CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

STRATEGIES FOR INTEGRATING THE ARTS INTO STEM LESSONS

A graduate project submitted in partial fulfillment

of the requirements for the Master of Arts in Education,

Curriculum and Instruction

by

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ABSTRACT

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The purpose of this paper is to examine how arts integration in the STEM disciplines can become a vehicle for engaging students in a deeper understanding of STEM curricula. There is much discussion in the educational world that the acronym STEM should evolve into STEAM, as the arts add the creative thinking, artistic design, social-emotional maturity, and collaborative skills needed by students to enter the workforce of the 21st century. This project includes a synthesis of the related literature, and a collection of five lesson plans that effectively integrate the STEM disciplines into the four different categories of the arts: visual, music, dance, and theater. Each lesson can be considered as a seed to help inspire teachers on how they can achieve arts integration in their existing science and mathematics curricula.

CHAPTER ONE: INTRODUCTION

One of the major concerns of educators today is the decline in student achievement and lack of engagement in school. Our current educational system is based on a century-old model of drilling students with facts and expecting them to regurgitate information. As we have come to better understand the importance of constructivist teaching and learning practices, the arts are becoming a dependable vehicle on which we can help struggling students become more engaged in constructing their own knowledge.

Through the innovation and hard work of our country's scientists, computer technologists, engineers, and mathematicians, the United States has become a global leader in our world's economy. In a world that continues to become more complex and ever-changing, the key to success is not solely based on what knowledge you have, but also what you can do with that knowledge base. It is now more important than ever for our students to attain the education and skills to problem solve, collect and evaluate evidence, and be able to use logic to make sense of increasingly disparate information. Students can acquire these foundational skills by studying the STEM disciplines. The acronym STEM refers to education in the areas of science, technology, engineering, and mathematics, in an interdisciplinary and applied approach. Unfortunately, today, few American students are pursuing careers in the STEM fields. There is clearly a need for teachers who are aware of these careers and pedagogically skillful in promoting student success in these subjects.

According to the United States Department of Education, the projected increases in STEM related jobs from 2010-2020 are as follows: mathematics 16%; computer systems analysis 22%; systems software developers 32%; medical scientists 36%;

biomedical engineers 62%; and other careers at 14%. The United States Department of Labor predicts that there will be over one million job openings in STEM related fields by the year 2018, and research shows that there will be a deficit in qualified graduates to fill them. In the Report to the President: Engage to Excel (2012), the President's Council of Advisors on Science and Technology affirm,

> Economic projections point to a need for approximately one million more STEM professionals than the United States will produce at the current rate over the next decade if the country is to retain its historical preeminence in science and technology. To meet this goal, the United States will need to increase the number of students who receive undergraduate STEM degrees by about 34% annually over current rates (p. i).

In the past decade, there has been much discussion in the world of education on emphasizing the need for better educational programs in the STEM fields. Students in the United States continue to fall behind their peers in other developed countries in science and mathematics according to the National Center for Education Statistics (2015). There is also great concern that we are trailing other countries in adequately developing our students in the fields of science, technology, engineering, and mathematics (Moomaw, 2013).

The Program for International Student Assessment (PISA) measures 15-year-old students' science, mathematics, and reading literacy, and also includes measures of cross-curricular competencies, such as collaborative problem solving. PISA functions in coordination with the Organization for Economic Cooperation and Development (OECD), an intergovernmental organization of industrialized countries and compares

scores in over 70 countries. The United States scored average in science literacy among educational systems, ranking higher than 39 education systems, fairly equal to 12 education systems, but remained lower than 18 other countries. The percentage of students scoring at proficiency level five and above was nine percent, slightly below the OECD average of eight percent, but still remains lower than 14 other education systems. The percentage of students scoring below the proficiency level baseline was 20 percent, which was higher than 21 other education systems. Science scores have not been measurably different since 2006. More alarming, in mathematics literacy, the United States scored lower than the OECD average. This rank was lower than 36 other education systems, higher than 28 education systems, and about equal to five education systems. The percentage of students scoring at proficiency level five and above was six percent, further below the OECD average of 11 percent. These statistics rank the United States lower than 36 other educational systems. The percentage of students scoring below the proficiency level baseline was 29 percent, which was higher than 35 other education systems. This score has declined when compared to the average mathematics literacy scores in 2009 and 2012. Twelve education systems had higher average scores than the United States in science, mathematics, and reading, which include: Canada, Estonia, Finland, Germany, Hong Kong-China, Ireland, Japan, Macao-China, New Zealand, Republic of Korea, Singapore, and Slovenia (National Center for Educational Statistics, PISA, 2015).

The new Common Core Mathematics Standards (CCSSM) and the Next Generation Science Standards (NGSS) are designed to promote more collaboration, critical thinking, and 21st century learning skills for our diverse population of K-12

students. But in order for students to be more engaged, the curriculum must be more meaningful to students and make a connection to real-world problem solving. STEM curricula must engage them in what working mathematicians, scientists, and engineers actually do. The question is what types of activities increase student engagement, develop creativity, and raise student motivation? By integrating arts-related skills into the STEM curriculum, students can be given the opportunity to further express their creativity in purposeful ways.

Taken together, art, science, and mathematics all have a common thread of discovery (Sousa & Pilecki, 2013). Sousa & Pilecki have stated this well:

> We have never discovered a culture on this planet, past or present, that doesn't have art in some form…. One likely explanation is that the cognitive, physical, and emotional activities represented by the arts -- dance, music, drama, and visual arts-- are basic to the human experience and necessary for survival. If they weren't, why would they have been part of every civilization from the Cro-Magnon cave dwellers of 35,000 years ago to the urban citizens of the twenty-first century? … Science, the scientific method, and mathematics, on the other hand, are more recent developments (p.16).

In the last few decades, several well-known researchers such as Eisner, Catterall, and Gardner have asserted that the arts are an important part in the education of the whole child. These prominent theorists have been advocates for supporting the lifelong learning benefits that teaching and integrating the arts into curricula can provide students for their futures. The arts have been tied to academic gains, but are often overlooked as a vehicle for student engagement and motivation in other disciplines (Gullatt, 2008).

Ironically, arts education and art electives seem to be the first to be eliminated in schools, as budget constraints and high-stakes testing assume the forefront. At the same time, the arts are proving themselves to be an essential part of future innovations, and innovation is the trademark of success in STEM. Wynn and Harris (2013) notably state,

> Steve Jobs repeatedly referred to linking technology with creative thinking and artistic design as a key factor in his stunning accomplishments. In school districts across the nation, the push to recruit and retain STEM students is profound while art education continues to be marginalized (p. 42).

As students in other nations are advancing in STEM education, achievement of American students continues to decline. This is where the arts and STEM both have significance, and the STEAM approach can successfully engage our students and assure their advance in STEM discipline achievement (Wynn & Harris, 2013).

