Melanie Ohm²

Abstract -- ArtVentures in Engineering (AVIE) is a series of community workshops and educational K-12 outreach projects designed to examine and explore the interdependence of science and the arts. This project was conceived from a unique partnership formed between the Katherine K. Herberger College of Fine Arts and the Women in Applied Science and Engineering (WISE) Program at Arizona State University. The primary goal of this collaboration is to educate and bring community awareness to a diverse population through the exploration of interdisciplinary principles and to value the contributions of artists to science and scientists to the arts.

To date, four workshops have been completed and a fifth workshop is scheduled for Spring, 2005. Preliminary workshops described will serve as a basis for statewide and national models to train teachers and educators in bringing multi-disciplinary learning and integrated teaching into the classroom. Results of each workshop were examined on an immediate basis however, future research will include both short-term and long-term assessment components to examine program effectiveness. An overview of workshops will be presented as well as future program expansion including preliminary discussions of teacher education and teacher training.

Index Terms – Arts & Engineering, Community Partnership Programs, Collaborative Projects, Integrated K-12 Education.

INTRODUCTION

A primary concern of the U.S. educational system is the inherent shortage of mathematicians, scientists, and engineers and an inability of the U.S. to meet future technological demands. Recent statistics show that women constitute approximately 20% of those awarded bachelor degrees in engineering in the 2001-2002 academic year [1]. In addition, though most of the nation’s largest communities have at least 25% underrepresented minority populations, dropout rates from grades 7 – 12 are highest in Native American, Hispanic, and African American students [2]. One of the most important challenges for higher education in the U.S. over the next ten years will be to supply world-class talent in science, engineering, and technology by developing a domestic talent pool and by specifically targeting these underrepresented populations [3].

In light of current issues, it is essential that new educational models be developed to ensure an ability to reach non-traditional student populations and to meet future technological demands. Traditionally, the arts, math, and science have been conceptualized as individual subject matter, each with their own realm of proficiency and fundamental principals. While science has been viewed as a process of gathering and evaluating information then devising and testing possible explanations [4], the arts are viewed as a direct link to the ability of students to develop multiple cerebral systems, become self-directed learners and to connect with other individuals on a humanistic plane [5].

The ASU ArtVentures in Engineering (AVIE) Program was created in 2002 due to an overwhelming need for community-based programs that center on interdisciplinary education and innovative program design to attract and recruit underrepresented engineering students [6]. The objectives for ArtVentures are to experience artistic techniques through scientific principles and initiate dialogue between two communities. Workshops are designed to explore the relationship between disciplines and how they inevitably depend upon one another. Each event centers on hands-on activities, lectures and a multitude of different perspectives to explain how science and the arts relate to one another. The product of these experiences is a heightened awareness as well as an understanding for and appreciation of the interdependence of the arts and science. Program objectives include the following:

- To serve as a catalyst for further understanding of the arts and science
- Create community education and awareness of these disciplines
- Promote advertising to entice a diverse community
- Obtain national recognition through educational materials produced by the project
- Develop curriculum for teaching interdisciplinary subjects through printed materials that may be disseminated to K-12 schools
- Open the door for collaborative work and research between two ASU colleges and community partners
AVIE Workshops

As previously stated, there have been four workshops completed to date. These include The Science of Painting, Acoustics: Exploring Sound, Pattern & Symmetry, and Music & the Brain. A fifth workshop, Bodies, Buildings, and Physical Form, is scheduled for Spring, 2004. Workshops are described below and include evaluation comments from participants. All workshops were partially funded by community partners and free to attending participants.

The Science of Painting

This workshop occurred on April 4, 2002 at the City of Tempe Public Works Center and was funded in part by the City of Tempe Cultural Services. Fifty-five people attended the event including children (ranging in ages from 10 – 16), parents, community members, teachers, ASU staff, ASU employees, and artists. Format for the workshop included three 20-minute lectures and demonstrations from speakers representing ASU and the community.

