The Chancellor's Awards for Excellence in STEM Education

Enhancing the Pedagogy of
Science, Math, and Technology
Through Music.

*Exploring Informal Science Education through the Arts*

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Proposal Description:

This proposal seeks to develop methods that enhance the teaching of science, math and technology through music. With the aid of the Boulder Laptop Orchestra (BLOrk), an electronic music ensemble at CU, we hope to expand the possibilities available to pedagogy in math, science, and technology and develop ways to engage in informal science education with students and audiences through the arts. Funds are requested to aid in the development of: 1) Visual and sonic representation of scientific data serving as a means to connect scientific research to a wider audience. 2) Development of computer applications that allow the users to explore interactive simulations of physical phenomena while performing for or with audience members. We believe that informal science education can happen in a variety of settings and mediums and we hope to form a foundation on which future instruction and performance can integrate science as a central component.

Background

BLOrk was founded in 2007, and like laptop orchestras at Princeton, Stanford, IRCAM and other research centers around the world, explores the integration technology within traditional performance contexts. Developments in digital technology have revolutionized how musicians and artists work and interact with others. Musicians are increasingly working outside their domain integrating sophisticated mathematical concepts, computer programming, and software design. Students in the ensemble at CU already work with scientific concepts such as analog synthesis, frequency, amplitude, types of waves (sine, sawtooth, triangle), wave form modulation, frequency modulation, and subtractive synthesis. Past performances have integrated multi-media through video and computer driven graphics and animation. Software such as Max MSP, Supercollider, and Processing are integrated to generate sound and imagery.
Methodology

Requested funding will support two primary initiatives towards developing models for informal science education relating to science, technology and math.

1. Visual and sonic representation of scientific data can be an effective way to represent mathematical formulas and relationships serving as a means to connect researchers to a wider audience. “Big data” in the form of weather patterns, stock exchange activity, or internet-traffic, can be visually or sonically represented. “Big data” applies to data sets whose size is beyond the ability of commonly used software tools to capture, manage, and process the data within a tolerable elapsed time. Examples include data from social networks, astronomy, atmospheric science, and genomics.

Applications of such representations include developing awareness of changes in our environment. Statistics such as changes in climate temperature, arctic ice-melt, biodiversity or loss of rainforest can be represented sonically and visually to communicate data in direct and compelling ways. Additionally, stochastic processes as found in random movement or random fields (wind, waves) can be demonstrated in a musical context. Pioneering composer Iannis Xenakis used probability, game theory, set theory, and Boolean algebra to produce music compositions. Such representations can be disseminated through a website, an installation at a museum or other public space, or part of a musical performance.

The first stage of research will identify a key area of data to represent as described above. Appropriate software will be identified and computer programs will be developed or adapted that can take existing data and represent it in a context that can be sonically and/or visually represented. The representation can then take the form of a musical/multi-media performance, museum or gallery installation, or through a website.
2. The second initiative explores the development of computer applications (apps for iPhone or iPads for example) that allow the user to explore interactive simulations of physical phenomena, particularly in the realm of sound and waves. Modeled after simulations that are part of the PhET project at the University of Colorado, similar applications can be developed or adapted that allow students and even audience members attending a performance, to download an “app” and interact as a group, while still exploring a particular physical phenomena such as the speed, frequency, or period of a sound wave. With the advent of iPads and similar technology, individuals or groups can use “apps” to generate sound and imagery in novel ways.

Additionally, I am in interested in a broader pursuit in regard to creativity and the commonalities that the creative process shares across both the arts and the sciences. It is my hope this research will facilitate a dialogue with researchers in other disciplines. When an audience attends a performance, they witness the creative expression of the composer or performer. Equally compelling is the idea that an audience could witness or understand the creative process of the scientist. Assessments will be administered as part of a public performance, class work, outreach activity.

**Assessment of outcomes**

In conjunction with performances and presentations, a measurement model for assessing individual learning will be developed. For example, a pretest, intervention (presentation), and a post-test could be given to an audience as part of a performance to gauge the effectiveness of the content and teaching presented. Alternatively, a “Retrospective Pretest” could be administered to collect self-reported changes in knowledge, skill, and attitudes of participants.
Budget And Timeframe For The Project.

Equipment: $4,000  6 iPads, sound equipment (6 amplifiers, cables)
Software: $2,000  Computer software licenses. (Max MSP)
Graduate Student Support: $2,000
Computer Programming: $2,000
Proposed budget: $10,000

Research to take place during the Fall 2012 and Spring 2013 semesters.

Current and pending funding:

The Boulder Laptop Orchestra and the Center for Innovative Studies in Music, Art, and Technology were made possible through an Innovative Seed Grant (2007). There is no other current or pending funding at present.

Statement Regarding Further Development:

After establishing a research initiative in music, art, and technology in 2007, (please see CISMAT.org) I have been eager to engage the scientific community at CU. I believe the initiatives of STEM education will provide a forum for establishing relationships with researchers and departments beyond the humanities. Collaboration across departments and disciplines will strengthen the CU community and broaden the possibilities in my own research. Furthermore, it is my belief that musicians and artists must proactively engage with a wide audience and across many disciplines so as to make a greater contribution in the community as creative thinkers and performers. It is my hope to share the fruits of this research and funding to the community beyond CU through outreach activities in the general public and public schools.
References:

National Science Foundation:
Framework for Evaluating Impacts of Broadening Participation Projects

PhET Interactive Simulations
   http://phet.colorado.edu/

Center for Advancement of Informal Science Education
   http://caise.insci.org

Stanford Center for Computer Research in Music and Acoustics
   https://ccrma.stanford.edu/

Columbia Computer Music Center
   http://music.columbia.edu/cmc/

IRCAM: Institute for Research and Coordination in Acoustics and Music
   http://www.ircam.fr/

Collaborators/Consultants:

John Drumheller, Director of Music Technology, University of Colorado Boulder

Michael Theodore, Associate Professor Composition, Director Center for Media Arts & Performance, CU Atlas.

Darwin Grosse, Director of engineering at "Cycling 74", Composer, Writer, Mastering Engineer

Luke Dubois, Professor of Music, Brooklyn Experimental Media Center
   at the Polytechnic Institute of NYU