The STEAM Journal

Volume 3
Issue 1 *Sediment*

Article 14

November 2017

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Recommended Citation

Davidson, Christopher D. and Simms, Willard (2017) "Science Theater as STEAM: A Case Study of "Save It Now"," *The STEAM Journal*: Vol. 3: Iss. 1, Article 14. DOI: 10.5642/steam.20170301.14
Available at: http://scholarship.claremont.edu/steam/vol3/iss1/14

STEAM is a bi-annual journal published by the Claremont Colleges Library | ISSN 2327-2074 | http://scholarship.claremont.edu/steam

Science Theater as STEAM: A Case Study of "Save It Now"

Abstract

What are the markers of a successful STEAM program? How and when can educators be reasonably sure that an interdisciplinary unit or project, rich in both the sciences and the arts, has delivered on its implicit promise – by adding value to a student's education in ways that are beyond the scope of traditional discipline-specific learning? I attempt to address this question with a case study of Theatre of Will's "Save It Now," a pilot program for 4^{th}, 5^{th} and 6^{th} graders at eight Los Angeles public schools that integrates theater arts, music and the STEM disciplines in a 9-week unit on energy, water and climate change. I am one of the program's four teaching artists. My goal here is not to convince readers that "Save it Now" is successful, but rather to propose a theoretical framework for understanding, categorizing and evaluating STEAM programs in general.

theatreofwill.org

Author/Artist Bio

Christopher D. Davidson is a teaching artist at Theatre of Will and an adjunct professor of Sociology at Southern New Hampshire University. Willard Simms is the founder and President of Theatre of Will, a non-profit educational organization dedicated to the integration of arts and class room education. Through the creative utilization of theater, music, and the visual arts - Theatre of Will creates STEAM Residencies and also Science/History Assemblies that supplement Los Angeles Unified School District core curriculum and match Next Generation Sciense Standards. Several STEAM Residencies are currently scheduled for the 2017-18 LAUSD school year.

Keywords

Next Generation Sciense Standards (NGSS), science education, theater education, STEAM, conceptual metaphors

Science Theater as STEAM: A Case Study of "Save it Now"

Christopher D. Davidson & Willard Simms

Introduction

What are the markers of a successful STEAM program? I will attempt to address this question with a case study of Theatre of Will's "Save it Now", a pilot program for 5th and 6th graders at 8 Los Angeles public schools that integrates theater arts, music and the STEM disciplines in a 9-week unit on energy, water and climate change. The creators are Willard Simms and his educational staff. I am one of the program's four teaching artists.

Using "Save it Now" as an illustration, I propose a theoretical framework for understanding, categorizing and evaluating STEAM programs in general. Effectiveness is in the eye of the beholder; it is only measurable if we know what we are measuring. This article is a first step in that direction.

At first glance, STEAM appears to be a catchy new acronym for an old and well-established idea. Since at least 1992, the National Science Foundation (NSF) has funded educational projects that integrated arts and sciences. Some recent examples are:

www.fusionsciencelearning.org

https://www.nsf.gov/awardsearch/showAward?AWD_ID=1623494&HistoricalAwards=false

The Floating Point Science Theatre, founded by Steve Mesure in 1989, toured Great Britain presenting plays about science, technology and geography to young students at elementary schools (Nature Publishing, 1999). And yet, even though the fundamental connectedness of arts and sciences has remained constant, the changing politics of education has caused years of turmoil for public schools and their curricula.

After the passage of No Child Left Behind legislation in 2001, school districts around the country began diverting scarce resources towards math and reading instruction (the new focus of nationwide standardized testing) and away from elective classes in music, art and theater. Other education industry players - government agencies, foundations and schools of education - directed research and funding towards the STEM fields because of their perceived importance to the economy. Schools that had cut back on music and theater began investing in computer labs and robotics.

It soon became clear that school climates were suffering as a result of cutbacks in the arts. Although STEM programs were getting funding and publicity, most students continued to perceive the scientific subjects as dry and boring –perceptions which, unsurprisingly, decreased students' enthusiasm for the sciences and were likely to drive even the most talented away from scientific careers (Papacosta, 2006; Varelas et al 2010).

