Summer 2022

How Music can be Integrated Into Life Science Teaching in a way That Enhances Scientific and Musical Learning in Middle School

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HOW MUSIC CAN BE INTEGRATED INTO LIFE SCIENCE TEACHING IN A WAY THAT ENHANCES SCIENTIFIC AND MUSICAL LEARNING IN MIDDLE SCHOOL

By

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A capstone project submitted in fulfillment of the requirements for the degree of Master of Arts in Teaching

Hamline University

Saint Paul, Minnesota

August 2022

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CHAPTER ONE

The purpose of this capstone is to explore and expand on the intersection of art and science. I will specifically be looking at how music both helps students learn, and retain information and how music infused curriculum can increase student buy-in through cultural relevancy. As a teacher at an arts school, I have heard the phrase “learning in and through the arts" more times than I can count, but have never had the time and opportunity to truly integrate music into my practice. I have created mini-units and projects that center the arts and have taught in arts integrated ways, but I have never sat down with standards from both the art area and from my science unit to conceive of myself as a teacher of both science and art.

As I move through the process of designing a comprehensive unit plan based on the integration of music and science I intend to explore and answer the question: *How can music be integrated into life science teaching in a way that enhances both scientific and musical learning?*

In this chapter I will explain my own context and personal interest in this topic. Within my context I will also include the positionality I hold and how it affects my perspectives as a teacher. I will also explain the school I work at, our professional goals, and mission for our students’ art infused learning. I will then outline my plans for gathering research, and using that as the grounds for my curriculum design to incorporate both music standards and the new science standards into a unit for future use in my classroom.

My Context

I grew up in rural upstate New York, and attended a small public school in Fayetteville-Manlius. My graduating class was 400 students, and I attended the only high school in the district. There were three elementary schools and I can count on two hands the number of students who joined and left my class in my thirteen years of school. My school was almost all white, something I was unaware of at the time, as I am also white. I was aware that I was Scandinavian while most of my peers were Irish, Italian, and East European. I started learning the Swedish language when I was thirteen and had the misfortune of being called 'the viking princess' by my ninth grade world history teacher for a full year. My classmates were mostly catholic, with a large Jewish community. I was one of four Lutheran students in my grade, but I left the church immediately following my confirmation in tenth grade as I felt unwelcome in a small town church as an openly queer teen.

I am an only child, and spent a large amount of my childhood alone, with cousins, or with adults. I reflected on who I was and how I held space for myself on many occasions, but always through the lens of sexuality. I came out, as gay, for the first time when I was twelve. I held that as a close personal secret for four years before I began telling large numbers of peers, and eventually my parents. My small town did not take it well, and I was one of about five out students at my 1600 student school when I graduated in 2012. My small town also skewed upper class Syracuse commuters rather than rural farmers, so the attitudes that I grew up around were very conservative, and founded in both religious ideology and conservative American Dream and 'I worked hard for my money' rhetoric. I wasn't able to truly form my own beliefs until I left.

I moved to Saint Paul for college, desperate for a change of scenery, pace, and acceptance. I went to Macalester, where I was able to pay full price, and graduated loan free since my father was a doctor, and I was the only child. I stayed after graduating and made myself a home in the cities. I was able to work as a paraprofessional and attend classes at Hamline to complete my teaching license, again as a result of generational wealth. I've now been teaching at a small public arts school in Saint Paul for four years. While there I've come out as trans - nonbinary, switched my pronouns to they/them and now co-facilitate the Gender and Sexuality Alliance (GSA) for middle schoolers. I live within walking distance of the school I teach at with my dog. I've been working on my mental health during the pandemic and finally feel like I'm working through the left over feelings from my own education and my own experiences.

The mission of the school I now work at is to provide a quality, comprehensive, arts-infused education. When I began teaching I did not fully know what I was signing up for in regards to delivering this arts-infused education. I applied to work at an arts school based on my own past participation in both band and visual arts in my high school experience. I also hoped that I would find an arts focused school to be more accepting and understanding of my own queer identities and I was not disappointed.

While student teaching I saw and helped deliver an arts integrated unit, executed on a grant, despite not knowing it at the time. This first unit was a spoken word and human body metaphor project with a graded in class performance. They had a guest artist come in to model, direct, and grade the students. Nearly every student stood and read something, and nearly all of the poems presented included a coherent comparison between a real world structure and a human body system.

When I was hired at my current school and began teaching there, I was able to see this same practice brought to life through artist residencies at every grade level. At the seventh grade level we execute a yearly (paused for COVID-19) mural inside our building. I was relieved to see collaboration in a way that was familiar to me, as we began to shape a mural all about community that connected all four core content areas, and the arts my first year. This continued again this past year, with students adding images to the hallway walls focusing on what they want the world to be like. This aspirational element translated into all four content areas as we helped students develop an understanding of how other content areas can help create social change to build the world they want to live in.

