STEAM 2017

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STEAM is hotter than STEM:
The why and what of my teaching paradigm in higher education

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The Road to Science-Art Integration

Although the call for STEAM education formally came out in 2008 and has significantly increased most notably over the past year – as if society wills to return to the Renaissance when the sciences and arts flourished as a result of integrative polymathic thinking that engendered innovation between architecture, art, law, literature, philosophy, politics, and science – the merging of science and art has been an integral part of my life for the past thirty years.

I grew up equally immersed in both science and art worlds. Up until college I spent as many hours in a white lab coat setting up experiments in chemistry, botany, and genetics as I did sitting at the piano playing scales, etudes, sonatas, and concerti or at my desk writing stories and poetry. Armed with the skill sets to do science and practice the musical and literary arts, I honed them in college while being told to keep them academically separate. Graduate school followed with even narrower mindedness as I studied for the PhD in cognitive science and acquired a degree in photography from another school. It was also during that time when I said “enough is enough” and took higher education into my own hands by creating two novel courses in two different departments that separately brought together what I had been told couldn’t be done: the brain, psychological, and computational sciences with the visual, literary, and musical arts. They would act as the springboard for a string of ever-evolving courses I’ve continued to teach from precollege to postgraduate levels that focus on cognitive science and its intersection with music, aesthetics, photography, film, and/or literature whereby students learn as much about science as they do about art. In creating these courses, I wondered, what if I could teach this multidisciplinary mindset to others? Give others the opportunity to find new connections otherwise unfound? After all, Leonardo da Vinci didn’t achieve his outstanding innovations by sticking to a single discipline!

My career as a brain scientist and a multidisciplinary artist naturally lead to the founding of my company, Le Petite Noiseuse Productions. For the last ten years I’ve worked as an educator within higher education actively pursuing an interdisciplinary teaching paradigm that has yielded effective learning results. Here, I discuss and present examples from my most recent advanced undergraduate course in music cognition at Johns Hopkins University in Baltimore, MD.

What Science-Art Research Reveals About Creative Thinking

As the campaign for integrating the arts within science education takes flight and other buzzwords like innovation and “the science of learning” enter the stage in the fight for an overall revolution to traditional fact-based test-driven learning

that simply doesn't work for today's and tomorrow's demands, I grin with amusement. Not because efforts being made to effect change aren't worthy, they most certainly are. But because the answer, I believe, has been sitting in plain sight all along: creativity, our most human of cognitive capacities, and yet the one to be rebuked within learning spaces, among other areas.

My choice to embrace creativity in the classroom is the result of not only my personal experiences, but the results of my research. As a cognitive scientist, I research how the mind/brain represents and manipulates language, music, and emotion during creative artistic invention. As an artist, I represent those moments in live dramatic contexts. The visual, literary, and performing arts offer a unique multi-sensory framework to empirically study creative thinking processes outside the traditional lab setting where basic mathematical and linguistic problem-solving tasks are typically carried out. As such, I've created a set of original film and theatrical productions through my company that serve as ecologically valid and rich audiovisual contexts from which to learn about the nuanced interrelationship between musical improvisation, natural language, emotion representation, aesthetic narration, and body language. Figure 1 has photo stills from several original works that were produced for live audiences.

Figure 1. Photo stills from one film and three theatrical productions.

What these empirical-artistic productions have revealed, is that creativity is the result of mini spontaneous decision-making moments that are dependent on stored knowledge, changing foci of attention, emotional targets, an openness to unexpected elements within an environment, and a quickness to perceiving the positive value of those unexpected elements. Moreover, the larger the improviser's knowledge toolbox from which to pull ideas from, the greater the number of possibilities for innovative actions and the willingness to enter into an unforeseen direction of discovery. **[1-3]** I implement these findings in the classroom as a way to teach creative thinking and doing in learners.

The Approach

I diagram my reseARch scienTIST approach in Figure 2 to illustrate two key points: how the research I carry out as a brain scientist is as much intertwined with and a result of how I create works as an artist, and how the art I produce is as much influenced by the scientific questions I ask as a brain scientist answering fundamentals of the mind/brain. This approach is what I bring to the educator's table.

