Hi, and thank you so much for joining me today. I'm excited to talk about my experience and research as both a science and arts educator and practitioner. I'm currently a doctoral candidate at Teachers College, Columbia University studying STEAM education. I also teach full-time at Columbia's secondary school in New York City and I am the sixth grade science teacher and ninth grade living environments teacher. I also conduct the middle school chorus, and outside of my educational commitment, I am a semi-professional musician and have done extensive performing throughout the United States.

The focus of my presentation today is going to be on the intersection of the arts and science. Albert Einstein stated that, "I am enough of an artist to draw freely upon my imagination. After a certain high level of technical skill is achieved, science and art tend to coalesce in aesthetics, plasticity, and form. The greatest scientists are artists as well." Now, please take a second to reflect on this idea. If you need more time, feel free to pause this video.

Our world is a reflection of the art of STEM, and art is inspired by the nature of science. An example of the intersection of the arts and science working together can be seen at Walt Disney Concert Hall in Los Angeles, California. The concert hall was constructed in October of 2003 and was designed by Frank Gehry. He was inspired by water and the nature of the sea, and as can be seen in the photos, the outside and inside architecture contains features that resemble the waves of the ocean. If you look at the outside, you can see the waves reflected in the outside architecture. Some examples there. Then, also, on the inside, if you look at the ceiling, you'll see, again, that idea of the wave.

Inside there are also more hints of underwater themes. There are the blue tinted windows and the curved ceiling, which gives the illusion that the audience is underwater. In addition, the organ was modeled after a sea anemone, which is a terrestrial flowering plant. Here is the organ. Looks like it's actually [inaudible 00:02:12] french fries. Again, it was modeled to be after a sea anemone. Here is another picture there.

In addition to the aesthetically beautiful architecture, the sound engineering is also one of the greatest in the world. One of the unique features that can be found at this hall is that the sound from the concert hall can be heard in the cafeteria, but the sound of the

cafeteria cannot be heard in the concert hall spaces. Because of the architecture, the sound is one directional, architecture and the engineering.

In this example, one can see how scientific principles have been marshaled to achieve an aesthetic purpose. You have the beautiful space, but you also have the way the sound behaves in a specific certain way. The idea of waves is that of the water, the aesthetics of the building itself, but you also have the aesthetics and the waves of the sound, which was due to the science and engineering, and even the math, that allowed the constructors and builders and Gehry to make that sound, again, so specific and one directional.

Another example of the arts and STEM coalescing was that of Frank Netter's medical illustrations. Frank Netter, born in 1906 and died in 1991, was fascinated and loved the arts. He had hoped to become an artist when he grew up. However, his parents thought he should have a more substantial job and pushed him to go into medical school. So when he was at the New York Academy of Medicine, he, in addition to studying to be a doctor, decided to also in his studies illustrate the human anatomy.

This leads us to ask the question, Is there a benefit to studying someone's anatomy through illustrations versus pictures? Pictures are able to capture a 3D look at the anatomy, whereas you wouldn't get that with an illustration, which is more of a 2D depiction. Artists, however, are experts at directing your attention. MRIs, for instance, are just raw data and unless your eye is trained, you don't necessarily know what is important. And when you learn something new, you need someone who's able to guide your eyes to what is important.

Frank Netter is the doctor who did all of the illustrations that we still use today, and even with all of the technology we have, medical schools still require students to buy this book, which begs the question, Why would medical schools still use this when we have all of this technology?

John James Audubon, born 1781 to 1851, was an ornithologist who documented all types of American birds, and is known for his illustrations that depict them in their natural habitats. His book, The Birds of America, is one of the finest ornithological works ever completed. Researchers, ornithologists, and avid birdwatchers still refer to it today.

When you look at a photo of a bird, you look at one bird. Audubon was able to look at the details of many of the same kinds of birds and pick out certain characteristics that emphasize what specifically made that bird unique from other birds, such as their fluffy head or the big tail, or even their posture. The way that Audubon portrays the bird tells you that this is characteristic to the bird in order to help identify it. In Audubon's illustrations, he gives you more information in his diagrams than you could ever get in a photo when your purpose is to identify a bird.