This workshop first included a scientific overview of visual arts, perspective, 3D imaging techniques, and optics by noted author, physicist and materials science & engineering faculty member, Dr. James Mayer. An emerging local artist, Candice Eisenfeld, presented slides of her artwork and described scientific techniques including chemistry involved in her artwork and in preparing media. Finally, respected artist and Herberger Fine Arts associate professor, Dr. Henry Schoebel, demonstrated the critical use of science in painting and how a visual artist views science.

After the lectures, audience members participated in six hands-on activities and demonstrations designed to highlight scientific principles and artistic concepts. Hands-on activities included imaging through infrared light, ultraviolet light, painting in layers, spectrometers, x-ray techniques, and pigments/artistic media.

Acoustics: Exploring Sound

This workshop occurred on November 9, 2002 at the ASU Herberger College of Fine Arts and was funded in part by Target. Eighty-six people attended the event including children (ranging in ages from 10 – 16), parents, community members, teachers, emeritus faculty, ASU staff/employees, engineering volunteers and artists. Format for the workshop included lectures, demonstrations, hands-on activities and two recital performances. This workshop first included a scientific overview of sound and acoustics by aerospace engineering faculty member, Dr. Valana Wells. Participants then rotated in two groups to one of two lectures: noted lutherist (string instrument maker) and Cremona School graduate, Timothy Jansma, or internationally recognized organ maker, Paul Fritts. The lecture by Paul Fritts was especially unique since ASU houses an original Paul Fritts organ. Participants attending either workshop were able to rotate to the other speaker later that afternoon.

After lunch, famed acoustician, Robert Mahoney, held a one-hour lecture to describe general principles governing acoustics and building design to enhance sound. Mahoney utilized the example of ASU’s Organ Hall to explain several acoustical design features. Through the afternoon, the ASU Engineering Ambassadors and Service Learning Program presented six hands-on activities to explore sound and acoustics. After the presentations and hands-on activities, ASU Organ Professor, Kimberly Marshall, gave a short demonstration of the Fritts Organ. Several ASU performance majors were featured on the organ and local K-12 cello students gave afternoon recitals.

Pattern & Symmetry

This workshop occurred on April 26, 2003 at the Phoenix Heard Museum. Over seventy people attended the event including children (ranging in ages from 8 – 16), parents, community members, teachers, emeritus faculty, ASU staff/employees, engineering student volunteers and artists. Format for the workshop included lectures, demonstrations, and hands-on activities. This event was unique to AVIE because it centered on mathematical techniques in patterning, visiting cultural perspectives from traditional Native American art to Moroccan tile patterns, and computer-generated math-art.

This workshop first included a scientific overview of tessellations, pattern, and symmetry from mathematician artist, ASU electrical engineering professor, and NASA Jet Propulsion Laboratory consultant, Robert Fathauer. Sierra Ornelas, Navajo Bead Artist, then gave cultural and traditional perspective of patterns found in nature and Native bead working. Participants were then invited to explore hands-on activities centered on Serpinski tetrahedrons, Navajo beadwork, computer imaging applications, Navajo rug weaving, kaleidoscopes, and games/puzzles to examine fractal patterns and tessellations. The second half of the workshop included lectures by Kerry Mitchell, fractal-focused digital artist, mathematician and educational technology specialist; and Barbara Teller Ornelas, Master Two Grey Hills Weaver.

Music & the Brain

This series of workshops and events occurred on March 11 – 13, 2004. The first workshop in the series was held at the Mayo Clinic and hosted by the Mayo Center for Humanities in Medicine. More than 85 participants attended this lecture that examined how the body responds to music and its healing effects. Guest lecturer, Dr. Daniel Schneck from Virginia Polytechnic University, led the information session and demonstrated lecture topics by using musical examples through quartet performances by Dr. Daniel Schneck (violin), Judith Schneck (violin), Petra Berenyi (viola) and Shawna Fletcher (cello). That afternoon, 82 participants also attended a technical lecture given by Dr. Schneck at the ASU Campus.
This lecture highlighted bioengineering principles and music applications.

