Using Art Pieces, Processes, and Movements to Integrate STEAM

Katey Shirey (katey@edukatey.com)

INTRO Video:

My name is Dr. Katey Shirey and I'm joining you today to provide a few planning tools to help you increase the STEM content in your art lessons, or the art content in your STEM lessons using art pieces, art processes, and art movements.

My background is in physics and sculpture, and in college I made art to teach physical principles and phenomenon. For example, I used bright lighting to heat air and make water move in a sculpture about clouds, I used projection and a rotating wave model to demonstrate translating sine functions, and I made a scale model of St. Peter's cathedral out of string in Fred Sandback's style to explore the cathedral's proportions.

When I became a high school physics teacher, I sought opportunities to bring art into the classroom and became a believer in the power of integrated-STEAM instruction for teaching students to be proudly independent and critical thinkers. My students were engaged by the connections and applications they found all around them between science, design, and art. I also realized that there were many more ways to bridge art and STEM than I had ever thought of when I was making my own art.

In this stack, I'm going to highlight and explore three ways that now, as a STEAM education consultant, I encourage educators to bring art to STEM and STEM to art using art pieces, art processes, and art movements. By centering on a topic or problem of interest, and taking a perspectives approach including art pieces, art processes, and art movements, you and your students will find memorable and even surprising connections among art, science, math, technology and engineering. I'm looking forward to sharing simple planning tools and examples to help you amp up these connections in your classroom. I'll see you soon.

ART PIECES VIDEO

Welcome back. In this video, we're going to explore how you can find connections between art and STEM by looking at art pieces.

[show slide 1. Integrated STEAM braid]

I believe that diverse disciplines and multiple perspectives contribute their individual strands to what we know as integrated STEAM education, making a rope that is stronger than the individual strands alone

Art pieces provide an immediate entry point for seeking interactions between art and STEM. I'm going to walk through several examples and show you my perspectives approach tool that you can use to generate even more examples.

[Show slide 2: Art pieces Venn diagram]
When I say, “art pieces,” I mean individual works of art—the product of art making and design. I also mean looking at art works and making art pieces. Seeking the science and math that a particular art piece embodies is a great way to explore how artists used applications of science and math through the design process to make their art.

Every art piece is itself a piece of “technology”—a created tool for illustrating an idea. By asking, “How does the piece work?” and, “What allows this art piece to be how it is?” we can reveal the science, math and engineering at work in the finished piece of art. Let’s look at a few examples before I introduce the tool I use with educators to select useful examples and design meaningful lessons for their classes.

[Show slide 3]
Let’s start simple. I taught physics just outside of Washington, DC, and many students have seen a Calder staybile or mobile downtown.
The size and heft of the steel in the sculptures is evident even from afar, so how do they stay so mobile, turning with just a slight air current? I challenged students to use images and make models of their favorite Calder to defend their understanding of how torque played out mathematically in the piece. (It was also fine with me if they chose a different sculptor’s work or something totally different that demonstrated torque around a center or mass, like dance.
[Show slide 4: dancer]

[Show slide 5: Hirst]
Hirst uses green formaldehyde to encapsulate animals, making some pretty startling sculptures. But the sculptures have been shown to have a negative side effect—off-gassing. You can ask students, why, physically, did Hirst choose formaldehyde? Is there another chemical that would preserve organisms and have less negative side-effects?

[Show slide 6: Giant’s table]
Art pieces use geometry, scaling, proportion, and ratios. In this example, I ask students to practice measuring the photo and their own table to make a scale factor. Then they must use the scale factor to determine how big they’d need to be in order to sit at the table. I can imagine an array of scaling needed for Oldenberg’s public art!

[Show slide 7: Arcimboldo]
This painting, Vertemnus, allows students to think about the ecology that this painter must have been surrounded by when Arcimboldo painted it.

Here’s how I support teachers to connect art pieces and STEM for integrated STEAM education.

[show slide 8. Perspectives approach]
To pull diverse disciplines together into an integrated STEAM braid, I use my “Perspectives Approach” planning tool. I place an artwork, specific piece of STEM content, or even an engineering design challenge, interesting question, or current event in the center. I brainstorm

all the connections that I can think of in all of these categories: the humanities and arts lens, the social legal or local lens, The historical lens, the mathematical lens, The science lens, and the engineering lens.

[show slide 9]
Let's look at Flavin's " 'Monument' 1 for V. Tatlin" for a moment. Where to start? I challenge you to pause right here and try the exercise yourself: Think about the sculpture through these lenses. Consider also these brainstormer questions (available on the handout) "How does this art piece work?"
"What allows this art piece to be how it is or look like it does?"
"What do I need to know in order to make something like this?"