During my first year the theater teacher, now our Arts Integration Teacher on Special Assignment (TOSA), ran a professional development where each teacher chose an art area to integrate into their teaching. I chose theater, and worked with the theater teacher to create a four week unit where students created plays to explain to and teach their peers about selective breeding in various plants, animals, and traditions. The following year I modified the assignment to focus instead on extinctions of various species - which middle school students were more easily able to translate through storytelling into a play. Throughout this unit students do scientific research, practice storyboarding, write an original script, create props, costumes, and set, have rehearsals, and perform their play for their class. The practice of designing this unit collaboratively started me on a more intentional path towards arts integration throughout the year.

When we returned to school after the onset of the COVID-19 pandemic it was time to write our SCIP (School Continuous Improvement Plan) - and we voted to include

our arts focus in our plan. This past year we aimed to have two arts integrated units in each content class. I taught a human body unit with a focus on medical illustration that culminated in a word art summative assignment. As well as the play project focusing, again, on extinction, I also taught a portrait photography unit where students used portrait photography to explore genetic versus environmental traits. As part of our artistic community we share our classwork and art on Fridays in an all school gathering. Four students from my class spent a week rehearsing, and then shared their artist statements and medical illustrations projects on stage with the whole school.

As I move forward in my career, I hope to find stronger grounding in my classroom for the importance of the arts and student buy-in through the arts. I want to continue developing my play project unit and my connection to the seventh grade mural. Students surveyed at the mid year mark requested more art, and said that they really enjoyed the word art project, so I hope that the addition of a music unit will increase the interest and buy-in.

The focus of the seventh grade Professional Learning Community (PLC) this year (2021-2022) is to have our students succeed on arts standards at the same rate as content standards. I found that in the first arts integrated unit I did this year - focused on medical illustration, students did not meet this goal. I hope that by increasing the interest in the art form - music over visual arts - I may eventually be able to see equal success as that also feels like an indication that I have created and taught both content areas in a way that is thoroughly entwined.

Arts Integration Context

My pedagogical foundation is based on all students, regardless of any factors, finding success in science. I believe that for science to progress it needs to have strong voices from all walks of life and I want every student to leave my class feeling like they could add something to scientific research, and understandings if they wanted to. A way that I included all students in science conversations is by using arts. Students are more engaged when the project is understandable or in a format that is clear to them - something like photography is familiar and they are then able to explore complex ideas of heredity, and shared traits through something safe, something that they feel themself to be good at already.

I also use art to push students to have a growth mindset about science and scientific learning. The arts forces students who have fixed themselves as 'good at science' to grapple with a new way of showing their strength. The arts also allow students who see themselves as 'bad at science' to push themselves to try a new medium, and when they find success they are able to reconsider their understanding of themselves as a scientist. Increased use of the arts in science can also lead to growth mindset for students; as students explore through the arts they are able to revise and revisit their work, which allows them to see their own successes based on their work (Adams, 2021).

There is already significant support for the concept of arts integration as a valued teaching practice. The Kennedy Center in DC supports arts education at every level, with Arts Integration being the most comprehensive way the arts can show up in a content classroom. With this understanding Arts Integration only occurs when science standards are taught alongside and with equal importance to the arts standards. Both content areas

are given the unique opportunity to hold each other up. In Minnesota we often reach out to the Perpich Center to consult on our arts integration; they give us access to materials as well as experts in specific fields to push us to be better teachers. The Perpich Center is specifically a great resource for exploring the Minnesota State Arts Standards as they have them color coded, and broken down by grade level and strand so it is easier to interpret what students out to be able to do at each level (https://perpich.mn.gov/professional-development/arts-education-resources/mn-k-12-arts-standards/).

I want to take the same challenges I present to my students and give them to myself - teaching science through music, incorporating an understanding of rhythm, tempo, beat, and tone into how students understand the living world around them.

Outline

This project will explore the pedagogical reasoning behind arts integration. Through that lens I am specifically interested to zoom in on the success students find through music. Once that has been completed I will find connections between music and ecology, and find ways to encourage students to explore those same connections. The bulk of this project will generate a unit plan for a musical ecology unit. Aspirationally I would like to fuse the teaching of the science and music so that they are both present each day of the unit. This means that I will be creating a co-equal arts integrated unit, a form of arts integration where both content areas (music and science) are taught and that I must understand music in order to teach it as equal to science in my classroom (Foust, 2017). I will conclude by considering assessment of both science and music standards on one summative assignment - and throughout the unit as formative assessments.

The next chapter is a literature review. It explores the topics that I thought were necessary to understand the desire for and development of a science and music integrated unit. The following chapter addresses my specific project design and context. The fourth chapter will be the conclusion, outlining what I learned through the process of unit design, and what my plans moving forward with implementation are.

CHAPTER TWO

Introduction

In this paper I intend to explore and answer the question: *How can music be integrated into life science teaching in a way that enhances both scientific and musical learning?* This chapter will explore six ways of conceptualizing and building knowledge necessary to create an in-depth unit. By placing authors on the various disciplines in conversation with each other, I will understand the background research necessary to develop a successful arts integrated unit that teaches students music and ecology standards side by side.

