Turning Math into Dance: Lessons from Dancing My PhD

Nancy Scherich

University of California, Santa Barbara, USA; nscherich@math.ucsb.edu

Abstract

Dance is a stunning and novel choice of expression to communicate abstract mathematical concepts. This paper outlines several techniques to effectively communicate using dance and visual aids. The author uses examples from her dance video that won Science Magazine's 2017 'Dance Your PhD' competition.

Why Dance?

There have been many efforts to use math to describe dance or use dance to teach basic mathematical concepts like symmetry and patterns [4]. However, I think dance can bridge the gap in the ever-growing disparity between the public understanding of math and a mathematician's view of math. A desperate need arises for *math communicators* to explain what math really is. I think dance is an excellent form of communication to explain highly abstract mathematical concepts to the public. I am not alone in this ideology, and in fact John Bohannon, and Karl Schaffer and Erik Stern, have given TED talks on using dance to describe complex scientific concepts in [1] and [2]. For the last ten years, Science Magazine has held the *Dance Your PhD* competition for graduate students in STEM fields to make a dance video about their dissertation. This competition is where my story begins. I made a dance video describing representations of the braid groups [3] and won this competition in November of 2017. I have received overwhelming positive responses towards my video, not just from mathematicians, but mostly from people outside of the math community. The general impression from these responses are "I think I might have actually liked math if someone had taught me using dance."

So why dance? From a communication standpoint, dance can be used to trick *math-phobic* people into thinking mathematically. The shock of putting two very different subjects together has the viewer suspend their beliefs about math, which allows them to rewrite with an open mind what math is or can be. The human element of dance removes a veil of intimidation and makes the math concepts more relatable. From a mathematical perspective, the very language we use to describe abstract concepts are words of movement: rate of change, flows, mappings, loops, twist, motion groups, level curves, continuous deformations, etc. Dance is a stunning and novel choice of expression to communicate these ideas of movement and relationships.

Effective Communication with Dance

Effective math communication has two major challenges. Firstly, it is very difficult to say what you really mean with out watering down the content and losing the spirit of your math. Secondly, there is an overwhelming culture of math-anxiety, which makes it difficult to ensure the attempted message is received and understood by the audience. Here are some techniques I stumbled upon when making my video to effectively communicate with dance.

Create an Analogy and Tell a Story

Turn mathematical concepts and objects into characters and use drama or romance to make the viewer care about the characters. The viewer is more likely to pay attention and learn if they are emotionally attached to the characters.

In my video, the cast of characters were braids, representations and kernels. The story followed a dangerous journey of braids being taken from their home and then transformed into matrices or kernels. I used romance to describe the difference between a faithful and unfaithful representation.

(a)

(b)

Figure 1: *(a) Dramatic anihilation of a kernel element by a representation, (b) Romantic moment between a faithful representation and his one kernel element.*

Use Visual Clues and Labels

It is inevitable to introduce new vocabulary when describing mathematics. Using labels and visual clues is a quick way to reinforce ideas, characters, and identify relationships.

(a)

(b)

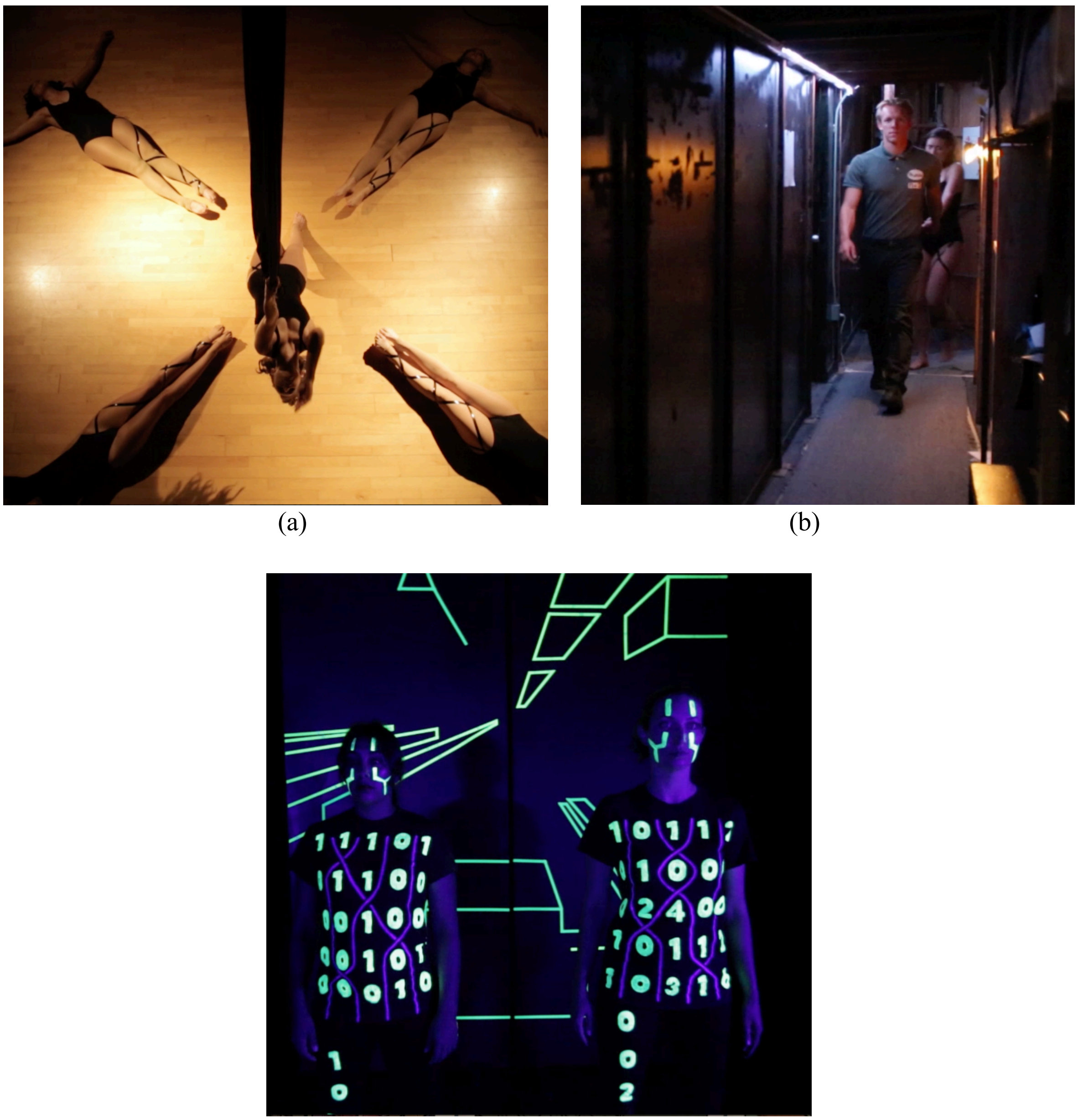
(c)