In January 2011, 60 leaders in art, design, educational research and the STEM fields visited the Rhode Island School of Design (RISD) for an NSF-funded workshop named "Bridging STEM to STEAM: Developing New Frameworks for Art-Science-Design Pedagogy." Their goal, as described in their grant proposal to the National Science Foundation (NSF) was to "initiate discussions about how to bridge STEM education practices and creative problem-solving" (NSF, 2010, para.1). The grant-writers, both on RISD faculty, defined STEAM rather narrowly as a movement to "build new connections between art and design disciplines and scientific fields to advance understanding of complex systems" (NSF, 2010, para.1) This design-centered approach to the integration of STEM disciplines has been reported on and discussed extensively in mass market publications such as *Education Week* (Robelen 2011; Jolly 2014), *Slate* (Feldman 2015), the *New York Times* (Fountain 2014) and *Scientific American* (Pomeroy

2012; Maeda 2013).

But as the contributors to this journal can attest, STEAM has since evolved to include other art forms - writing, videogames, music and theater. NSF has followed suit; after the 2011 workshop at RISD, the agency began funding multi-year school-based initiatives to cultivate student interest in STEM fields through videogame design, music remixing, and decorative object-making in maker-spaces equipped with 3D printers.

STEAM is a relatively new addition to the pedagogical landscape, so there is only a smattering of published and peer-reviewed research about it. But the evidence we do have supports STEAM advocates. Students in integrative programs tend to (1) enjoy learning science, (2) improve their academic performance, and even (3) raise their standardized test scores - in both math and language arts! (Peleg & Baram-Tsabari, 2011; Hendrix et al, 2012; Ceylan et. al, 2014; Inoa et. Al, 2014; Stroupe & Kramer, 2014; Kaplan, 2017; Sterman 2017).

Theatre of Will's newest initiative, "Save it Now" is a Los Angeles Department of Water and Power (LADWP) funded pilot program that began in August 2017 and brings our faculty members (whom we refer to as teaching artists) to 4th, 5th and 6th grade classrooms in the San Fernando Valley. By the end of this academic year, we will have completed 9-Week STEAM residencies in 25 different classes, at 8 Los Angeles area public schools. At every participating school, each teaching artist pairs up with a regular classroom teacher who has expressed interest in the program.

Our curriculum is deeply interdisciplinary - a full-on, down to the roots synthesis of theater arts, music, and sustainability science. The STEM content is designed to meet LGSS standards for grades 4-6. The theater exercises prepare students for a culminating event in the school auditorium or equivalent, in which every participating in the residency shares what they have learned with the school community.

Save it Now

"Save it Now" has two main goals. First of all, we use ideas and techniques from the theater arts to teach complex scientific concepts - such as energy conservation, the water cycle, or electricity - to elementary and middle school students in Los Angeles. Secondly, we treat the science content of our curriculum as a vessel through which our students can develop the "soft" communication skills that are essential for both theater and adult life - public speaking and relaxation techniques, active listening and mirroring, improvisation, and teamwork.

At our first culminating event at John C. Monlux Elementary, in October 2017, the 5th grade class who had worked with teaching artist Danny Shorago pantomimed the water cycle in a hydroelectric plant, with one group mimicking a turbine, another the flow of water, a third the transfer of electricity into homes. The audience of teachers, parents and school administrators roared with appreciative laughter when Group 3 jerked their bodies around, with musical accompaniment, to imitate the flow of electricity into household appliances. A second 5th grade class presented 3 emotionally powerful short skits they wrote under the guidance of teaching artist David Guerra, about the history of The Los Angeles aqueduct and the destructive effects of Los Angeles's vast water demand on the 1000-year old irrigation system of the Peyote Indians in the Owens Valley. Teaching artist Juliette Angeli led her class of 4thgraders in a personification of three different kinds of lightbulbs – the low-efficiency incandescent bulb, the medium-efficiency fluorescent bulb, and the highly efficient Light Emitting Diode (LED). Each kind was represented by students who mimicked its emission of light and heat energy with their body movements. As the music director played a mock dirge, they also demonstrated, with impeccable comic timing, how each lightbulb dies – rapidly in the case of the 1200-hour incandescent bulb, and 50,000 for the long-lived LED – by staggering and collapsing onto their seating mats.

The culminating event was a huge success with its audience and its performers. But how can we therefore conclude that "Save it Now" is successful?

Regarding individual participants Theater of Will looks for:

- ***Permanence of knowledge*** – our students should have the subject matter entrenched in their long-term memories.
- ***Growing enthusiasm about the STEM fields***, particularly among girls and children who belong to minority groups that are under-represented in those fields. If our program is successful, we should expect some students to become inspired, and begin seriously considering careers in the STEM fields.

At the institutional level, we expect

- ***Close collaboration with classroom teachers***, and division of labor so that residents can teach to their strengths while the classroom teachers teach to theirs This criterion is similar to one of the criteria proposed by Kaplan (2017) in a recent article about "Mind over Music," a collaboration between the Phoenix Symphony and the local public school system.
- ***Administrators who support our program***, and all the teachers and classes that participate.