The six categories necessary to understand the background information are Arts Integration, Benefits of the Arts, Existing Arts and Science Connections, Good Science Teaching, Good Music Teaching, and Cultural Relevancy in Science and Music. In the Arts Integration section I will go through a brief history of arts integration, explain various theories of arts integration practices, and introduce the reader to resources available locally and nationally. In the Benefits of the Arts section I will articulate the reasons that students do better when they learn through the arts. Following that I will describe the existing connections between arts and science – these are existing units, projects, and outreach that has been done. I will describe how arts and science complement each other as well as what success other people have found while executing arts integrated science lessons and units. Then I will describe current theories in science practice in order to find intersections between what works in science education and what works in music education. The next section will focus on what works well in music education. The literature review will conclude with an exploration of cultural relevancy

in both science and music that will be translated into the successive unit that integrates music and science.

Arts Integration

Arts Integration is the broad term for teaching the arts alongside, and in partnership with, other content areas. There are multiple levels of arts integration: at its most basic, the model is more 'subservient' where art serves the content, but the art is not being assessed or taught explicitly. The models get more complex, building up to a co-equal model where the art and the content standards are taught in conjunction with one another. In this form, both sets of standards are assessed with equal weight, and students are expected to learn both core content and art content in and through their classwork (Foust, 2017).

The model this project will use is the co-equal model, where both content areas are taught and the teacher must understand the art form they are using in order to teach art as equal to the other content (Foust, 2017). This model also most often occurs in places where there is administrative support for, and intentionally offered professional development around arts integration so teachers see the value add of doing it, and executing it well (Foust, 2017) (Smilan, 2016). However, this model acts in direct contradiction with the ways that teachers are taught and licensed. Teachers are taught and licensed in ways that encourage compartmentalization and a fragmented understanding of knowledge, assuming that various content areas can be siloed off from one another instead of assuming that teachers can be stewards of knowledge in multiple areas, potentially across disciplines (Hrenko, 2010). In order to create a unit plan based in the

co-equal model of arts integration there will need to be massive amounts of team collaboration and work outside of the school day to build the comprehensive curriculum.

Arts teachers also need space to teach in an arts-integrated manner; they, too, can study and use other disciplines within their classes to benefit and develop student learning (Smilan, 2016). This allows them to explore other interests while still teaching through the arts. It also gives space for the understanding that within a co-equal arts integration model arts teachers are a resource rather than a co-teacher (Hrenko, 2010). It also allows the converse to be true - non-art content teachers can serve as a resource to the arts teachers. This also underlines the importance of arts teachers as a necessary resource for any school or district attempting to use a co-equal arts integration model; while content teachers can and should teach the arts, art teachers are needed for this model's success.

Arts integration does not need to span a whole school year in order to be worthwhile (Foust, 2017). It is possible to have rich stand-alone lessons that students walk away from with an enhanced understanding of both the arts and their content class. Given that arts standards around the country are heavily processed based, it is possible to integrate the idea of art, or the ways of thinking through the arts without the completion of a large-scale art project (Foust, 2017). Arts integration can also refer to learning about art; it does not have to be the process of creating original art (Smilan, 2016). That said, teachers can only assess what they teach, so if they expect students to produce art, then they must teach art (Smilan, 2016).

In arts integrated units and lessons, assessment of both content and artistic standards still matters (Foust, 2017). Assessment is still the tool that teachers use to make

sure they communicated the learning targets to their students, and that their students were able to master them. That said, there is a lack of formal testing, measuring, standards, and requirements in arts integration which leaves a large amount of the execution up to the teacher (Hrenko, 2010). Both reflection and action are integral parts of the artistic process, and the assessment process for those viewing the art (Smilan, 2016). In order to view arts integration as successful, students should be meeting arts benchmarks and content benchmarks through their work. In a co-equal arts integration model, students should find success with both sets of standards; they should also know what they learned through both standards and successfully reflect on their own learning.

Students need to be able to see and find themselves in every classroom; arts integration can promote student choice and introduce ideas of democracy and self-directed learning for students (Hrenko, 2010). Making art is a process, not just a means to a classroom decoration, so any time students work through the process, they are engaging in similar ways of practicing learning and creation to what they experience in both ELA and Science class (Hrenko, 2010). Including the arts in content area classes helps all students succeed in school, as they are able to find success and comfort in making something tangible, while also following their own academic interests (Hrenko, 2010). Teachers should look to create sustainable arts integrated content lessons that can be revised to match the make-up of their students, to maximize the success of arts integrated content lessons (Hrenko, 2010). By this logic students are able to find new success through the arts in their content classes. The success that students find through the arts allows them to feel success in content areas that may have previously felt inaccessible to them.

The Kennedy Center is generally seen as the national authority on arts integration, and the Perpich Center is the accepted local authority, with both a library and an arts high school in Minnesota. These will both be discussed in greater detail later in the literature review as they have resources specific to strong music education and other practices.

In a co-equal model students will be able to demonstrate learning in multiple ways, through multiple subjects. The importance of this comes in when students are able to understand that the world is not siloed the way that classrooms can be. Students will graduate from school and see the world, and their future careers as places where they will need to know about many things, and how those different things interact with one another. Arts integration is the beginning of challenging students to think in new and different ways that will help them as they continue to progress.