Here are some of my thoughts: Flavin is using pre-made fluorescent tubes and getting a white light. There must be some excited gas in there, and in fact, it's a really fascinating bit of plasma science that allows the electric potential difference across the length of the tube to excite the atoms, split off some of their electrons making ionized gas, and slam back to their atoms, casting off light. I am struck also by the proportion of the heights that makes me think about common ratios in architecture and what kinds of skyscrapers were being built in the 1960s. I'm also enjoying the specular reflection on the floor and thinking about how that makes me think it must be big. Turns out, it's 8 feet tall.

[Show slide 10]
But what is it? And I'm also super curious about Tatlin, and this reference to the unbuilt Tatlin Tower from 1920 with its double-helix design.
Why did Flavin extrapolate this shape from that one? Turns out, there are 39 other versions of this sculpture, all with different variations on the geometry. So much to unpack and explore!

[SHOW SLIDE 11]
This tool is not only useful for looking at STEAM connections in an art piece, it's also great for making art pieces that incorporate STEAM connections because it can help you to define the problem within the engineering design process using multiple perspectives.
I wanted to quickly highlight a two projects that ask students to use science and technology to make art while tethering to other perspectives.

[Show slide 12]
In the museum of our times project, I asked students to make an interactive art museum piece using LEDs to showcase something about how we live in today's society. My friend Jordan Pasqualin has a similar project in which students add lights and circuits to hanging wall art. Jordan has agreed to share his project materials with you, the link is in your handout.

[END SLIDE SHARE]

We all need a little help, so I really encourage to reach across the hall, so to speak, and engage other teachers at your school to think through these perspectives. If you're an art teacher who wants to discuss a specific piece of art, share an image of it with your science, math, or STEM colleagues and ask them what science and math they see in the art. These teachers think about their content constantly and will enjoy helping you identify useful content connections. If you're a STEM teacher and wish you knew about art works that exemplified the very content you're teaching, ask your art colleagues! They are experts in art and will love sharing their expertise with you.

In the next video we'll take a look at how art processes are another rich opportunity to connect Art to STEM.

START OF ART PROCESSES VIDEO

STEAM integration is not only present in art pieces but is also synonymous with making art. In this video, we'll review STEAM connections in major art processes and practice finding these connections using the Perspectives Approach tool.

[Show slide 14: Art Processes]
In my thinking, art processes include making art, validating the authenticity of art, restoring art, and photographing art.
Emphasizing how diverse disciplinary expertise and multiple perspectives come together in art processes can be the spark your students need to learn and remember content more deeply. Integrated STEAM learning is stronger than the sum of its parts, like a braided rope tying content to application in myriad ways.

[Show slide 15]
When you start to think about integrating art processes into your STEM content, or STEM into your art instruction, ask yourself one or more of these brainstorming questions:

- "How does this art process work?"
- "What technologies allow this art process to work? When were they discovered?"
- "What do I need to know and use in order to make something like this?"

These questions are also available on your handout.

Let's dig into some art processes that I feel are particularly rich with STEM connections. If you feel I've left something out, please forgive me. You should feel free to add to the following lists and invite conversation with your art or STEM colleagues to learn more.

[SHOW SLIDE 16]
In our last video on art pieces, we began with Calder's staybiles and mobiles. This video will layer on a processes approach, thinking about how STEM and art work together to make these sculptures. I could expand the discussion to include how the large steel sculptures were made.

[Show slide 17]

In the next set of slides, we'll think through STEAM connections in low-tech and industrial art processes, art restoration, ceramics and pottery, painting and pigments, printmaking, and photography and filmmaking. While some of these techniques may not be available to you at your schools, investigating the processes involved in making any art piece may help to make the art feel more tangible to your students.

[SHOW slide 18]
I've categorized some art processes that do not involve electricity as low-tech including metal and glass work in forges, plaster and form making, building on armatures, carving, sizing a canvas, and stamping. From simple machines in the carving wedge to the contraction of lipids in rabbit-skin glue, science is what makes these low-tech art processes work, and the use of that science is itself a technology.

[Show slide 19: industrial art processes]
Industrial art processes use optimized technologies to do specialized feats of science. In welding, steel must be is heated to extreme temperatures before it can be bent or cut or welded. Metal's unique characteristics allow it to melt and cool readily enough to do this, a great lesson on how metals and metaloids differ from other elements. The gases used in oxygen-acetylene welding torches are significant too, as is the mixture with which they are combined. Learning about conservation of energy and combustion are great connections here!

[Show slide 20: Restoration]
Art forgery, art smuggling, hidden art discovery and even bad art restoration are super engaging topics—the kind that Hollywood makes movies about! From the elasticity of bread to chemical solvents to X-Ray imaging, the science of art restoration and authentication can bring your students into the world of art while motivating them to invest in understanding the science that allows career art experts and scientists work together.