The purpose of this project is to suggest how arts integration into the STEM disciplines can be a vehicle for engaging students in a deeper STEM curriculum. There is much discussion in the educational world that the acronym STEM should evolve into STEAM, as the arts add the creative thinking and artistic design to the already inquisitive nature of our future scientists. Adding the arts can also spark the interest of students who may not have considered going into a STEM- related career. The arts also teach students the value of collaborative and critical thinking skills, which they need to be successful in our changing world.

The project includes a review of the related literature, a description of the methodology used to integrate arts into the STEM disciplines, and a collection of five lesson plans that integrate the four different categories of the arts: visual, music, dance, and theater. Each lesson can be considered to be a seed to help inspire teachers on how they can achieve arts integration in their existing science and mathematics curricula.

CHAPTER TWO: LITERATURE REVIEW

Educational research is constantly analyzing and reporting on new methods of STEAM integration for educators to incorporate in their practice. This makes it possible to appeal to all the different learning styles of our diverse student populations. They are finding that when teachers use the arts in core-curricular lessons, students become highly motivated and more engaged. Research is showing that the effects of a fully-integrated arts program are "fewer dropouts, higher attendance, better team players, an increased love of learning, greater student dignity, enhanced creativity, a more prepared citizen for the workplace of tomorrow, and greater cultural awareness as a bonus" (Jenson, 2001. p. iv). When students enjoy learning, they will be more likely to stay in school. This is an important issue with academically at-risk students. The arts also help to build cooperative and social skills that will benefit the students in their future endeavors.

According to Aprill (2001), the ongoing work at the Consortium on Chicago School Research along with the research of Shirley Brice Heath at Stanford University results in the assertion that the solution is not test prep, but rather authentic intellectual work, requiring students to engage in wide-range representations and to express themselves in a wide range of formats, that will make the difference between successful achievement and failure. Still, many teachers are only teaching to the tests. The result in mathematics for example, is a narrow education of facts and figures that limits the opportunity for students to engage in creative experiences. Instead, we might see the arts as becoming an essential, integrated part of instruction for all students, being a domain of knowledge that can challenge young students to exercise their full capacities.

Furthermore, the movement toward integrated curriculum has been promoted by current research on the brain and learning (Hamblen, 1997; Jensen, 2001; Sousa &

Pilecki, 2013). Early interest evolved from Gardner's Theory of Multiple Intelligences, which describes kinesthetic movement, musical knowledge, and visual image as individual and specific ways of knowing, equal to but unique from linguistic and mathematical understanding. His theory "suggests that all intelligences are necessary for complete human development and communication and that education without the arts is indefensible" (Snyder, 2001, p.29). With this in mind, educators should be implementing a curriculum rich in the arts, which tap into our different intelligences and aptitudes, in order to provide a well-rounded education.

The Arts and Cognitive Science

Research in cognitive science and curricular instruction has brought the power of the arts to the forefront of teacher education. It is believed that the brain and body make up a single integrated cognitive system. Scientists have found that most of our thoughts occur on a level below our conscious awareness and control, and involves the intake and processing of a continual stream of sensory information. We are constantly representing thought through metaphors that we associate with emotions and our physical experiences (Damasio, 2003; Lakoff & Johnson, 1999, as cited in Rabkin & Redmond, 2006). When learning through the arts, students experience not only the academic benefits of learning new information, but also engage their socio-emotional self in the process (Gullatt, 2008).

In addition, cognitive research suggests that visual thinking consists of mental images that make up information, experiences, and fantasies (Finke, 1985). These images are then categorized into structures that are constructed and manipulated on the basis of the learning experience. To that extent, art is a mind builder that allows access to ways of

knowing that may not be channeled by other forms of communication, and may not be dealt with in other subject areas (Hamblem, 1997). For example, when students explore the historical meanings of art and artifacts from their own culture and other cultures, teachers engage them in the use of the skills of inquiry, problem solving, analysis, investigation, evaluation, and synthesis. These higher-order thinking skills create a deeper learning of the content than would a direct-instruction lesson about history and culture in which students are passive learners. Arts integration is a pathway for promoting engaging lesson plans that build minds.

Moreover, all children are unique and have their own learning styles. As educators, we need to apply different approaches and strategies to reach the wide range of learners. Teaching through the arts is a way to engage students through their different learning modalities. The arts tap into the other thinking systems that help us learn, such as our integrated-sensory system, attention, cognitive-emotional system, and our motor functions. That does not mean that one cannot learn without the arts. However, the arts provide learners with opportunities to simultaneously develop multiple brain systems, which are not easy to assess because they are the "underneath" support processes that can produce cumulative results (Jensen, 2001). In a sense, we are teaching to the multiple intelligences.

The Arts and Engagement

In the study Champions of Change: The Impact of the Arts on Learning (Fiske, 1999), the researchers discuss the benefits of teaching through the arts. The arts could reach students in ways not normally reached, in ways not normally used, and keep them engaged and in school. The arts in this study helped keep tardiness, truancies, and drop-

out rates down. Students were reported to be connecting to each other better and had greater camaraderie. Teachers also responded that the arts changed the academic environment to one of discovery. The arts reignited the love of learning in the students who were tired of being filled up with facts. The arts provided challenges to students of all levels from academically delayed to gifted children. Exposure to the arts was found to help bridge the gaps in achievement between students of poverty and affluence. Art is a class where students can find their own level automatically (Jensen, 2001). When at-risk students become engaged in school, they are more likely to become intrinsically motivated to become active learners.

In a research study by Oner, A.T., Nite, S. B., Capraro, R. M., & Capraro, M. M. (2016), seventh through twelfth grade students attended a two-week summer camp and participated in several STEAM project-based learning activities. Over half of the students who participated stated that they would be more interested in future STEM careers if they were able to use their creativity in the job itself. Several students expressed a belief that STEM careers do require creativity, but had not made the connection that real-world problem solving required artistic solutions as well. As they engaged in experiences in which they were able to design products and solve problems by using their creativity and STEM content knowledge, there was a higher interest in pursuing the STEM fields. The researchers stated that,

> By giving students the tools they need to solve 21st century problems from a variety of perspectives and using a variety of approaches by integrating skills from the arts and STEM, future scientists and engineers will fully understand the benefits and importance of STEAM for our world (p. 11).

Learning for the 21st Century

We are living in a fast changing world that relies on electronic data and devices. "As information and intelligence becomes the domain of computers, society will place a new value on the one human ability that can't be automated: emotion. Students today are flooded with data but often starved for meaningful learning" (Jensen, 2001). As stated, we need to educate our students beyond learning facts. Students of the future may not have to know from memory of the periodic table or be able to name five countries in Africa; but they will know where and how to find that information quickly. What they really need to know and understand is how to solve problems, what makes an argument valid, how to collaborate with and contribute to teams, and how to incorporate the concepts of fairness and equity into daily life. We need to teach them the creative and cooperative skills that art activities can provide. Employers are telling us that they want thinkers, they want people skills, they want problem solvers, they want creativity, and they want teamwork. In other words, they are seeking workers who have acquired the 21st century "soft skills" that ensure their enterprises can be both agile and productive. If our students acquire emotional balance and cognitive flexibility, they will have the self-discipline, and social and thinking skills needed to thrive in a fast-changing world and workplace that depends upon individual and team productivity arising from these 21st century soft skills (Jensen, 2001). "If our goal is for students to become skilled in 21st century learning outcomes, then we need to provide the time for learning experiences that foster development of the essential skills of problem-solving, collaboration, analytical and critical thinking" (Barnes, Johnson, & Neff, 2010, p.21). An arts-integrated curriculum teaches beyond the surface of academic content. It teaches students to think

outside the box as a new, world model of education that is parallel to the model of STEM education and project-based learning.