Benefits of the Arts

Benefits to students who learn the arts in school gained mainstream attention decades ago when cuts to public education were coming first to arts programs at schools around the United States. Students who are able to think creatively and see the arts as a part of their daily school life are more likely to find connections between other subjects and their personal lives. The arts add a level of relevancy that helps both students and communities engage with and take pride in their schools. Students who are able to see themselves as artists, are additionally able to imagine themselves as other kinds of professionals (such as scientists), and are able to carry that identity with them throughout their education (Öcal, 2021). Increased use of the arts in science can also lead to growth mindset for students; as students explore through the arts they are able to revise and revisit their work, which allows them to see their own successes based on their work

(Adams, 2021). The nature of both arts and science is procedural, focussing on student development of ideas and revision of work, which encourages growth mindset in students and they are challenged to better their own work rather than accept it as ‘good enough’.

Involvement in the arts can motivate and encourage students to become more active community members (Adams, 2021). In a reflective piece, Adams explored how a partnership with the Kennedy Center helped to turn around a school from failing status to increasing enrollment through community investment and partnership in developing an arts integrated focus (2021). Starting at a young age means students don’t have a chance to develop things like stage fright because performance is a skill that is nurtured (Adams, 2021). A skill like public speaking is a direct benefit to a lack of stage fright, and can be beneficial in every academic setting a student finds themself in moving through their schooling. An activity like improvisation can be used to encourage students to practice exploring new ideas, and let their creativity shine in ways that they may not have felt comfortable to do in a traditional classroom experience (Öcal, 2021). Students can also use an art form like theater to play out and explore social (interpersonal) issues that they experience as children, and learn about social (societal) issues that they may face outside of school (Öcal, 2021). Art that feels real also tends to resonate with students (Feldman, 2002). This can transcend artform, but Feldman worked with students who saw visual art at museums specifically, and students identified that art that felt real to them depicted people or feelings that were part of their lived experience (2002).

Beyond benefits to students who engage in arts integrated learning, there are also societal benefits to having students who are well versed in the arts alongside their content classes. Society needs and relies on people who are able to engage in inquiry, and inquiry

is a skill that comes from both arts and science (Öcal, 2021). Science and art both explore the concept of 'imagining the unimaginable,' and allowing children to explore that in multiple ways fosters creative problem solving in their adult lives (Öcal, 2021). In one case, after more exposure to art in core classes, student demand for arts classes led to a need for increased staffing at the middle school (Adams, 2021).

The research shows multiple successes of arts integration and that the benefits affect both students and communities. Students who engage in arts lessons earlier, develop important skills (both critical thinking, and life skills founded in the arts). Through engagement in the arts, and explicit instruction in the arts students are better prepared for their futures, and more able to see the successes of their present.

Existing Arts and Science Connections

In recent years, the mainstream push for science education and science career ready students has been adding the arts. The field of Science Technology Engineering Arts and Mathematics, abbreviated STEAM, has grown exponentially since 1990 (Grant, 2016). There is now both Science Technology Engineering and Mathematics (STEM) and STEAM in science education; the addition of the A to STEM to transform into STEAM seeks to emphasize the ways that the creative process is integral to science learning, and the practice of science. The presence of art in science lessons is twofold: it helps to engage students, reinforces a belief that they can perform in science, and shows them exactly what inquiry is commonplace in careers in both the arts and in scientific fields (Wilson, 2021). STEAM is about the integration of each and every letter in each part; STEAM can also include work on and around how scientists share and present their learning (Grant, 2016). Arts integration is specifically important in areas that cannot

afford consistent field trips for the arts (Grant, 2016). Involvement in the arts is perceived to foster independence, creativity, and critical thinking (Grant, 2016). STEAM helps to reframe negative feelings around the difficulties of STEM – it serves to increase student interest and engagement while still pushing students to interact with challenging scientific and mathematical problems (Wilson, 2021).

Art can also decrease the stress students feel about both school and science as students feel more freedom and relaxation in their artistic pursuits (Turkka, 2017). Music is included in science to add relevance, as it is a cultural phenomenon that can serve as a hook for students. It also gives students another access point to new topics in the potentially challenging and vocabulary heavy field of science. And the presence of music, and rewriting music allows students to practice their communication skills in the science classroom without having to create and present a full poster for a science fair (Ward, 2018). Music is integral to young people's lives and so accessing it makes content relatable and exciting to them (Ward, 2018).

Art allows for many connections and ways that students can begin to think like scientists without even realizing that they are doing it. Art can connect to social issues in a way that students do not always understand that science does (Grant, 2016). Art also gives students a means to explore social issues that are relevant in science. Arts integration allows for collaboration, and coworking with peers (Wilson, 2021); which are both integral skills for scientists to have. Students create things with their peers for both artistic and scientific growth, and may not ever see the processes as similar if they are not taught them side by side. Art and science are related because of how artists and scientists have to imagine and create new things (Turkka, 2017). Science, and STEM more broadly,

is widely viewed as a highly constructivist field, one where students learn by doing (Ward, 2018) which can also be extended to art where students must try new things, and also have hands-on experiences.

Students are also asked to express emotions and consider feelings of others in both science and art (Turkka, 2017). Additionally, art can encourage and engage students who are below grade level readers to try in scientific pursuits (Turkka, 2017). Art allows more personal connections, and with more personal connections comes better retention of materials (Wilson, 2021). Beyond just art, any integration of content materials makes those materials more memorable for students (Wilson, 2021). The practice of writing music mirrors scientific processes of revision and making mistakes (Ward, 2018).