[Show slide 21: Ceramics]
Ceramics and pottery are just a wonderful demonstration of uniform circular motion, and anyone that's thrown wet clay on a wheel that's spinning too fast has learned a lesson in inertia. If you're wondering why I didn't say the fictitious "centrifugal" force, then you should check in with your physical science teachers!
Another hot connection to STEM is that archeologists and geologists can use magnetic domain orientations found in clay in ancient undisturbed furnaces to help fill in the story about the history of the Earth's changing magnetic field.

[Show slide 22: Paint and pigments]
There are a lot of connections to make between pigments and biology, and paint making and chemistry. The history of pigmentation is a story of our understanding of chemical stability, availability, synthesis, and health. My friend, Allison McMahon, created a beautiful unit about stoichiometry and solutions related to paint and pigments.

Students learn about making binders and paint through chemical reactions and solutions. Alison has graciously shared this unit with all teachers and it is linked on your handout.

[Show slide 23: Printmaking]
I'll admit that when it comes to printmaking, I'm by no means an expert, but I know that the process involves creating negative space on a plane for the selective transfer of pigment. That simple inverse relationship intrigues me as a mathematical metaphor, but so does the science of metal corrosion to make printing plates, the pressures of the printing press, the photo exposure of silk-screening emulsion, and biological risks to printmaking artists.

[Show slide 24: Photography]
Digital and film photography and filmmaking are showstoppers for STEAM integration. Students feel bonded to taking pictures in deep and emotional ways. If there's one art process out there that your students care about, it's how to take pictures and movies. Take advantage! Get nerdy with the process and see what happens! You might well need the help of your colleagues to get a firm grasp on all of it, too.

[Show slide 25: Jordan's story board]
Teacher Jordan Pasqualin scaffolds movie making with a narrative-building story board activity atomic motion. Story boards are a great first step in thinking about all kinds of time-based art work, plus drawing and describing allows students with narrative or illustrative strengths to flex their skills in science class.

[Show slide 26: The perspectives approach]
You can generate STEAM connections for other art processes by using the Perspectives Approach tool. To turn it into a STEAM lesson, consider asking students to change one variable in the process in increments and measure the outcome on the art product. Gathering data on the outcomes and comparing it to the independent variable levels you used will help to make predictions for future art experiences, and that's a successful science experiment.

[Show slide 27: Perspectives with restoration]
Or you could have students debate and defend an argument using the tool. For instance, to encourage a debate about restoration I would center the news story about this Spanish restoration and ask students to consider how each of the surrounding perspectives played into the choices and consequences of the restoration. I might ask, What processes were used and why? How does the historical lens shape the modern local reaction? What would they recommend future restoration efforts consider and why? This interdisciplinary investigation will help grow students' critical thinking skills as well as their empathy, not to mention, your students may need to expand their artistic vocabulary to discuss the subject.

[END SLIDE SHARE]
Thank you for being here and for watching this video about some of my go-to favorite STEAM-rich art processes. If you need further inspiration, make sure you talk to your colleagues in Art or STEM. They'll be happy to share their expertise with you.

Art Movements Video

[No slide showing, Katey on screen]
The third way that I like to engage teachers to think about STEAM integration is through art movements. Artists are products of their times, and undoubtedly contribute substantially to the zeitgeist of their times in return. The art pieces and processes that contribute to art movements in any era are influenced by the full range of STEAM disciplines—science and math contribute to engineering the technologies, tools, and subject matter that artists have access to use in any era. What is known about the universe, the body, and the mind influences what artists produce, as do contemporary events, trends, and discoveries.

[Show slide 28]
Each art movement offers a peek into the STEM world at a given time, not to mention, they each speak a different language of perception and influence that both shaped and was shaped by society.

As you seek the influence of STEM In art movements, and the ramifications in art of STEM knowledge, ask yourself one or more of these brainstorming questions:

- "What distinguishes this art movement?"
- "What technologies are involved in this art movement?"
- "How have these artists been influenced by their world including by contemporary understandings of technology, science, and mathematics?"

These are also on your handout.

[Show slide 29]
In the previous two videos, we started by thinking about Calder's staybiles and mobiles. We saw science and math content in the balance and torque of a mobile. We saw chemistry and metal properties in the processes used to bend and weld the steel. In terms of art movements, we can now explore how Calder's art, situated in kinetic art, surrealism, and abstractionism and more, helps us understand how art and STEM intersected in these movements.

[Show slide 30: integrated STEAM braid]
Art history is a story of STEAM. Let's take advantage! Diverse disciplines and multiple perspectives coalesce at a specific point in time creating art that is influenced by the full range of STEAM subjects. Intertwined, their impact can be strong enough and distinct enough to be called an art movement.

So how might an art movement be useful in STEAM education? I'm going to show you two examples of how I've incorporated art movements to enhance STEM instruction, and then discuss how these projects evolved from using my perspectives approach tool.