With the fast pace of technology and the ever-changing needs of our evolving and global society, we must be preparing our students for a future that we cannot fully define. Effective educators see the need to teach beyond the curriculum to develop higher-order thinking skills that involve creativity, problem solving, social-emotional maturity, and collaboration. Jensen (2001) suggests that teaching with and through the arts enhances these abilities, while simultaneously improving content knowledge in the core content standards.

Arts and Social Studies: Already a natural fit

We understand the importance of arts education, but time constraints play an important part in why the arts are overlooked in the classroom. Integration is an approach to teaching in which the arts can have co-equal importance in the lesson plan. Any of the four arts, which are visual art, drama, dance, and music can be integrated with any of the core academic subjects in the curriculum. Learning through the arts, such as using paintings in describing a culture to students, promoting analysis of life in historical periods, or using drama and theater to reenact historical events, allows students to learn beyond the recall of rote information. It encourages students to appreciate, construct, and apply new information. Through these art-based techniques, students engage in higher-order thinking skills, academic risk taking, and exploration of their own creativity. It allows them to apply the historical content they are learning in a new constructive, meaningful, and multi-sensory way (Rabkin & Redmond, 2004). For example, a teacher can pair journal writing with sketching; reading literature or studying a cultural history

while looking at representative art, or listening to music from that historical period. “The paired subjects engage the same cognitive processes of attentive observation, identification of meaningful detail, student refection and self-critique. Setting these parallel processes in motion to generate a cognitive resonance between the two subjects, deepening the learning in both” (Eisner, 2002, p.15). In combining the arts with other subjects, arts integration turns the curriculum into engaged study that does not just reproduce knowledge, but uses knowledge in authentic, intellectual ways. This kind of learning experience is more interesting and meaningful, promotes higher levels of engagement, increases students’ intrinsic motivation, and encourages students to invest more energy than traditional learning requires of them. (Newmann, as cited in Rabkin & Redmond, 2004).

According to Burstein & Knotts (2010), the visual and performing arts aid students in understanding the core content while being immersed in the creation of an art form. Students have the opportunity to express themselves and explain what they have learned in social studies by singing, dramatizing, dancing, or creating visual art. Children will learn about other cultures and develop a deeper understanding of their own culture. Using the arts as an alternative learning modality to teach core-curricular content also helps students to better develop their understanding of the non-tangible concepts, vocabulary, and content in social studies. Teaching through the arts deepens understanding by “providing context, often a tangible product, which then connects them to the content in explicit and relevant ways… By integrating the arts with social studies, students tap into other forms of intelligence, such a s visual-spatial, musical, kinesthetic, and interpersonal” (p.22). This strengthens the argument for integration. Also, by

allowing students to choose a mode that makes sense to them, such as visual arts, drama, or music, they can select the best strategy that allows them to construct their own understanding, thus making it meaningful to them. It is proposed that these methods will have a positive outcome on students' learning in this research project.

Hamblen (1997), another expert in the field of arts education and integration, suggests that art objects can be studied as clues to the ideas and values of the people and societies that produced them. Teachers encourage research skills by asking students to find out where an art object was made, by whom, why, how, and when. This employs higher-order thinking along the scale of Bloom's Taxonomy (Bloom, 1956), and creates deeper learning experiences for students. When students are required to synthesize, evaluate, and apply information, rather than to merely recall it, they use critical thinking skills that will prepare them for higher education and the workforce of tomorrow.

In addition, teachers also need to understand the importance of engagement on student learning. Facilitating student learning is not simply a matter of placing young people in classes. Their teachers must also motivate them, while nurturing their minds and engaging them actively in learning. The teacher's role in building upon student interests and in creating a love of learning is key to building bridges between what students know and can do and what they are capable of learning. Teaching through the arts can be the vehicle that can get students to become motivated learners.

How the Arts are Currently Taught

In discussing how the arts are currently being taught in our schools, Davis (1999) has noted several different approaches: The arts-based approach (arts for art's sake), arts-injected (an arts-enhanced integration), arts-included (arts alongside other subjects), arts-

expansion (real world aesthetic appreciation), arts-professional (career preparation), arts-extra (extracurricular activities), aesthetic education model (a constructivist approach), and arts- cultural (the arts as a cultural connection).

Each style has its unique benefits, and a blending of all styles would be the most effective. The term interdisciplinary as defined by Veronica Boix and Howard Gardner (1983), states that interdisciplinary understanding involves the "integration of knowledge and modes of thinking from two or more disciplines in order to create products, solve problems, and offer explanations of the world in ways that would not have been possible through single disciplinary means" (Rhodes (2006), p.16). Teaching two disciplines simultaneously is the goal of integration. According to Burns (2003), "expanding the concept of literacy from traditional notions, the arts are being enlisted to enhance the linguistic, visual, musical, mathematical, and kinesthetic skills and capacities of school children" (p.33). In effect, this is teaching with and through the multiple intelligences.

From a different viewpoint, Bresler (1995) defines arts integration as having four different approaches: 1) The subservient approach, 2) the co-equal cognitive integration style,3) the affective style, and 4) the social integration style. In the subservient approach, the arts are used as filler or to enhance the main curriculum. Such activities would include singing songs about the content or making crafts. Typically, these tasks are not cognitively challenging and do not require critical reflection or develop aesthetic awareness. In the co-equal cognitive integration style, the arts and core subjects are taught simultaneously. Teachers can use the artistic skills that require students to observe, perceive, and interpret information in aesthetic ways with higher-order cognitive questioning. The affective style is an arts immersion that compliments other curricula.

Such examples would be listening to calming music or looking at works of art in a book, just for the aesthetic quality of it and the responses and feelings it creates. On the creative side, students can also have artistic freedom with open-ended projects in all areas of the arts, in which there are no set of rules or expectations of conformity. Uniqueness is appreciated and empowering. Last, the social-integration style is a performance-based approach. As with the affective style, this compliments the curriculum, but also is directed towards the social functions of the school with the community, such as an international dance festival or a holiday chorus. Each of these styles has its own unique value, with the co-equal cognitive style having the same processing skills to compliment the STEM disciplines (Bresler, 1995).

The public may often see the arts and STEM consisting of opposite traits. The characteristics of STEM subjects are typically objective, logical, analytical, reproducible, and useful; whereas art is seen as subjective, intuitive, sensual, unique, and frivolous. In essence,

> Arts and science do not compete; they are complementary. The arts create a very subjective view of the world, while science creates an objective view of the world. A person's brain needs both views in order to make suitable decisions (Sousa & Pilecki, 2013 p. 16).