Many different disciplines of art work well within the science classroom. Turkka found that most retained knowledge came from experiences and projects in the classroom (2017). This transfers to logically assume that students engaged in meaningful art and science projects will take more away from those experiences. Classroom drama helps develop verbal skills; playing and listening to music helps develop spatial reasoning; plays can help students process controversial topics in science (Turkka, 2017).

While there are many noted benefits to arts integrated science units, there are also inconsistencies and struggles within the field. There has been little research done into correctly executed arts integrated science units (Turkka, 2017). When arts integration isn't the norm, or isn't in the content standards, then it is implemented inconsistently (Turkka, 2017). There is also research that art integration benefits art learning more than content learning, though more research is needed to validate this, and student outcomes clearly depend on how the art is taught in the content class (Turkka, 2017).

Some meaningful examples of science and arts integrated units and projects are described in varying detail in this paragraph. In the field of computer science/ programming students created a collaborative art quilt that was founded on the question: 'What is art?' (Grant, 2016). Students also engaged, via visual arts app, in an exploration of color mixing that led to discussion of traditions surrounding death and dying (thinking specifically about preservation of memory) (Grant, 2016). In the field of ceramics arts and biology, students found diatoms, and created prints and plates using those shapes and forms (Smilan, 2016). In the fields of photography and biology, students explored ways to communicate and show their understanding of global warming through pictures (Smilan, 2016). Öcal wrote about a theater production project where students acted as scientists, going through their lives as means of understanding how the scientific process works (2021). Öcal found that students who understand connections between their own lives and science do better understanding and predicting the jobs of scientists (2021). Öcal also found that students who know about the lives and discoveries of scientists are more likely to be engaged and invested in their own science learning (2021). In a review of students sharing songs they wrote at a science fair, Ward found that students were able to explain a topic through lyrics, but struggled to explain how the genre of the song informed the meaning of the song (2018).

Science and art connections already exist and are doing good work in education. Students who are able to see the benefits of both artistic and scientific thinking are better prepared for making connections, and engaging in critical thinking work. Students who understand the connections between science and art are also on better footing to become scientifically literate adults, who engage critically with the world around them.

Good Science Teaching

In recent years, science teaching has turned its focus from rote memorization and scripted labs to inquiry and phenomena based explorative projects. “Students learn best by doing their science learning hands on!” has long been in the science education vernacular, but now the focus is on exploration of a concept through phenomena students are already familiar with. In 2019, the state of Minnesota went through a revision process of its science standards and created a significantly pared down document with a statewide emphasis on these phenomena (https://education.mn.gov/MDE/dse/stds/sci/). Students will still be able to go through the learning cycle, and use the 5Es – both of which have described the process of inquiry-based exploration in science for years – as they engage with new ideas in hopefully more meaningful ways (Llewellyn, 2014).

The National Research Council spent several years developing new ideas about how to teach science. They focus on seven crosscutting concepts in science: patterns, cause and effect, scale proportion and quantity, systems and system models, energy and matter: flows cycle and conservation, structure and function, stability and change (2012). These crosscutting concepts can be found in all fields of science, and tie the different contents together. Then every content area has core ideas (NRC, 2012). In life science those core ideas are molecules to organisms – structures and processes; ecosystems – interactions, energy and dynamics; heredity – inheritance and variation of traits; biological evolution – unity and diversity (NRC, 2012). These are integral to teaching planning of the content they will cover in science.

They were also integral to the development of the new Minnesota State science standards (2019). The 2019 Minnesota State Standards can be found in appendix A.

They are set to be implemented in my district in the next two to three years at the seventh grade level (https://education.mn.gov/MDE/dse/stds/sci/). These are the standards specific to ecology, which my unit focuses on. The state education department worked with science educators from around the state to utilize phenomena that translated the NGSS (Next Generation Science Standards) crosscutting concepts and core ideas into the new standards. The number of standards decreased, and their depth and specificity increased to provide students with an understanding of how the scientific process works. The foci of the ecology standards are modeling the cyclic nature of matter and energy, how different organisms in an ecosystem interact, the ways ecosystems changes impact everything in the ecosystem (noted through data), creating solutions for environmental problems, and recognizing indigenous knowledge about local ecology (https://education.mn.gov/MDE/dse/stds/sci/).

Beyond the background, there is then specific methodology to executing good science teaching. Science is constructivist, built on the understanding that students learn by making connections between what they know and what they're learning (Bossé, 2010). To do this, science teaching follows 5 Es – which are a sequential cycle of learning and students exploring phenomena (Bossé, 2010). The 5 Es are meant to work with National Standards and are Engage, Explore, Explain, Elaborate, Evaluate (Llewellyn, 2014). They are not meant to be a linear process, but rather to be a cyclical experience that students work through as they explore scientific phenomena (Birmingham, 2021) and attempt to answer questions about them, and pursue their own scientific inquiries that arise through their work. Utilizing everyday phenomena to explore science topics helps students to engage in interdisciplinary thinking in the science

classroom and beyond (Song, 2021). The goal of this model is to create a classroom culture of inquiry and argument where students know how to ask (and begin to answer) scientific questions in a way that is accessible (Llewellyn, 2014). Students should be consistently somewhere in the 5E cycle of inquiry in science class, and applying that "E" to a new phenomenon to deepen their understanding about a topic. There are developed units, and phenomena that correspond to the Minnesota State Science Standards on the Open Sci Ed curriculum website (https://www.openscied.org/). This website walks educators through a full plan for a phenomena based unit that engages students in learning through the 5Es.