To sum up, the markers of a successful residency program are (1) student ***knowledge retention***, (2) ***student enthusiasm for STEM***, (3) ***close collaboration*** between the resident teaching artists and the regular classroom teachers, and (4***) institutional buy-in***.

Figure 1. Visual display about understanding causes of drought.

Outcomes

The residency at John C. Monlux is, essentially, a pilot of a pilot. Monlux is the first of eight schools that we will partner with over the 2017-18 academic year, and the residency itself is a brand-new initiative. But our early results there suggest that "Save it Now" is fulfilling its educational mission, and meeting the criteria for success. Consider these findings:

a) The day before the culminating event, students completed surveys measuring their knowledge of the material in our curriculum, and most of them got 100% of the questions right.

b) On the day of the event, all three classes set up information-packed, colorful tripartite displays along the path from the main office to the auditorium where the culminating event was taking place. The posters didn't stay in classrooms. Clearly a group effort, they summarized and elaborated on all the material from our "Save it Now" curriculum. One of our partner teachers had allotted a week of class time to making the displays. Theater of Will did not expect the regular classroom teachers to add poster-making to their lessons; we only required that every class participate in the culminating event. But the level of commitment to "Save it Now" was so high among the teachers and the students that they chose to create posters anyway, and display them in a public area outside the auditorium so that everyone passing by could see them. They clearly took pride in their work.

c) During the event itself, almost all the participating students were smiling throughout the 30-minute performance, a sign that they were enjoying themselves.

d) One enthusiastic mother told me that her daughter, a student in Angeli's class, had been talking about energy efficient lightbulbs at home and demanding that they replace all their incandescent bulbs with LEDs.

e) Most encouraging of all, the principal invited us to return next year. LADWP funds will not cover the costs of visiting a school twice, so he agreed that the school would fund our return.

These are all fragments of data with no statistical significance, but they illustrate the kind of evidence that, if it were gathered systematically, would demonstrate that our pilot program had succeeded.

- Survey results like those I describe in (1) would allow us to measure, with quantitative data, the level of ***knowledge retention.***
- The public displays from (2) could be described as evidence, not only of what the students

know, but also of ***student enthusiasm*** for STEM and fruitful ***collaboration*** between teachers and teaching artists.

- The smiling faces from (3) are an example of the visual, sensory evidence we would need to measure ***student enthusiasm.***
- The enthusiastic mom from (4) shared evidence of ***knowledge retention*** and ***student enthusiasm.***
- The principal's invitation, and his willingness to pay us with school funds, demonstrates ***institutional buy-in.***