The integration of art-related activities with the interdisciplinary nature of mathematics, technology, engineering, and science with students has three potential benefits. First, it empowers students because they are able to produce varying representations of what they learn through a variety of media. Second, students are able to make connections between STEM disciplines and the arts to view these subjects as

equal, rather than any one area being more important than another. Third, when we as teachers regularly incorporate the arts with STEM topics in all grade levels, the students will come to see no boundaries among and between the disciplines. In that event, if a learner sees no boundaries that limit fields of study, it can advance their creativity and genius to thrive and flourish (Sousa & Pilecki, 2013).

CHAPTER THREE: METHODOLOGY

The purpose of this graduate project is to inspire teachers to integrate the arts into other core-curricular areas, especially the disciplines of science and mathematics. With the educational pendulum moving towards STEM-integrated curriculum and project-based learning, many teachers may feel apprehensive about teaching the newly-adopted NGSS, as well as the arts. The goal in creating this collection of lessons that co-equally teach the arts with mathematics and science is to provide teachers with examples of how the arts can help students develop a better conceptual understanding of science and mathematics concepts by sparking their natural creativity and tapping into the multiple intelligences. Each lesson plan is an example to show teachers samples of how to create an arts integration lesson, and how all four of the arts can be included.

This project includes five separate lesson plans that integrate one of the four arts into science and mathematics lessons. They are not considered a unit, but five stand-alone lessons that cover different content. The lessons are written for grades two, three, and four, but can be adapted for any of the elementary grades. Each lesson has stated student learning objectives, the corresponding California Visual and Performing Arts Standards, with either the California Common Core Mathematics Standards, or the Next Generation Science Standards. Next there is a list of materials needed for the lesson, followed by the vocabulary to be taught prior to the lesson for better student comprehension. There are lesson procedures that give teachers step-by-step directions in how to implement the lesson, with guiding questions to ask the students as they begin inquiry and discussions. Following the procedures, there is a formative assessment which is aligned to the student learning objectives, and a four-point rubric for formal assessment of student learning.

Lessons with group tasks also include a student self-assessment rubric for collaboration and social skills, as well as a teacher checklist for informal assessment of these skills during the student group work periods. These lessons are designed to show teachers how to co-equally teach science and mathematics through the arts. Furthermore, as with any lesson, there is room for adaptation to meet the needs of your own students. They are meant to be examples of how seamlessly the arts can be integrated into the curriculum, and encourage teachers to see them as inspiration to finding more creative ways to bring the arts into the classroom.

Lesson One is a fusion of music, engineering, and scientific discovery. Students will explore how to make a xylophone using glass bottles. This is a collaborative project where students will test and design their classroom instrument together, while learning about how vibrations create sound. They will then compose and perform a simple melody on their instrument for the class. This lesson promotes teamwork as the students work together to find the correct pitch of their bottles, and then explore the music they can make together.

Lesson Two is a combination of visual arts and mathematics. Students will use string art to create a variety of shapes. They will then analyze the attributes of the shapes, and the lines that created them. Next, they will provide an explanation of the shapes that they created. The beauty of this artwork is that no two projects will ever be the same. The student is free to design whatever shapes they want, and then color the shapes to their own choosing. Though this lesson is stated for second-grade standards, I have personally taught this lesson in all grades from kindergarten to third grade with success.

Lesson Three is an integration of visual arts and mathematics. As, a third-grade teacher last year, one concept that the students had difficulty understanding was equivalent fractions. We used fraction bars, tiles, and fraction circle manipulatives, but there were still misconceptions. This lesson uses the artwork of Piet Mondrian as an inspiration to create equivalent fractions. Students will create their own artwork in the style of Piet Mondrian, as well as appreciate the aesthetics of his and their own work. Through the use of line and color, they will create their own fraction bars, and then label those equivalent fractions. This will help them with the conceptual understanding of equivalent fractions, as well as engaging in an artist study and a creation of their own beautiful work.

Lesson Four is an integration of science and theater. Students will explore the life cycles of butterflies, dragonflies, and frogs. They will work collaboratively in teams to create a poster to share with the class which illustrates and describes each stage of development of a frog. Then, the students will reflect and add personal emotion to each state of development through a narrative describing what the frog would be feeling through personification. Next, they will form new teams and create a play to be performed for the class, using the different elements of theater to portray the emotions and development of the personified creatures. This lesson promotes socio-emotional learning, as students will explore their own feelings and emotions, as well as gain an appreciation for nature.

Lesson Five is an integration of science, technology, and dance. Students will learn about and explore how batteries work. In this highly engaging lesson including fun videos and hands-on invention, students will create their own simple batteries using

lemons and some hardware. They will develop a better conceptual understanding of voltage, current, and power through the use of kinesthetic dance. Students will learn the formula that engineers use to calculate voltage and power. Then, they will connect those equations to the elements of dance. Last, they will use these elements to perform a dance of how different batteries of varying voltage will have a different power output.

The goal of these lessons of varying integrations is to provide teachers with new approaches they can use to teach science and mathematics, as well as bring the arts back into the classroom. With the demands of high-stakes testing, the arts have often been overlooked as teachers are under time constraints to teach content aligned with all the standards. Also, many teachers may feel apprehensive about teaching the Next Generation Science Standards (NGSS), as I have learned in my own school and from discussions with my colleagues. As the adoption of the NGSS begins, we are now just beginning to have professional development at my school location. There is also no scheduled time for art with the district-required mandatory blocks of mathematics, language arts, English language development, and one-hundred minutes of physical education per week. Integrating the arts into the STEM disciplines is a highly engaging way to make good use of valuable instructional time, promote student collaboration, and bring the arts back into the curriculum. These lessons plans follow in the next chapter.

CHAPTER FOUR: LESSON PLANS

This chapter contains five different lessons plans to provide elementary school teachers with highly engaging arts-integrated lessons. Each lesson has a co-equal integration of a STEM discipline, with one of the four visual and performing arts. Each lesson is a step-by-step guide with objectives, state standards, materials, vocabulary, procedures, assessments, and rubrics. Though written for a specific grade level because of the correlation of the standards, they can still be adapted to any grade level, as our newly-adopted are standards are more connected in flow from grade-to grade. The goal of these lessons is to spark imagination and creativity in the teacher, as well as the students.

Lesson One

Grade 4 Science/Engineering/Music Project

Create a Glass Bottle Xylophone

Objectives:

Students will create a xylophone made of glass bottles.
Students will experiment with water levels in the bottles to create a pitch.
Students will recognize how the change in pitch will create a different musical note.
Students will compose and perform a simple melody on their instrument.
Students will work collaboratively in teams to complete the task

California Content Standards:

NGSS 3–5-ETS1-3. (Engineering Design) Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Music 4.2.3 (Creative Expression) Compose and improvise simple rhythmic and melodic patterns on classroom instruments.