Beyond the standards, science is experiencing a renaissance in the era of culturally relevant teaching. There is more focus now than ever on how to make students see that science matters, that they are scientists, and that their experiences add to scientific canon (Birmingham, 2021). Included in this is a growing commitment to community that allows students to have a voice within their learning, and direct some of their own inquiry (Birmingham, 2021). One form of this is encouraging action taking – community bettering through youth led experiences – because youth are experts in their communities (Birmingham, 2021). Through action taking, students see themselves as community experts, and are helping to build a more equitable science classroom where the knowledge they bring is the starting point for their own learning (Birmingham, 2021). The expansion of projects out of the classroom and into the community creates the long-term student buy-in that is essential to teaching the next generation of scientific thinkers (Birmingham, 2021). Students can then make a difference in their community

through scientific actions, and can conversely make a difference in the field of science through their community based understandings of the world.

As students are pushed to consider community connections, it is also hugely important for them to see science as an interdisciplinary subject that connects to many of their other school subjects. Students perform better when their classes are connected to one another, and science can serve to provide the reality of using math in and for the real world (Bossé, 2010; Song, 2021). One of the many benefits of teaching students the connections that science has to other subjects is developing their understanding that everything they are learning is inextricably linked, and cannot be siloed no matter how hard their day to day school schedule tries (Song, 2021). Song wrote that middle schoolers specifically need this connectedness to see the relevance of their content learning to their own life and to their specific interests. Middle grade students need a working understanding of all their classes in order to grow into well-rounded adults, and seeing their classes work together can help support this growth. Within the middle school model, most interdisciplinary learning focuses on projects and activities, which in science lends itself well to engineering challenges for students to solve. Students shared with Song that they felt most successful as problem solvers when they had more scientific content knowledge. They still brought knowledge from their own experiences, but were able to interpret it within the scientific content. Student attitudes about both interdisciplinary activities and science are the biggest predictors of their success in science (Song, 2021). Integration (of any subjects) is reliant on teacher engagement and professional development opportunities so that teachers have time to create the materials

necessary for learning (Bossé, 2010). Science teaching specifically is exceptionally reliant on materials in order to provide for hands-on inquiry experiences for students.

Finally, because of the unique jargon of science, it is imperative to consider the methods that can best accommodate and include multi-language learners (MLLs) in the science classroom. Best practices for MLLs are also best practices for all students learning a new academic language in a subject area. Due to the complicated nature of science jargon, best practices for MLLs in middle school science are really best practices for all students as they work together to make meaning of new concepts utilizing new, hyper-specific words. Teachers must connect to language in the classroom, because the language spoken is what all students are using to make meaning of the materials (Infante, 2021). Translanguaging allows students to interact with material in multiple ways, and engage with content in ways that make sense to them (Infante, 2021). Mixed language usage occurs most when students are trying to make meaning of something – which in the context of science means that students should often be engaging in mixed language use while they study and explore various phenomena (Infante, 2021). If the phenomena that they're exploring are relevant and connected to their lives, it is likely that they have familiar words in any number of languages that will help them build understanding. Scientific practices and other standards within the NGSS do not require a script or specific language; students should be able to engage in science work and practices in any language (Infante, 2021).

Through good science teaching students should be learning ways of thinking, and ways of questioning rather than memorizing any specific processes. Students who engage in science taught this way also are able to see themselves as people who do science rather

than just people who learn science. Students who build critical thinking skills through science should also see those skills transfer to other areas, especially areas within the arts where process is hugely important as well.

Good Music Teaching

Minnesota music standards come in strands and they are focused on creation, revision, and performance. The standards build over time, but depending on where students have gone for elementary school, it can be beneficial to start middle school arts exploration in elementary levels. The Perpich Center has created documents and examples for each type of art taught in schools (https://perpich.mn.gov/professional-development/arts-education-resources/mn-k-12-arts-standards/). Music is often used to engage students since pop culture is so music heavy, but to integrate and engage with music more has to be done than just rewriting a song, or using a song as a neat mnemonic device. Students need to understand multiple parts of music, and be able to explain beyond the words what the meaning, feeling, and genre of songs are.

The seventh grade music standards are separated into four strands (Perpich, n.d.). They can be seen in their entirety in appendix A. The strands are create, perform, respond, and connect. There are nine music standards for all of grade seven. My unit will pull one to two of them, from different strands in order to create a meaningful experience within the science classroom, without overextending what is possible. Some key details in the music standards at the seventh grade level are evaluating a musical performance, identifying historical and cultural contexts to music, creating compositions with musical

features (such as dynamics, articulation, and tempo), and demonstrating understanding of different genres and styles of music.