[Show slide 31]

My first example is a high school engineering design challenge based on one of the National Academy of Engineering's Grand Challenges of the 21st Century, to reverse engineer the brain. Engineers would love to understand how the brain works in order to replicate the function in technology, and doctors would love to know how the brain works in order to better treat mental disorders and disease.

Human understanding of the brain is actually all over the art world. From expressions of love in art, to artworks that depict an understanding of brain function, and art that uses artificial intelligence, art is closely tethered to thinking and expressing contemporary neuro-awareness.

[show slide 32]
At the outset of the project, students select a personal feeling or emotion that they would like to externalize. They identify their pre-existing knowledge about what inputs, outputs, logical processes, and unknowns (called blackboxes) impact their thinking.

Next, I have students explore artistic expressions of emotion and cognition in the fine arts and in literature. I scaffold this with whole-class exposures to several art movements including surrealism and automatic paintings, feminist and LGBTQ poetry, and dance choreography like the dance below from the popular show, So You Think You Can Dance, which represents addiction. Students make a chart of how at least three more movements addressed or depicted the emotion that they wish to portray in their project.

[Show slide 33]
Next, students learn about our modern understandings of cognition and contrast contemporary and current science understanding of the function of the brain with artistic representations. Students can explore the limits of what we understand about the brain using the National Academy of Engineering's Grand Challenge, "Reverse Engineer the Brain."

[Show slide 34]
For their final product, student must create a piece of sculpture with an embedded electrical device that mimics their own brain function as they defined in the beginning of the unit and improved by their more developed understanding of the brain.

Students also need to describe the influences on their model and the limitations of the model.

The example shown here is a proximity sensor. It shows with LEDs how the student feels when her "crush" comes near.

[Show slide 35]
In the next example, the art movement guides the design of electrical device by setting up a context.

Students will build a charger to power a device (fan, cell phone, watch, light bulb, etc.) OR charge a battery using wind or solar energy.

In order to choose which options they'll use for their design, they meet a "stakeholder" from a specific art movements' place and time, and tailor their final product for that person's needs.

Next, they must market their device to their customer and explain the unique features of their technology using an aesthetic that is appropriate for that art movement.

[Show slide 36]
This is an example of how I introduce advertising and art movements. These are two different Nike ads for two different customers. Why do they need two different ads? What are they referencing?

[Show slide 37]
Perhaps the Black Lives Matter series from 2020 is referencing American realism with its serious tone and unflinching look at people's faces and bodies.

[Show slide 38]
Perhaps the Sponge Bob campaign is referencing pop art, the kitsch in life, and even the soft pop art sculptures that these squishy shoes reference.

[Show slide 39]
Students designing for their particular stakeholder will then create their advertisement in the art style which they have been studying, employing characteristics of the style to relate to the stakeholder, demonstrating their understanding of the relationship between the art movement's style and purpose, and presenting their final design.

[Show slide 40]
Both the reverse engineering the brain example, and the art movement advertisement example show how positioning the driving question is positioned inside of many lenses. It's up to me as a teacher, to create a driving question and project requirements that ask my students to see the problem through all of these lenses.

[show slide 41]
In the charger project, I used the art movement as a context to research historical lenses as well as contemporary engineering, science, and artistic lenses. I like to think that using the context of an art movement could be useful for many STEM design challenges and exploration of science, math, and technology.

[Show slide 42]
I hope you'll agree that art movements can be a great grounding point for discussing integrated STEAM topics.

As you think about what art movements to bring into your STEM courses, I encourage you to acknowledge that art history, and the art movements that we are familiar with have been

recorded and remembered through the lens of mankind including all of mankind's dominance, erasure, and bigotry.

Contemporary art courses, museum exhibitions, and art publications are working to represent and teach culturally and historically diverse art media, techniques, and styles. So, in addition to the quote, "biggest" art movements, consider some others as well.

[show slide 43]
Let's get to more continents, to Southern Asia, to Indigenous Australia, and to Iraq. Let's talk about art on our continent: the Harlem Renaissance, Mexican mural art, Chicano art, Afro Cuban art, Queer art just to name a tiny fraction of non-western art movements that can be used to teach STEAM.

Outtro video

It's been my pleasure to share three ways to bring art into STEM instruction and STEM subjects to art: Art pieces, art processes, and art movements. We saw interactions between the STEAM disciplines born out as individual artworks, in the processes used to make them, as influences on entire art movements. You are invited to use my perspectives approach tool to tease out the multiple contributing perspectives related to any content, question, or challenge. Acknowledging the range of influences in the subject and helping your students recognize their interplay with strengthen your integrated STEAM instruction.

If you'd like to learn more about my work as an STEAM education consultant, see examples of my physics art, or be in touch, please visit my website at www.edukatey.com. That's e-d-u-k-a-t-e-y.com. My name is Katey Shirey and it has been a please to speak with you.