Materials:

glass bottles of equal size with caps, labels removed
wooden spoons
water
funnels
pitch pipe (or a phone app can be used)
Journal for recording data and notes
Student self-assessment checklist for collaborative skills (see Appendix A)

Vocabulary:

pitch
note
melody
vibrations

Procedures:

Play the following video available at https://ca.pbslearningmedia.org/resource/204b772f-12bf-42fe-a261-34d0e4019734/fractions-in-music/#.WM8dxWe1vIU.
This six-minute video explains the vocabulary/concept of pitch, melody, rhythm, and tempo, and is demonstrated on a simple five-note xylophone made out of different size wrenches.

The teacher will have three equal-size bottles with three different amounts of water in them in front of the class.
Ask the students, "Have you ever blown into a bottle, or tapped a bottle with an object to make a sound?" (Students share responses).
Explain that sounds are made by vibrations, and vibrating objects can create sounds. When something vibrates fast it makes a higher sound, or pitch. When an object vibrates slower, it makes a lower pitch. When our glass bottles are tapped, the glass will vibrate and make a sound. Also, an object with more mass will vibrate more slowly, and an object with less mass will vibrate faster.
Ask students to think/pair/share with their partner to predict which bottle they predict will have the highest or lowest pitch, considering the mass that is added to the bottle from the amount of water.
Now, tap the bottles and compare the sounds made.
"Which bottle had the lowest pitch when it was struck?" (the bottle with more water).
"Which bottle had the highest pitch when it was struck?" (the bottle with less water).
"How does the mass of the water in the bottle affect the rate of the vibrations?" (the higher the mass, the slower the vibrations).

Students will be grouped in teams of four and will create their own six-note xylophone using glass bottles. Teacher can use preferred class routine for forming groups, or see Appendix B for tips on forming groups and assigning group roles. Distribute and explain student self-assessment rubric and expectations for the task.
First, students will add water to one bottle to create a starting note. Then using a pitch pipe, students can find the note's pitch. Students will use trial and error in the water level, until they can find the correct pitch or note to finish the scale. This will allow them to "tune" the rest of the bottles. For the six note xylophone in C-Major, the scale consists of C,D,E,F,G,A.
Students will then make observation and record the level of water in each bottle.
Students will recognize that the more water that is in the bottle, a lower pitch is created.
Students will discuss their findings.
Teacher will circulate to informally assess student understanding of task and make notes of collaborative skills using the student group work checklist (see Appendix C).
Teacher will then show students some examples of songs that they can play.

Simple melodies like “Row, Row, Row Your Boat”, “Twinkle, Twinkle Little Star” or “The Alphabet Song”, “Mary Had A Little Lamb”, and “When the Saints Go Marching In” can all be played on a six-note xylophone.
Students will then improvise a melody on the xylophone.
Students will also compose an original piece of music through experimentation and improvisation. They may also choose to play a rhythm alone.
Place caps on the bottles to avoid evaporation, and the instruments can be used for the week.

Assessment:

Students will be assessed on their teamwork and experimentation in creating their xylophone. Xylophones pitches should be within a reasonable melodic scale. Students will then perform their musical creation for the class.

Rubric:

4 – Student/Team worked collaboratively and effectively, recording all experimental water levels, to find correct pitch of their xylophone scale without assistance. Student/Team worked collaboratively to improvise a melody or rhythm and performed for the class.

3 – Student/Team worked collaboratively, recording most water levels, to find correct pitch of their xylophone scale with minimal assistance. Student/Team improvised a melody or rhythm and performed for the class.

2 – Student/Team worked somewhat collaboratively, recording some water levels, to find a close pitch of their xylophone scale, with assistance. Some team members improvised a melody or rhythm and performed for the class.

1 – Student/Team was not able to create a xylophone, until assisted. Student/Team needed assistance in creating a melody or rhythm, or did not perform for the class.

Lesson Two

Grade Two Math/Visual Art Project

Creating Shapes with String Art

Objectives:

Students will create and identify the use of line in visual art and geometrical shapes. Students will use key vocabulary in identifying various geometrical shapes.

California Content Standards:

Math 2.G.1. (Reason with shapes and their attributes) Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.

Visual Art 2.1.3 (Artistic Perception) Identify the elements of art in objects in nature, the environment, and works of art, emphasizing line, color, shape/form, texture, and space.

Visual Art 2.4.3 (Aesthetic Valuing) Use the vocabulary of art to talk about what they wanted to do in their own works art and how they succeeded.

Materials:

6x8 rectangles of cardboard
yarn
scissors
aluminum foil
permanent markers

Vocabulary:

line
shape
triangle
quadrilateral
pentagon
hexagon
diagonal lines
vertical lines
horizontal lines
intersecting lines

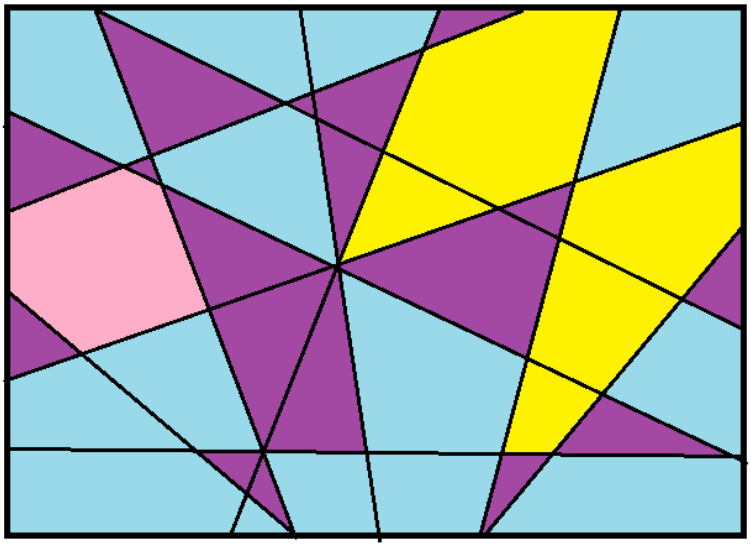
Procedures:

Each student will receive an 8x6 piece of cardboard.
The teacher will demonstrate how to cut half inch slits around the edge of the cardboard. This may also be done by the teacher ahead of time, according to the needs of the students.
Each student will receive about 1.5 yards of yarn.
The teacher will explain that in our art, yarn will represent straight lines.
The teacher demonstrates and students follow how to wrapping yarn around the cardboard to an opposite side and through any given slot.
The teacher explains that we should be using different types of straight lines (horizontal, diagonal vertical). The process is repeated until the student is satisfied with their design and the yarn is used up.
Each student receives a 9x11" piece of aluminum foil.
The teacher demonstrates and students follow how to cover the cardboard and yarn with the aluminum foil, and then tape the edges down on the back surface.
Students use their fingers to trace the yarn with their fingers, to flatten the foil around the yarn lines.
Students are prompted to examine their creation
The teacher asks the following guiding question
Remembering what we have learned about shapes and lines, what shapes can you find in your work? (triangle, quadrilateral, pentagon, hexagon)
What part of the shapes do the lines represent? (edges)
What would happen if you combined two that were next to each other? Would you have a new shape? (A new shape is created with a line passing through it.)