The next workshop was held on Friday, March 12 at the City of Tempe Cultural Services, Vihel Building. This free workshop open to the general public discussed theoretical basis and clinical applications for music therapy, engineering, and autism. Guest artists included Dr. Daniel Schneck, Barbara Crowe (ASU Music Therapy Faculty), Dr. Cindy Schneider (M.D. and founder of CARE Center for Autism), Kathleen Walsh (Music Therapist), and Sheryl Kelly (Music Therapist). 48 people attended the event. In addition to the autism workshop, 85 more people attended a master class and dinner concert given by Laurel Masse, original lead singer of the Manhattan Transfer, and Francesca Tanksley, jazz pianist and composer.

The final Music & the Brain workshop event occurred on Saturday, March 13 at the City of Tempe Cultural Services, Vihel Building. This free workshop featured hands-on activities and lectures open to general public and children ages 10 and up. Guest lectures included a general overview of sound and how sound travels, Bioengineering principles, an overview of the brain and how sound/music is physically processed, and Music Therapy forms and techniques. Eight activity stations were presented including a Somatron Mat, Frequency and Physical Responses, Drum Circle, The Human Brain, Laser and EEG Imaging, Muscular Control, Sound Manipulation with Computers, Cochlear Implants, and Music Therapy Video. Guest artists included, David Wright (ASU Center for Solid State Science), Dr. Daniel Schneck (Virginia Polytechnic University), Laurel Masse (Manhattan Transfer), Judith Schneck (Juilliard School of Music), Steve Helms-Tillery (ASU Bioengineering Faculty), and Barbara Crowe (ASU Music Therapy Faculty).

Partnerships formed for events included the City of Tempe, Mayo Clinic and Center for Humanities in Medicine, ASU Harrington Bioengineering Department, Phoenix Ritz-Carlton, CARE Center for Autism, Carey Home Inspection Service, Washburn Piano, Tres Aquas Adventures, The String Shop of Tempe, Motorola, Macy’s and the Katherine K. Herberger Foundation.

Members from the community are essential in designing the format and content of workshops. Much of the guidance has been obtained through evaluation comments and comments of participants. Over 376 people attended AVIE workshop activities for this topic. Overall evaluations were extremely positive and showed that audience members were intrigued and interested in future workshops and topics. The following are a few comments provided by audience members regarding lecture topics and speakers:

Future AVIE Workshops

Bodies, Buildings and Physical Form is the fifth workshop in the AVIE series and will be held in Spring 2005. Dance troupe members from the world-renown dance company, Pilobolus, will be invited to conduct a series of workshops in collaboration with Avi Wiezel from the Del E. Webb School of construction and select faculty members from ASU’s Herberger College of Fine Arts and the Ira A. Fulton School of Engineering. Pilobolus dance members will conduct two workshops for students interested in how physics is used to create innovative and interesting body structures. They will demonstrate the importance of balance, form, and architecture to create artistic and physical structures. ASU faculty members will co-lecture regarding how physical form interplays with structural form and how the body’s machinery can be translated into both man-made forms and those found in nature. Hands-on activities and interactive learning will be an integral part of educating the community on how dance, form, and body movements have a scientific basis that is also found in architecture, engineering, and construction.

RESULTS

Each of the workshops described exceeded expectations in quality of interactions between artists and scientists and community participation. Audience members were actively engaged in discussions and hands-on activities, leaving with more questions than answers. This indicated that the workshops were thought provoking and approached workshop topics in a unique and stimulating format. Before the pilot program, audience members were asked to write their comments to three questions about the interaction between art and science. During the discussion, they were asked to re-visit those same questions to see if they had changed their opinion after hearing from the artists. The following information relates to participant comments prior to experiencing the event:

I. How does understanding SCIENCE affect your view of ART?

- It gives you a greater appreciation of art.
- It gives you a better connection between two seemingly completely different areas.
- Helps you understand why the object of your art looks and is the way it is.
- Science helps you understand the way things work and function – for example, if you study science, you may notice patterns, genres, or similarities most [people] miss.