Arts and science are symbolic and contribute to each other. The arts helps us to communicate scientific ideas and helps us to determine what to investigate. One can improve the results of each other. An artist, for instance, can help a scientist make their results more compelling and better understood. For instance, interpreting graphs and presenting data can be made more convincing when having artistic adds to it can make the case and the point.

A scientist can also help artists achieve their purpose. I always take for granted the fact that I can get any color I want out of a Crayola box. Back in the day, certain colors were absent and you couldn't make them or they were extremely expensive or rare to make. Now, with the scientific advances, I can pick any color I want and not have to worry.

How can we simultaneously teach science and the arts? How can the scientist become the artist, and how can the artist become the scientist? In my own science class, I have amalgamated science and the arts. In this activity specifically, I had students create word problems based on the speed and acceleration formula in physics. I collaborated with the art teacher at my school, who had students illustrate the word problems using various styles of art that they had studied in her class. They were able to both reinforce and expand the scope of our lessons by dong this joint project together.

From this project, students made visual connections with the material by drawing illustrations with word problems. They also got to bring in their own experiences and made it also culturally relevant to their ideas and their likings. At the end of the project, it also grew into a finance project as we decided to publish and sell the word problem books that we had made from the word problems. As a result, this great fundraiser allowed us to take our students to different arts and science venues throughout the city

to further expand their knowledge that they were looking at in class and [inaudible 00:07:58].

Another activity I had students partake in was creating postcards on one of our field trips. Oftentimes, institutions will hire artists to come in and do different exhibits and help them, again, draw the attention of the audience. For this specific activity, students were told that they were being hired as artists at the Bronx Zoo to create a new line of educational postcards for the zoo. They were required to, of course, make them colorful and then illustrate them based on factors that they had studied in class and then what they saw at the zoo.

So they had to do two biomes, including both abiotic and/or biotic factors, and then they had to draw a food web on the side showing the different energy transfers, and then add a creative greeting along with the organisms that they saw in those biomes. So it was a way of incorporating learning into a field trip and also seeing how artists are very needed and necessary at these scientific institutions and vice versa. It also was a way to incorporate different modalities of learning, such as illustrations, clear, distinct ways of showing scientific knowledge, and then also bringing in visuals to help accompany what they learned and what they saw.

Another example of artists and scientists collaborating is on museum exhibits. Often, artists are hired to create dioramas in educational institutions such as museums in order to provide the visitors background to what is being presented. In that case, the artist is becoming the scientist in researching what needs to be included on the exhibit, where the scientist is becoming the artist in order to figure out how to make the information meaningful to the visitors.

In this specific example, my students went to go and visit the Gottesman Hall of Planet Earth at the Natural History Museum. They went and they saw the different rocks, and then had to think about and learn about where did these rocks come from in order to present how they got there, how they were formed, and even what they are used for today when they are not in their natural settings. This also adds to being culturally sensitive in the classroom and making them aware that, for some people who are coming to visit these places and learn, if they don't speak the language of what's being written, that picture, that background, that diorama, and that setting will still be able to educate people on the information trying to be shared.

When creating interdisciplinary lessons, I always consider what stories I want students to tell in the classroom and what tools I can provide for them to do it.

Next, we're going to simulate a STEAM activity looking at instrument sound and waves. This is an abridged version of several lessons that it typically takes for me to complete this unit, but this activity I hope will give you some insight in what it's like to partake in a STEAM lesson. Hopefully, you can expand this for your own classroom or be inspired to come up with something [inaudible 00:11:17].

Prior to beginning this activity, please make sure you obtain the handout that you got this video from. You will record your responses for the next few slides in the tables that look like this. The handout, real quickly, just looks like that. It's two pages, or double sided. There should be two charts. They're exactly the same. They're just going to do them for two different instruments, and then on the back side, or the second page, you'll have a bunch of different pictures.