The teacher hands out permanent markers and explains that the next step will be identifying shapes with color.
Students are asked to choose four colors: One to represent triangle, one for quadrilaterals, one for pentagons, and one for hexagons.
Students are guided to color the various shapes they find. Students may choose to color in in each solid shape, or shapes that contain intersecting lines, creating a composite shape.

Assessment:

Students will be assessed by correctly identifying shapes with color.
Students will be assessed according to using posted vocabulary in describing their artwork.



There are 15 purple triangles.
There are 13 blue quadrilaterals.
There are 2 yellow pentagons.
There is 1 pink hexagon.
There are no vertical lines and 1 horizontal line.

Rubric:

4 -Student's artwork utilizes straight lines, Students correctly identify triangle, quadrilateral, pentagons, and hexagons through color. Student's artwork incorporates horizontal, vertical, and diagonal lines.
Student uses four or more vocabulary words in describing their art.

3 - Student's artwork utilizes straight lines, Students correctly identify most triangles, quadrilaterals, pentagons, and hexagons through color. Student's artwork incorporates horizontal, vertical, and diagonal lines.
Student uses three or more vocabulary words in describing their art.

2 - Student's artwork utilizes straight lines, Students correctly identify some triangles, quadrilaterals, pentagons, and hexagons through color. Student's artwork incorporates two of the following: horizontal, vertical, and diagonal lines.
Student uses two or more vocabulary words in describing their art.

1 - Student's artwork is incomplete, Students correctly identify at least one shape through the use of color. Student's artwork incorporates two of the following: horizontal, vertical, and diagonal lines. Student does not use any vocabulary words in describing their art.

Lesson Three

Grade Four Math/Visual Art

Equivalent Fractions Inspired by the Art of Piet Mondrian

Objectives:

Students will create and analyze their own artwork in the style of Piet Mondrian.
Students will create, label, and explain three sets of equivalent fractions.

California Content Standards:

4.NF.1 1. *Extend Understanding of Fraction Equivalence and Ordering.* Explain why a fraction a/b is equivalent to a fraction $(n \times a)/(n \times b)$ by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.

Visual Art 4.1.5 Analyze *Art Elements and Principles of Design*. Describe and analyze the elements of art (color, shape/form, line, texture, space, value) emphasizing form, as they are used on works of art and found in the environment.

Vocabulary:

Equivalent fraction

Materials:

Grid paper
Markers, crayons, or colored pencils in red, yellow, blue, and black
Images of artwork from Piet Mondrian
Fraction tiles (if necessary for scaffolding)

Procedures:

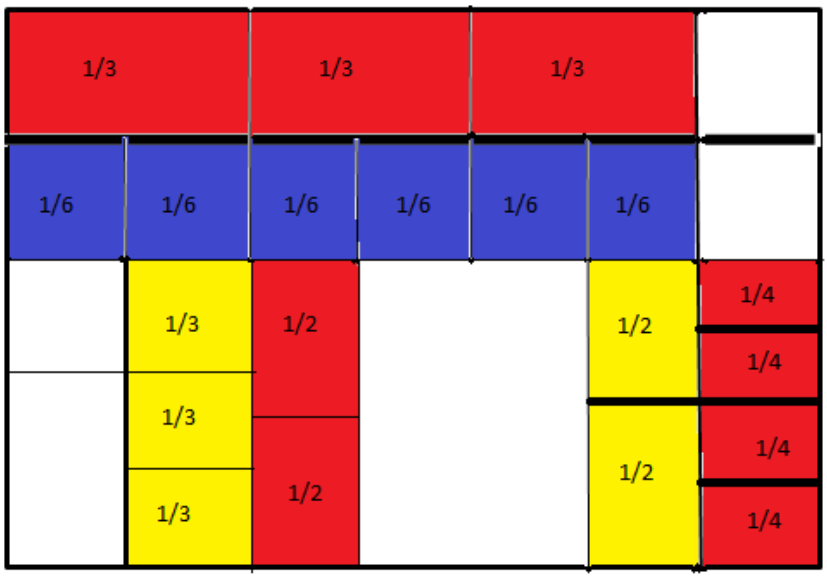
Begin the lesson with a biography of Piet Mondrian. There are many online resources available, including http://www.theartstory.org/artist-mondrian-piet.htm, or http://www.piet-mondrian.org/.
Show the class several pictures of his geometrical artwork.
Discuss how he uses color, line, and shape to create his images.
Look for patterns in his work. Are there any fractions that you see? Are there any equivalent fractions that can be found?

Review equivalent fractions.
Draw a rectangle on the board. Divide it in half and color in one part.
Ask, “What is the fraction that was created?” (1/2).
Now divide the rectangle into fourths, leaving the same portion colored in.
Ask, “What fractions do we have now? Has the colored portion changed? Are the new fractions equivalent to the first fraction?” (Yes, 1/2 is equal to 2/4).
Review that if the numerator and the denominator are multiplied or divided by the same number, you can find an equivalent fraction.

Now the students will create their own Mondrian-style artwork.
On the grid paper, they will use lines of different weights to created fraction bars in different positions throughout the paper. They will use different primary colors to highlight the fraction bars. They will then label the equivalent fractions.

<u>Assessment:</u>

When students have completed their artwork, have them work with a partner to discuss how they represented their equivalent fractions, and peer review each other’s work. They should correctly label their fraction bars, and recognize the patterns that show the relationship of the fractions to each other.



1/3 = 2/6 2/3 = 4/6 1/2 = 2/4 3/3 = 2/2

Rubric:

4 - Student created a visual art piece using block patterns, and correctly labeled and explained four or more sets of equivalent fractions.

3 – Student created a visual art piece using block patterns, and correctly labeled and explained three sets of equivalent fractions.

2 – Student created a visual art piece, and labeled at least two sets of equivalent fractions.

1 – Student created an incomplete visual art piece, and/or was unable to correctly draw, label, or explain equivalent fractions.

This lesson was adapted by a lesson plan written by Susan Riley (2016) and retrieved from https://educationcloset.com/2016/02/09/steam-lesson-mondrian-fractions/

Lesson Four

Grade Three Science/Theater

My Life as a Frog

Objectives:

Students will sequence the life cycle of a frog through illustrations and paragraphs describing the corresponding stages.
Students will work in groups and collaborate, share ideas, and participate in a dramatic production that artistically demonstrates the stages of metamorphosis.

California Content Standards:

NGSS 3.LS1.B: *Growth and Development of Organisms*. Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.

Theater Connections *and Applications* 3.5.1 Use problem solving and cooperative skills to dramatize a story or a current event from another content area, with emphasis on the five Ws.