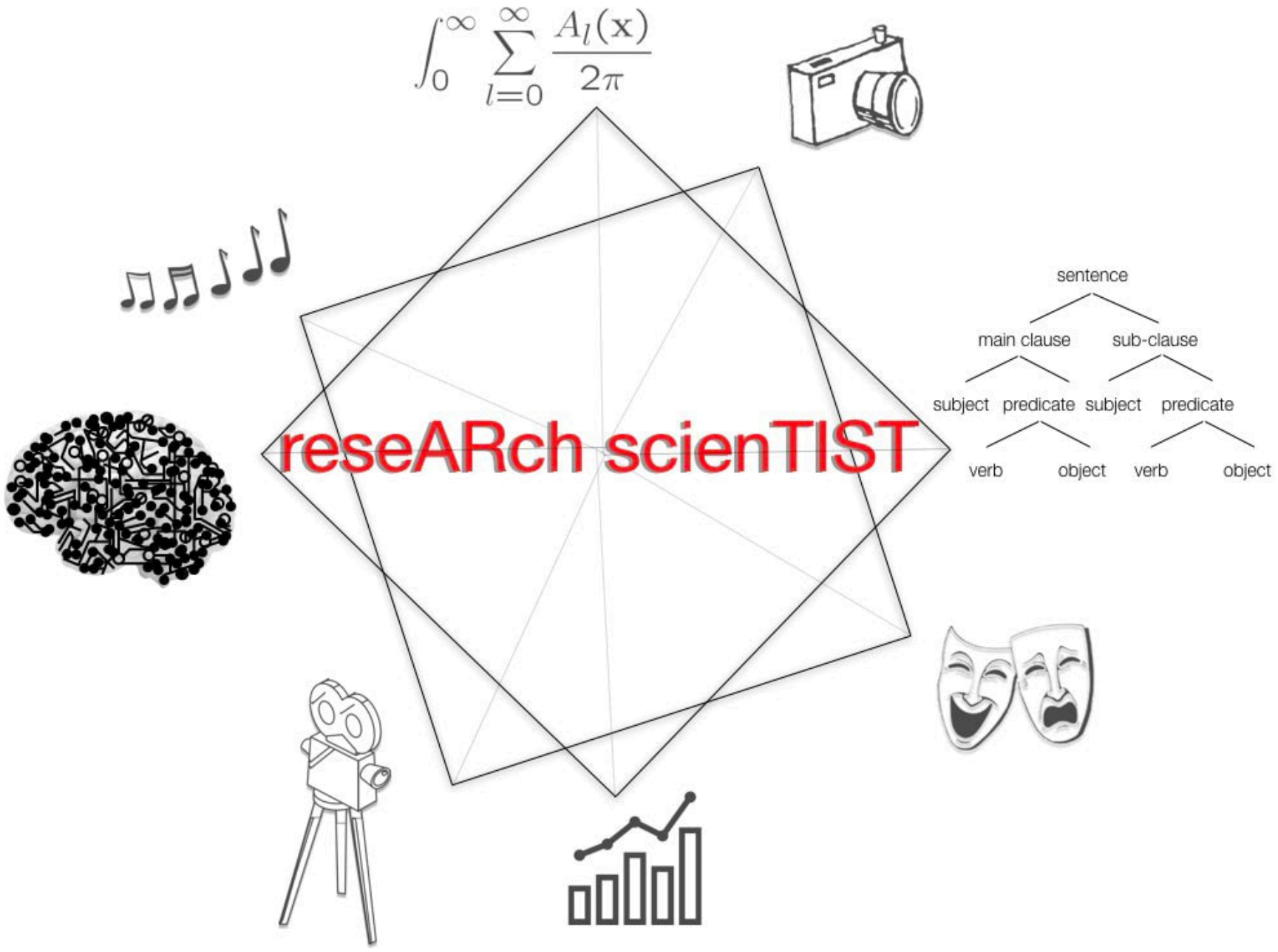

Figure 2. My reseARch scienTIST approach.

Course Deliverables

But theory stands the test of time if it works in practice and yields consistent results. Dates, names, experiments, theories, etc. can be googled within seconds without even the slightest notion of their meaning or value. The availability of Google and other search engines have in part suggested long-term fact memorization as a phenomenon of the past. Concept comprehension and transformation, on the other hand, is not googleable.