The questions that we're going to deal with, again, for the first part are going to be in the chart. The first one's going to ask you to describe the sounds you hear and compare them with other sounds you have heard. You're also going to have to sketch and describe the instrument that you will be shown, and you will then have to look at the structure of the instrument and think about the sounds and how they're affected by the structure of that instrument. Then, in box four, it's whatever questions you may have remaining that you're going to just go ahead and jot down there.

For the first part of this activity, I want you to just predict some instruments that you may find in an orchestra. For the first part of this activity, you will have several minutes to collect data on what you hear and what you see. I'm going to ask you to pause this video and then play the clip Twinkle Twinkle Little Star, which can be found in the link below labeled Twinkle Twinkle Clip 1. Go ahead and play it now, and pause this video.

For the second part, I'm going to ask you to examine the picture to your right. Let me show you. Got my laser pointer. Here's the picture. This is a violin. You're then going to sketch the structure, you're going to think about how the sound that you just heard from the clip relates to the structure, and then in box four, if you have any remaining questions you can go ahead and jot them down there. Go ahead and pause the video

until all the boxes are completed. You may also replay the clip several times in order to rehear what that sound structure was.

At this point, you should have completed the chart. You may now pause this video and compare your responses to that of the example I've provided on this slide. This is a lab that I do with my sixth grade students, so this is the response from one of them. You can see how my student analyzed the music with the body and compared it to what your results were.

We are now going to repeat this activity, except this time we'll be listening to the flute. In your handout to the second chart on the second page, you are going to repeat the activity again listening to the flute. You will go ahead, push pause, play the Twinkle Twinkle Clip 2, and then after complete the prompts in the various boxes of the chart. When you are done, you may move on and I will on the next slide provide a sample of my student and how they responded. Here is a sample of a response for the flute portion of the activity in [inaudible 00:14:24].

We are now going to rest our ears and we're going to do a little bit of reading. I have provided for you a few PDF readings to give some background on waves and sound. Pause this video to take a moment to read those short readings about the science behind the waves and how sound is produced.

As you learned from the reading, waves are composed of various parts. The top of the wave is called the crest, the bottom is called the trough. The distance between the trough and the crest is what we call the amplitude, and the wavelength is between a crest and a crest or a trough and a trough, which is not labeled, but the troughs, again, are the bottom and the crests are at the top.

Some key concepts that you should have taken away from the waves and sound readings is that frequency is the number of waves passing a point in one second. The longer the wavelength, the lower the frequency. The shorter the wavelength, the higher the frequency. Remember, wavelengths are measured crest to crest or trough to trough, so crest being the top part or the trough being the bottom.

As we look at this diagram here, the lower the frequency, the longer the wave is passing through in one second and then the higher the frequency the shorter the

wavelengths. Pitch is also another key concept here. It's the highness or the lowness of a sound. The higher the pitch, the higher the frequency. The lower the pitch, the lower the frequency. Then, lastly, intensity is the volume of the sound, and that is dependent on the amplitude of the wave. Again, the amplitude is the height of the wave.

Now that we have completed our short physics lesson, I'm going to invite you back to re-examine the activity that we had started. Please pause the video and in another color pen from what you originally wrote in, re-evaluate box three in the table for the two instruments. You can add what you wrote on from the activity, and then also I'm asking that you sketch a diagram of the wavelength that each instrument is producing. Remember our short physics lesson, but also feel free to use other information that you may have learned from the readings, as I didn't, unfortunately, have a chance to talk about the different types of materials and how waves are affected by them.

In art and science, it is always good to go back and re-evaluate our work. By doing this, we can see what misconceptions we may have had and even track the amount of learning that has occurred. It also allows students to go back and answer their questions but also inspire new ones so that their curiosity continues to grow, so that they want to continue to grow and hopefully eventually push the boundaries when they eventually get into the workforce. On this slide, you can pause the video and you can compare your re-evaluation to that of the sample from my student.

Thank you so much for joining me today. I hope that you had fun and that you go back and reflect on what we did in order to think about how the arts and science are connected both in the classroom and outside. For more information or more lessons, please feel free to check out my website, steamscholar.weebly.com, or reach out with any feedback or any questions. My email is below. Have a good one. Bye.