Materials:

From Tadpole to Frog, Following the Life Cycle. By Suzanne Slade
From Tadpole to Frog. By Wendy Pfeffer
How a Tadpole Grows Into Frog. By Davis Stewart
Wild America, Toads. By Lee Jacobs
Frog, A Tadpole Tale. By Robert Lieber
Life Cycle of a Frog Video: https://www.youtube.com/watch?v=rJOOxlFs9Is
Metamorphosis; Change of Plans video:
https://ca.pbslearningmedia.org/resource/tdc02.sci.life.cyc.metamorph/metamorphosis-change-of-plans/#.WPFR8vnyvIU
Student self-assessment checklist for collaborative skills (see Appendix A)

Vocabulary:

amphibian
gills
tadpole
spawn
froglets
lungs
cycle
metamorphosis

Procedures:

Part One:
Review the life cycle of the butterfly and a dragonfly.
What are the stages of metamorphosis that they go through? How do they change from birth to mature adult?
Using the butterfly as an example, have them pose in a frozen position that resembles to them the life cycle stage (egg, larva, pupa, adult). Then informally break the students up into groups of four. Have each group improvise their four stages in poses for the class.

Show the videos on the life cycles of frogs.
Divide the students into groups of five for research. . Teacher can use preferred class routine for forming groups, or see Appendix B for tips on forming groups and assigning group roles. Distribute and explain student self-assessment rubric and expectations for the task.
Give each group a book about frogs. Have them read the book together, taking turns by passing the book through the group. Have the students in the group decide which stage of life they will become the expert on (egg, embryo, tadpole, froglet, frog).

Have the students discuss in their group and describe the stages in their own words. Then, students will create a life-cycle poster, which illustrates and briefly describes the stages of development, using the academic vocabulary. Teacher will circulate to informally assess student understanding of task and make notes of collaborative skills using the student group work checklist (see Appendix C).
After they have completed their posters about the life cycle of frogs, ask the children how this compares to the life cycle of a human. What are the similarities and differences? Do humans go through a metamorphosis? Do humans resemble their parents when they are born? How about when they are full grown? Do frogs resemble their parents when born? How about when they are full grown? What do they resemble when they are in the froglet stage? Do they have characteristics of both the tadpole and the adult frog?
Have them compare the life cycles of the frogs to that of the butterfly and the dragonfly. Discuss what the similarities and differences might be. Ask them how the life cycle of animals can compare to that of a plant. Ask if all living things must have a beginning of life and end of life.

Part Two
Review what was previously learned.
As a whole group, make a chart on how the stages of life and the metamorphosis might have an impact on the frog's life. What new and different experiences would come with those changes? How do you think the frog would feel if we gave it human emotions? Students will then independently write a short narrative story about what it would be like to be a frog living from egg, through metamorphosis, to adult frog. Keep narrative for informal assessment.

Using the developmental stage that the student became the expert on, have them paired with students from the same role. How was the frog thinking at this point in their stories? Using what they have learned about theater, how might they dramatize this role for the class? What body expressions, motions, voices, and dialogue could they use to express themselves? How can they imitate through theater arts the elements of transformation?

Assessment:

Have each group perform their stages, as if they were a family of frogs, creating a Life Cycle of the Frog performance. Also, assess them on their group work and poster.

Rubric:

4 – Student actively participated in the group poster, thoroughly describing their stage of development. Student was an active participant on the production and execution of the play, portraying their feelings about their role of development.

3 – Student participated in the group poster, and described their stage of development. Student was an active participant on the production of the play, portraying their feelings about their role of development.

2 – Student somewhat participated in the group poster, and somewhat described their stage of development. Student participated in the production of the play, but only somewhat contributed their feelings about their role of development.

1 - Student contributed little to the group poster. Student had little involvement in the performance.

This lesson was adapted from a lesson plan written by Susan Riley (2015) and retrieved from
https://educationcloset.com/2015/11/18/arts-integration-lesson-life-cycle-tracking/

Lesson Five

Grade Four Science/Technology/Dance

The Dance of the Battery

Objectives:

Students will create a battery using a lemon and hardware.
Students will create an interpretive dance representing voltage.
Students will describe their dance using appropriate dance vocabulary.
Students will work collaboratively in teams to complete the task

California Content Standards:

NGSS 4-PS3-4. *Energy*. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Dance 4.1.3 *Comprehension and Analysis of Dance Element.* Demonstrate increased range and use of space, time, and force/energy concepts (e.g. pulse/accents, melt/collapse, weak/strong).
4.1.5 *Development of Dance Vocabulary*. Describe a specific movement using appropriate dance vocabulary.

Materials:

Elements of Dance Poster
batteries
lemons
wires with alligator connector clips
multimeter for measuring voltage
copper pennies
galvanized nails (coated with zinc)
small LED light
Student self-assessment checklist for collaborative skills (see Appendix A)

Vocabulary:

tempo
level
flow
weight
current
voltage
resistance
power
watt
circuit

Procedures:

Part One:
Show the three short videos about batteries and how they work:

How do Batteries Work? - TED Ed by Adam Jacobson
http://thekidshouldseethis.com/post/how-do-batteries-work
This engaging animation gives an overview on the invention of the battery, how batteries work, and the technological innovation of batteries in our modern world.

A is for Ampere – Circuit Playground by Limor Fried
http://thekidshouldseethis.com/post/47031722463
In this video, Limor and her robot friend Adabot explain how electrical current can be measured in amperes, and how electrons move to make electrical current. The multimeter measures the amount of electrons, or current, flowing through a circuit.

B is for Battery – Circuit Playground by Limor Fried
http://thekidshouldseethis.com/post/54519442567
In this video, Limor and Adabot give another explanation of how a battery works. Then they demonstrate how to make a simple battery with lemons, wires with alligator connector clips, multimeter for measuring voltage, copper pennies, galvanized nails (coated with zinc), and a small LED light.

Have students share and discuss in groups what they learned in the videos.
As a whole group, chart the scientific concept vocabulary:
current - the rate at which charge is flowing.
voltage - the difference in charge between two points.
resistance - a material's tendency to resist the flow of charge (current).
power – the amount of watts created
watt - a measure of how much power a device uses when turned on, or how much power a device can supply.
circuit – a closed loop that allows charge to move from one place to another.

Explain how engineers use the following equations to find voltage and power of a battery.
Current x Resistance = Voltage Current x Voltage = Power.
These values describe the movement of charge, which is the behavior of the electrons.

Now divide the class into small groups. Teacher can use preferred class routine for forming groups, or see Appendix B for tips on forming groups and assigning group roles. Distribute and explain student self-assessment rubric and expectations for the task. Following the instructions in the video, make the lemon batteries. The video gives a simple step-by-step explanation that is kid-friendly to follow.

First, roll the lemons to loosen the juice. Next, add a penny to one side and a nail to the other. Then, connect the positive terminal (penny) to the negative terminal (nail) and you have created a one volt battery, which you can measure using the multimeter. You will need to connect four or more lemon batteries together to create enough power to light a small LED light.

Teacher will circulate to informally assess student understanding of task and make notes of collaborative skills using the student group work checklist (see Appendix C).