A single model of teaching mid-level music does not (and should not) exist given the diversity of students (Gerrity, 2009). Curriculum examples are notably absent, and because music is personal, teachers tend to gravitate toward the music that speaks to or spoke to them which can alienate students (Gerrity, 2009). The three notable recommendations that Gerrity makes are:

1) Units should be generative and focus on exploring and creating new things following the theme provided by the teacher.
2) The essence of the music used in teaching should remain unchanged.
3) A student centered, problem solving focus helps students engage in music education. (2009)

If students see music as a hook, or bait and switch, they may feel tricked and become disinterested in engaging with the topic instead of gaining interest as the instructor likely hoped (Gerrity, 2009).

When teaching about and through music, the key concept to remember is that music is always culturally infused; the meaning is already innate and cannot be extricated from it. Along with this, music outside of its context no longer truly makes sense, which means that engagement with music must also engage with the context of the music. That said, much music has been performed, described, and remixed many times, so there is not always one inherently correct reading, understanding, or even way to perform a piece. In order to engage students with the context of music, it can help to ask things like "How was the music produced? For whom? By whom? In what context? For what purpose?

With what influences?" (Koops, 2010). All of these questions fit within the music analysis standards that Minnesota has, encouraging students to always remember the context of music because that context informs both its interpretations and original and intended meanings. If authenticity cannot be achieved by learning about context, then a cultural grounding of the students can make all the difference in engaging in their own learning (this makes it an experience of authenticity rather than performance of authenticity) (Koops, 2010).

Cultural Relevancy in Arts and Science

Cultural relevancy means that a school content area is related to students' cultural background and has a clear connection to their community, and their role in it (Hammond, 2015). In science, an emphasis on how it benefits the community can encourage students to persist. Students whose culture is seen, validated, and understood learn better (Hammond, 2015). Cultural relevancy is based on the idea that students need to be able to see and find themselves in classroom activities, projects, and content materials (Hrenko, 2010). Things like data collection in their community, or working with local partners to install and implement real changes, build connections for students to see the work they do in class having a real impact in their community. In the arts, students are more readily able to see themselves and their cultural heritage represented, both in the artists and the subjects of various works of art. In both cases, students are better able to engage with the class materials and better understand the purpose of their learning because of the ways that they are shown that learning directly connects to their identities and interests.

In order for classes to be culturally relevant, teachers need to put in yearly work to see and develop their students' identities. Teachers also need to see the process of creating lessons that are culturally relevant as fluid - class' demographics will change year to year and students will have ever changing interests over the years. Teachers who understand their own cultures are better able to teach, relate to, and engage their students (Hammond, 2015). Teachers should look to create sustainable and revisable arts integrated content lessons that can be altered to match the make-up of their students (Hrenko, 2010). The whole class community, and school community are integral for the success of the class, and of the learners (Hammond, 2015). Teachers need buy-in from both students and families in order to be effective. A large part of getting that buy in is by listening, being a team player and community member (Hammond, 2015).

Arts integration can be an additional way to provide cultural relevancy to content areas. Art integration can promote student choice and introduce ideas of democracy and self-directed learning for students (Hrenko, 2010). That said, students should not have the final say in classwork, or school changes, but should feel heard and accounted for in the development of course materials (Feldman, 2002). Students identified art that they saw themselves in (black students liked art featuring black people) as their favorites, which could confirm the importance of seeing their own culture as part of their educational canon (Feldman, 2002). Through the arts, new voices can be introduced to all students, and meaning can be co-created with students, using their own community knowledge to further their content knowledge and scientific confidence.

Summary

This literature review began grounded in my research question: *How can music be integrated into life science teaching in a way that enhances both scientific and musical learning?* I explored potential background information to answer this question in six categories. I first explored arts integration, emphasizing that my project will deal in the co-equal model of arts integration. I will teach music and ecology standards together in order to give students a music integrated final seventh grade science unit. I then explored the benefits of the arts for students, as well as what arts and science connections already exist. I found a majority of visual arts and theater connections as well as many ideas of how the artistic process and the scientific process overlap. This encouraged me to continue exploring ideas of how students can interact with science and art in process based, inquiry focused, problem solving ways. I then reviewed a large amount of the information that I am familiar with from obtaining my teaching license and from district offered professional development to elaborate on the best practices in science education. This section explored both the 5Es and crosscutting concepts, and core ideas in life science from NGSS. Next, I had a brief exploration of what makes strong music teaching, and found that there aren't set rules, and that music education depends on the wants and needs of the students and that the context of the music is what makes it important and relevant to students. Finally I defined cultural relevance and explored how cultural relevancy could be benefited by an arts integrated approach to science. I hope that through my project I am able to create a modifiable unit that integrates music and ecology in a way that makes both topics relevant for students in a community focused way.

Chapter 3 will focus on the methods that I will use to answer my research question: *How can music be integrated into life science teaching in a way that enhances both scientific and musical learning?* I will begin by explaining how to develop a curriculum using best practices in educational literature. I will then describe my own process for designing the unit, how I will implement it in my classroom, and how I will assess student understanding of both music and science standards throughout. Next, I will elaborate on the theories I have read about that support the ideas and developments around my project – specifically those that support arts integration as a means of engaging students in scientific learning. I will describe the setting of the project, the context that I teach in, so that my work on relevancy makes sense for the students I serve. Finally I will describe the students and colleagues who will be involved in the eventual implementation of my curriculum.