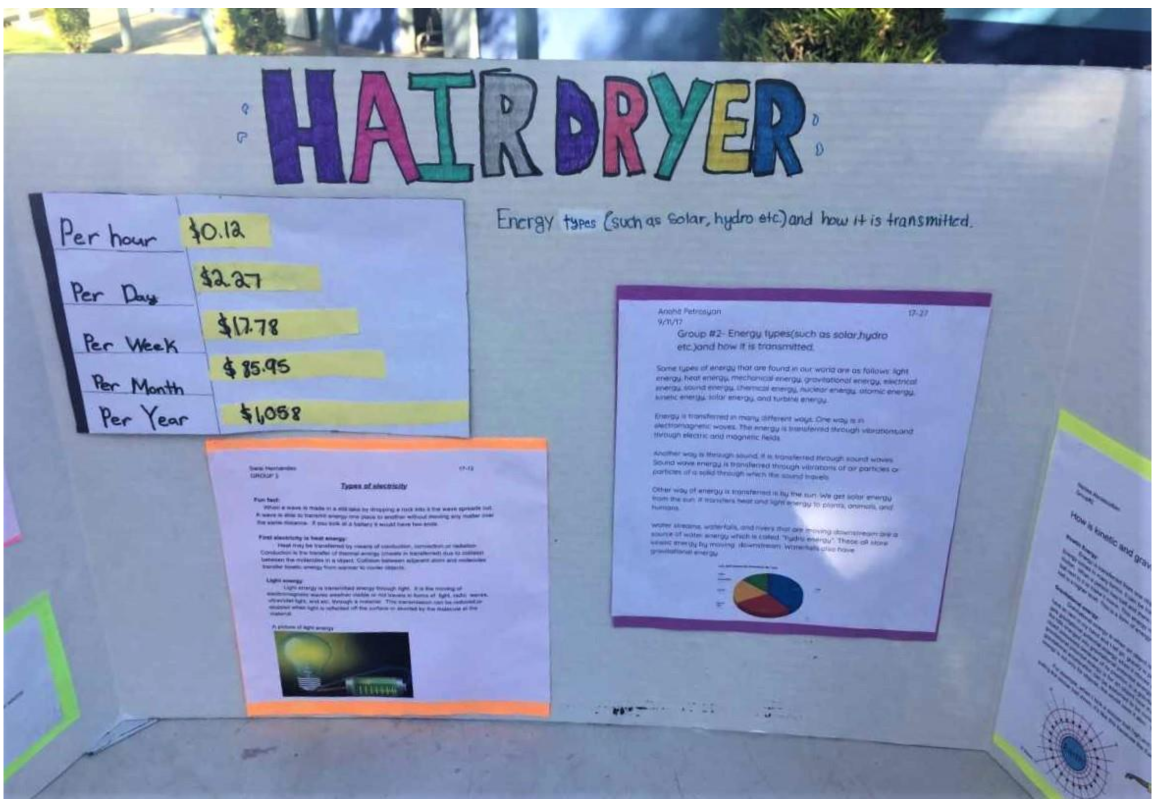

Figure 2. Analyzing electricity

So what does our analysis of the Monlux pilot imply for a general model of successful STEAM programs?

Willard Simms and I believe the most important factor in our success so far is reproducible, and could be relevant for many other STEAM programs. At Theatre of Will, the secret sauce we use to make complex science easier to understand, even for younger children, and to translate between the abstract ideas of the educational standards and the real-world grittiness of theater, is what psycho-linguist George Lakoff has described as conceptual ***metaphors*** – abstract ideas that are understood and described in terms of other more tangible ideas (Lakoff & Johnson 1980). Examples of frequently used conceptual metaphors in the English language include (1) love as a journey, (2) government as parent and (3) nations as families.

When Theater of Will's teaching artists take an abstract idea from the elementary science standards, and find a way to act it out on a stage, they are, in effect, creating conceptual metaphors. We used one metaphor extensively in the culminating event at Monlux: ***energy as a substance***. We are not the first science theater group to do this, nor was I the first to describe what we do as a conceptual metaphor (see Close and Scherr, 2015). When Danny Shorago's students acted out the energy cycle of a hydroelectric plant, (see above) they were, in effect, showing with their body movements that energy flows from the water in an aqueduct, to the turbine, to the generator, to the household appliances it powers. Energy is not visible to the naked eye, so we have to imagine it – in this case, as a substance moving from one place to another.

A second conceptual metaphor we used at the culminating event was ***mechanical failure as death***. The human lightbulbs in Juliette Angeli's class fell to the ground and 'died' on stage to demonstrate how different types of lightbulbs burn out at different rates.

Figure 3. Students demonstrating how water can be made to flow uphill

Conclusion

A great STEAM program is like fruit salad. (Note the conceptual metaphor that follows.) Not just any fruit salad, but the special kind on sale at food trucks all over Los Angeles. A few dollars can buy one-serving bags overstuffed with mango, watermelon, cantaloupe, maybe a few slices of apple or pear – mixed with long chunks of fresh cucumber, jicama and celery, and over the top, a generous sprinkling of chili powder and lemon. I have never eaten a fruit salad so delicious. If you grew up, like I did, in a world of binaries - science and art, male and female, salad side dishes and fruit desserts - you might be puzzled, even a bit appalled by a spicy, sour, sweet and salty mixture of fruits and vegetables bought from a street vendor. What a mess!

Science, technology, engineering and math - or STEM - seem to go together intuitively. Until recently, it was common practice for educators to talk about them and teach them together. That appears, at first glance, to make sense. Science depends on mathematical calculations; engineering is applied science; technology has to be engineered. Furthermore, many well-paid full-time jobs with benefits require STEM-related skills from their employees. Like a green salad, the STEM disciplines are healthy, practical, maybe a bit boring, but necessary for a productive adulthood.

Many children are used to learning in single-subject chunks, and identifying themselves as "good" at one subject and "bad' at another. Maybe they like reading but hate math; or perhaps they can do long division in their heads but they choke when it's time to write an essay. They might consider themselves "fruit" experts or "salad" experts, but not both.

STEAM, like the street corner fruit salads of Los Angeles, is a counterintuitive mix of flavors. Our hope is that "Save it Now" will prove to be a STEAM unit that turns children's expectations – of themselves and of school – upside down, even as it helps students master new concepts, skills and vocabulary with their whole brains and bodies. Then, if they are asked what they know about renewable energy, or electricity production, or the water cycle five years from now, they will still remember everything they learned.

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