My approach to education is not a boilerplate methodology that can be copied and reused over and over again without change. It requires deep knowledge in both art and science to be able to continuously mix, match, and/or merge methods in order to create, innovate, and advance knowledge. I assign a multidisciplinary array of readings from various perspectives (e.g. biology, cognitive science, computer science, humanities, musicology, neuroscience, philosophy, psychology) but I don't lecture. Instead, I converse with and guide my students. Together we break down the what, why, when, and how of the reading materials and then offer (dis)agreements and alternatives – issues they then write out into cartoons or diagrams (see Figure 3). This serves as the theoretical background to work with them one-on-one and in groups as they create original projects, because I don't give exams either. Through several drafts and revisions, I guide

them to develop, write, design, and produce on a related course topic (in the present discussion relating to music and the brain) of their choice three types of products: research papers (experimental and/or theoretical in nature), short films (documentary or fiction styles), and popular science articles (see Figure 4).

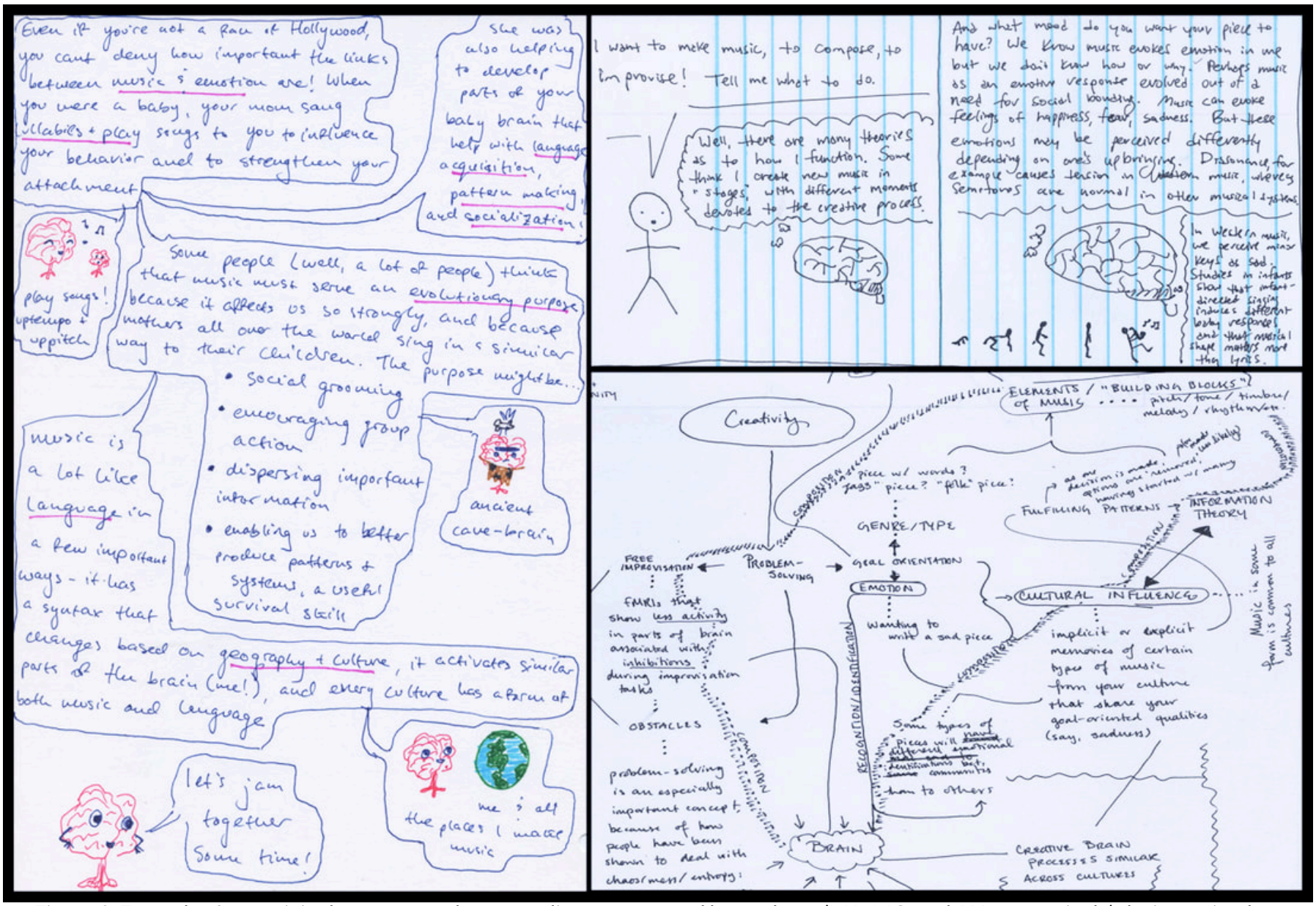

Figure 3. Examples from original cartoons and concept diagrams created by students (MA, MG, and AH, respectively) during an in-class writing assignment.