II. How do artists use science?

- How the eye sees – how the brain processes information.
- Studying botany zoology anatomy etc. helps artists depict natural forms & behaviors.
- The chemistry of paint, binders, materials etc.
- In photography – the chemistry of developing film & prints.

III. How are science & the arts connected?

- Require creative ways of seeing relationships that are new or not obvious.
- You need knowledge of both to be a truly cultured and open-minded person.

Overall, audience members thoroughly enjoyed the speakers, the activities, and the workshop. Reactions from participants were overwhelmingly positive and most agreed they would attend future events. From each event, it was
evident that the greater population felt the need and importance of bringing the expertise of ASU faculty, staff, and student volunteers to their community. The following are evaluation comments received after workshops:

- Very well done, good teaching aids
- We were a reserved group - the “discussion” was more approachable in the demo groups!
- I never really thought about how science and art could be connected in this way. This new information I find quite fascinating!
- I liked the artist’s presentation and her art. I also liked the hands-on activities.
- All three speakers were first class. I was expecting at least some discussion of the art of being a scientist, i.e. how scientist might use art theory or practice in their work.
- Very interesting, informative and entertaining
- The presentations were very informative and I enjoyed a lot…I really appreciated ASU putting on programs like this so our youth can experience the many opportunities that exist. As a result of WISE my daughter now wants to be an engineer. Thanks a lot!
- “Hands-on” activities great for kids – BRAVA for the entire program!
- This program was great. As a parent, I never realized how many things we do have a lot to do with engineering.
- As a home-school mom I look for opportunities for my students to learn from professionals and determine what courses of study they might want to pursue in the future. My seventh grader, who now attends Tempe Prep, was told by his music teacher that this would be an excellent event to attend…Thank you for organizing this community event!

**ESSENTIAL WORKSHOP FEATURES**

Although each workshop centered on a unique combination of topics, information, and guest speakers, these workshops all included common elements and centered on collaboration and community awareness. Some common features include:

- Expertise enlisted from engineering faculty, arts faculty, student volunteers and specialists in related fields from the community
- Community awareness & education
- Intergenerational engagement
- Hands-on activities to explore artistic and scientific principles
- Collaborative partnerships to bring ASU to the community

**FUTURE RESEARCH AND TEACHER TRAINING**

Projected future research and teacher training models will examine and build upon effective aspects of the AVIE integrated curriculum and selected workshop topics. The information derived from past and present workshops will serve as a guideline for future programming. This year marks the beginning of a planning phase for ASU and the Arizona Department of Education (ADE). Teaching training will be planned in collaboration with ADE’s specialists, bringing the best of integrated arts and science education practices to K-12 classroom teachers throughout Arizona in user-friendly modules.

One of the ultimate goals of AVIE is to publish multiple editions of *Chain Reaction Magazine*; ASU’s curriculum publication for area K-12 schools. *Chain Reaction Magazine* is a free publication disseminated statewide to Arizona schools and is primarily used for teaching science to elementary and middle school students. This magazine is a K-12 publication usually developed from the ASU Research Magazine and includes practical curriculum for teachers. It is hoped that the AVIE edition(s) will include topics discussed from workshops and tools for educators to introduce integrated curriculum to their classrooms.

Every AVIE seminar and publication developed reinforces ASU’s commitment to education. ASU’s location and established reputation make programming that reaches the community and its teachers, students, and parents a primary focus. ASU has a strong commitment to establish and maintain relationships statewide, nationally, and internationally.

**SUMMARY**

ArtVentures in Engineering is a collaborative community partnership program that was created due to an overwhelming need for community-based programs that center on interdisciplinary education and innovative program design to attract and recruit underrepresented engineering students. To date, ArtVentures collaborative projects have centered on four topics that integrate the arts, science and engineering. Future programs will include curriculum development to assist teachers in integrating interdisciplinary modules into their classroom.

**REFERENCES**