Figure 2: *Visual clues. (a) A braid painted on the arm of a 'braid' character, (b) Labeling of the 'Kernel' character and the night club 'GL(V)', (c) Labeling of a 'Representation' character.*

Create an Abstract Landscape

The lighting, costumes, colors schemes and surroundings give context and feeling to a scene. The landscape is fictitious, but can give the viewer a sense of being in a different realm, which mimics the way a mathematician feels when working with different sets of tools.

In my video, I used three separate landscapes. I used a warm, wooden room with dramatic lighting for the realm of the braid groups. Then, the representation characters took the braids out of their realm down a dark hallway to an entrance to the matrix world. I used blacklights, neon colors and geometric designs as the landscape for the matrix world.

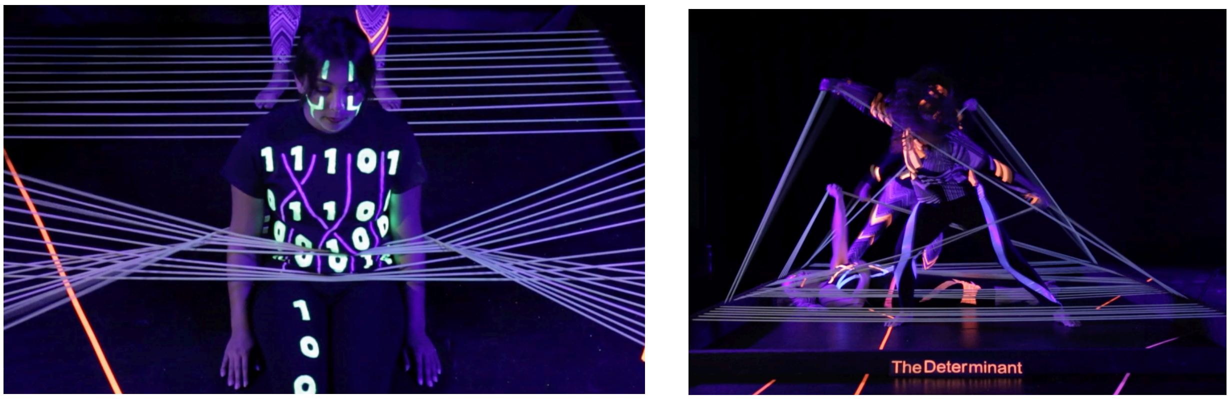


(a) (b) (c)

Figure 3: *Abstract Landscapes. (a) Warm, wooden landscape of the braid groups, (b) Creepy hallway transition landscape, (c) Neon and Blacklight landscape of the matrix world .*

Look for Visuals in Computations

It is an easy trap to think that math is not visual or physical. However, with some creativity, there are visuals even in the most abstract places. I suggest looking for visuals in the notation, formatting and computations. For example, in my video, I used an apparatus, created by Emily Baker, made with surgical tubes stretched across a rectangular frame. The tubes were woven around a matrix dancer which physically recreated the basket weaving method for computing a 3x3 determinant.



(a) (b)

Figure 4: *An apparatus visualizing computing the determinant of a matrix.*

Acknowledgements

The photos in this paper are stills from the original video [3] which was filmed and edited by Alex Nye. The dancers in the photos are part of Lauren Breese's AIREDANSE collective, namely Corinne Guichard, Claire Lindstrom, Kaleena Quarles, Marisa Allan, Olivia Davi and Eric Boesser.

I would like to thank Ken Millett for his support and everlasting encouragement for my Math-Dance projects. I would like to thank my thesis advisor Darren Long and the Graduate Division at UCSB for awarding me a fellowship, giving me the opportunity to pursue these projects. Lastly I would like to thank Dean Morales for his support and editing.

References

[1] J. Bohannon. TED Talk. https://www.youtube.com/watch?v=UlDWRZ7IYqw

[2] K. Schaffer, E. Stern. TED Talk. https://www.youtube.com/watch?v=Ws2y-cGoWqQ&t=230s

[3] N. Scherich. Dance video "Representations of the Braid Groups." https://www.youtube.com/watch?v=MASNukczu5A&t=295s

[4] C. von Renesse, V. Ecke, J. F. Fleron, P. K. Hotchkiss. "Discovering the Art of Mathematics: Dance." Working Draft 2016 available at https://www.artofmathematics.org/books/dance