Figure 4. Examples of published research work, popular science articles, and short film program notes created by students for the course's creative project assignment. Link to Music and Medicine short film: https://www.youtube.com/watch?v=VBey5C9jn4c

This type of hands-on and experiential creative work uniquely requires students to master concept comprehension in order to transform, apply, and communicate the course's material. Whether they're writing a novel research paper that proposes experiments and critiques evidence and theories, developing and producing an original film short that incorporates course material into a fictional or non-fictional narrative, or working on their popular science articles highlighting the quotidian nature of the course's material, they are engaged both intellectually and emotionally. And by encouraging students to *choose* the topic of their project they maintain positive attitudes of discovery throughout.

In Sum

My educational upbringing and the observations I've seen in my own hybrid empirical-artistic STEAM work have directly affected my teaching approach. In other words, my teaching approach is a direct result of who I am as a Scientist-Artist and the critical-thinking, creative, and interdisciplinary mind I seek to awaken in my students no matter their age or intellectual background. And the fact of the matter is that engaging in creative problem solving and discovery not only within a single discipline, but across several disciplines in the classroom, engages crucial cognitive processes important

for successful learning such as emotion (e.g. positive engagement) and memory (e.g. long-term). Semester after semester, year after year, my students create original and complex work a three-hour final exam could not produce and have gone on to present and publish their research work in international scientific conferences and/or used their artistic work to pursue professions in the arts. My appeal to the research world is that brain imaging and computational studies must work in tandem with innovative behavioral studies to identify how multi-sensory stimulation *altogether* effects positive learning outcomes.

I believe that to be able to create the next generation of innovators and problem solvers, we need to implement integrated science and art in education from kindergarten all the way to graduate school to create hybrid Artists-Scientists. Artists-Scientists are vastly knowledgeable and historically have been the most impressive creatives with their enduring innovations. They're builders, seekers, inventors, thinkers, communicators, and risk-takers that reach success in all their endeavors.

[1] Lopez-Gonzalez, M. (2015). Cognitive Psychology Meets Art: Exploring Creativity, Language, and Emotion Through Live Musical Improvisation in Film and Theatre. Proceedings of SPIE 9394, Human Vision and Electronic Imaging XX, 939403 (March 17, 2015); doi: 10.1117/12.2083880.
[2] Lopez-Gonzalez, M. (2016). Minds in the Spotlight: Using Live Performance Art To Uncover Creative Thinking Processes, IS&T Electronic Imaging Symposium: Human Vision and Electronic Imaging, (IS&T, Springfield, VA, February 14, 2016); doi: 10.2352/ISSN.2470- 1173.2016.16HVEI-143.
[3] Lopez-Gonzalez, M. (2017). Trading Conversations Between Science and Art: When Musical Improvisation Enters the Dialogue on Stage, IS&T Electronic Imaging Symposium: Human Vision and Electronic Imaging, (IS&T, Springfield, VA, 2017). doi: 10.2352/ISSN.2470-1173.2017.14.HVEI-156.

Dr. Monica Lopez-Gonzalez is a multilingual cognitive scientist, multidisciplinary artist, educator, entrepreneur, public speaker, science communicator, and writer. Fascinated by the cognitive relationships between creative artistic, emotional, musical, and linguistic behavior, she merges methods, data, and theory from the sciences and arts. She is the co-founder and Executive Scientific & Artistic Director of La Petite Noiseuse Productions. Monica has pioneered many STEAM courses and workshops at the intersection of the mind/brain and computational sciences and the visual, literary, and performing arts at Johns Hopkins University and other organizations. She is a frequent invited speaker, consultant, and guest Scientist-Artist polymath at various national and international venues. Monica holds B.A. degrees in Psychology and French, and a M.A. and Ph.D. in Cognitive Science, all from Johns Hopkins University, a Certificate of Art in Photography from Maryland Institute College of Art, and was a postdoctoral fellow at the Johns Hopkins School of Medicine.