Part Two:
Students will explore four different elements of dance: time, which is the tempo of the dance; space, which includes level of high, medium, or low to the ground; and energy,

which consists of flow of their movements and the weight, which is heavy and firm or gentle and soft.

Begin by playing a selection of music and ask the students to randomly move and improvise choreography based on the tempo and feeling of the music.
Then play a few more musical selections of varying tempos.
Have students discuss how the speed of the music affected their movements. What was the energy and flow used in their movements? What levels of space were they using?

Display and review the Elements of Dance poster (available at https://educationcloset.com/wp-content/uploads/2011/07/elements-of-dance.jpg

Discuss which element they think could be used to represent the current of a battery (energy: flow).
Then, ask which element could represent the resistance (energy: weight).
Next, ask which element could represent the voltage (space: level).
Last, ask which element could represent power (movement).

Review the charted equations that engineers use to calculate voltage (Current x Resistance = Voltage).

Now substitute the like dance elements into the equation, and you have Flow x Weight = Level.

Then you can do the same for the equation engineers use to calculate power (Current x Voltage = Power) and you have Flow x Level = Movement.

Now, in small groups, students can explore and improvise a simple dance performance that represents different levels of voltage and power of batteries. Groups may remain the same, or teacher may choose to assign new groups. Each group can select a battery voltage from low, medium, or high. A low-voltage battery may have a gentle weight and a restrained flow. A high-voltage battery may have a firm and free flow. Have other students provide feedback on the performance.

Assessment:

Have students explain how they interpreted the movements to represent the voltage. There are many possibilities. Students should use appropriate dance vocabulary. Also assess students on their collaborative work on the lemon battery.

Rubric:

4 – Student was able to collaboratively make the lemon battery and explain the procedures. Student was an active choreographer in the dance performance, and was able to explain the terminology and its relevance to the dance using all correct vocabulary.

3 – Student was able to collaboratively make the lemon battery, following the directions. Student was an active participant in the dance performance, and was able to explain the interpretation using the correct dance vocabulary.

2 – Student somewhat participated in making the lemon battery, or had difficulty following the directions. Student was somewhat active in the choreography or the dance performance. Student could use some of the dance vocabulary.

1 – Student showed little participation in the lemon battery. Student did not actively contribute to the dance performance. Student used little dance vocabulary.

This lesson was adapted by a lesson plan written by Susan Riley (2015) and retrieved from
https://educationcloset.com/2015/05/21/steam-lesson-movement-batteries/

CHAPTER FIVE: CONCLUSION

The purpose of this graduate project is to provide elementary school educators with highly-engaging lesson plans that co-equally teach the disciplines of science, mathematics, and engineering with the four areas of the visual and performing arts. As the review of the literature demonstrates, there is a high demand for future careers in the STEM fields with an achievement gap of students who are pursuing those future endeavors. Much research has proven that the arts are a vehicle to promoting high student engagement, teach collaboration and social-emotional skills, and provide students with varying creative outlets to express their understanding of content. The arts also teach the multiple intelligences, inherently allowing for differentiation for different types of learners.

This project includes five separate lesson plans that integrate one of the four arts into science, engineering, and mathematics lessons. They are not considered a unit, but five stand-alone lessons that cover different content. The purpose of this design is to show the variety of lessons that can be created with the seemingly unrelated and different content standards that may not have been considered. These lessons are written for grades two, three, and four, but can be adapted for any of the elementary grades. As I was developing these lesson plans, I selected a specific grade to cite. But as I researched the different grade level standards, it became apparent that there was much room for flexibility in grade levels, as the new standards in science, mathematics, and art are more fluid between grades. The new standards are designed to build upon each grade level, becoming slightly more complex with each grade, with many standards covering grade-

spans. Each lesson can be adapted to meet a particular grade level through slight modifications to meet a particular grade level standard.

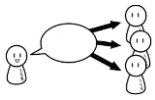
These lessons are meant to show teachers how to co-equally teach science and mathematics through the arts. In the co-equal approach, two or more standards (at least one in the core content and at least one in the arts) are taught simultaneously. Each standard has an objective in the lesson, and is assessed at the conclusion of the lesson. In designing future lessons, teachers can begin by selecting a core content standard or a previously designed lesson, and then select an art standard that can enhance or exemplify the learning in the lesson. Adding the artistic creativity, aesthetics, movement, music, or any of the qualities that the arts provide can help to engage the students and make learning more personal and meaningful beyond rote memorization. Furthermore, as with any lesson, there is room for adaptation to meet the needs of your own students. These lessons are meant to be examples of how seamlessly the arts can be integrated into the curriculum, and teachers can see them as inspiration to finding more creative ways to bring the arts into the classroom. Moreover, with the time constraints that teachers face in the instructional day, arts integration is a way to allow teachers to fit the arts back into the curriculum.

In conclusion, with the educational movement towards project-based learning and a fully-integrated STEM curriculum, there is also the movement to include the arts, creating the fully-integrated STEAM curriculum. Many teachers may feel apprehensive about teaching the newly-adopted NGSS as well as the visual and performing arts. The lessons provided are designed to co-equally teach art with mathematics, science, or engineering, which can allow a pathway to design more fully integrated STEAM lessons

or units. This curricular project is designed to enable teachers know how to begin by integrating an art form with one or more STEM fields at a time.

Appendix A

Student Collaboration Self-Assessment Rubric

Social Skills	Not Yet	Almost	Got It!
I stayed in my group and did my work on time 			
I shared my ideas with my team 			
I listened to ideas from my team 			
I encouraged my team 			
I treat my teammates with respect 			
I used my 6 inch, small group-work voice 			

Appendix B

Strategies for forming student groups

Sometimes you may need groups with varying number of participants. A task may work well with three, four, or five members in a group. Sometimes a task may require different groups in the same lesson. A simple way to form groups is to have students count off numbers and find their number mates. Another engaging idea is to make a class set of cards. Each card will have a random number 1-3, one of four colors, one of five shapes, one of six animals, or any other combination or category. Pass out the new cards each morning, and that can be the student's card for the day. When forming groups, call out numbers, colors, shapes, or animals, and the student can quickly find their group. Once in a group each student will be assigned a role and receive a role card which has directions reminding the student of their role expectations.

Materials Manager	Picks up, distributes, collects and returns materials
Checker	Makes sure tasks are being completed. Also asks for teacher assistance when necessary.
Encourager	Promotes positive team spirit within the group at all times and leads the group in silent cheers and energizers.
Recorder/Reporter	Records notes, group predictions, responses, and also reports out findings of the team.
Time Keeper (if there is a fifth person)	Make sure the team is running on time, keeping track of minutes left.

Appendix C

Teacher Checklist for Group Work Skills

Team # _____	(name)	(name)	(name)	(name)	(name)
Group Process Skills					
1. Stayed on task, worked efficiently					
2. Performed group role					
3. Handles materials appropriately					
4. Resolved disagreements					
5. Encouraged one another					
6. Used small group voice					
Group Task Skills					
1. Completed task on time					
2. Worked hard to complete					
3. Showed creativity					
4. Showed enjoyment					
5. Learned something new					

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