CHAPTER THREE

Project Description

I am creating a curriculum project to explore and answer the question: *how can music be integrated into life science teaching in a way that enhances both scientific and musical learning?* In this chapter I will describe my plan for that project. In doing this I will explore the setting/audience for eventual unit implementation, the timeline for completing and executing the project, as well as how I will eventually assess the success of my unit based on student learning outcomes. The plan for my project will include an explanation of my planning process, as well as highlighting the different learning activities that I am planning based on both research based practices and recommendations from my colleagues. The setting/audience section will describe the demographics of the school where I will eventually be teaching the unit. The timeline will describe the creation and eventual execution of the unit. I will conclude with a description of how I will assess the success of the unit after implementation, drawing on past experience and based on student outcomes.

The project will be to create a six-week music integrated ecology unit to be taught in a seventh grade science classroom. Music will be integrated throughout an inquiry-based ecology unit following the new science standards (2019) for Minnesota. Music will be integrated into the ecology unit throughout biology content learning in order to improve student understanding in both content areas. In order to achieve this, students will explore and develop an analogy comparing a full symphonic orchestra to an ecosystem. They will compare what happens when an instrument is removed to what happens when a plant, animal, or other ecosystem features are removed. They will also

listen to a symphonic piece where the melody moves around the orchestra and compare that to ways that energy and matter cycle through an ecosystem. This will lead to student creation of matter mapping charts and graphics that show how the melody is picked up and moved through a large group of instruments.

Students will also explore music based on and inspired by nature in order to learn about mood and tone in music and recognize mood and tone in plants, animals, and other parts of an ecosystem. While talking about ecosystem parts students will hear chords, and create a comparison to a relationship within the ecosystem. Here they will be demonstrating understanding of biological concepts through a comparison to music, because of the heavy amount of a music theory - that is beyond the seventh grade level - they will be focusing on generating the science side of the analogy. This will allow students to explore ways to hear a chord where the notes all work together (mutualism) and chords where the notes clash and one might harm or overpower the other (parasitism).

Once students understand features of both music and ecosystems they will be asked to look specifically at genre. Doing this in a music context will allow them to hone in on a music genre they are specifically familiar with or interested in. In their deep dive into genre they should find that different songs are different based on their context, and the execution of the music even though they belong to the same genre. This same line of thinking can then be applied to an ecosystem comparison. There are multiple rainforests around the world and because of their contexts they are not the exact same ecosystem.

During the unit students will be assessed often, both for formative and summative points. In my classroom students are graded on four categories – Workbooks (formative),

Ignite/Review (formative), Homework (formative), and Projects (summative). Workbooks are a week-long assignment that students complete on their iPads in Pages. It includes space for many forms of formative assessment, allowing students to reflect, answer questions, and take notes all in one place. In the formative category students will be assessed using things like reflections (on schoology), music analysis, definition work (creating vocabulary cards), participating in class discussions, giving peer feedback, creating concept maps, identifying main ideas, and by having some of their notes graded.

The student summative category is project based in my class, and in this unit will all be presented alongside student written artist statements explaining the purpose of their work, and what they learned. Some example projects students will be able to complete over the course of the unit are creating their own music based on an ecosystem/biome, comparing songs within a genre, alongside a comparison of two ecosystems of a similar type, and original chord creation to represent different symbiotic relationships.

I will evaluate the success of the unit based on student participation in lessons, student outcomes on summative assignments, and student success rates on art and science standards. In 2022 my professional learning community focused on creating arts integrated units and measuring student success in those units. I created spreadsheets to track student success within the unit, and differentiated their scores on science standards and arts standards. I will duplicate that methodology in order to create a tracker as I execute this unit, and others, next year.

The unit will be built backwards, beginning with ideas about what students should learn, then the actual lessons and activities will be created (McTighe, 2011). Lesson activities will then follow the 5E model of science teaching. The 5 Es are meant to work

with Next Generation Science Standards and are Engage, Explore, Explain, Elaborate, Evaluate (Llewellyn, 2014). They are not meant to be a linear process, but rather to be a cyclical experience that students work through as they explore scientific phenomena (Birmingham, 2021). The lesson activities will be built around exploration of ecological phenomena, with students going through the 5E cycle to learn more.

Setting/Audience

The designed unit will be taught at the school I have taught at for the past four years in Saint Paul, MN. It is a public arts focused school that serves students in grades PreK through eight over two campuses. I teach seventh grade science at the upper campus, and the following demographic descriptions will all be focused on the upper campus specifically. Students commonly enter the middle school both from other schools and the lower campus, so not all the middle schoolers have had consistent exposure to the arts, and even those who have do not all enjoy it.

The Upper Campus serves students in grades five through eight. There are 452 students in those four grades. The racial breakdown varies by grade, sometimes significantly, but school wide is 35% white, 9% multiracial, 14% Hispanic/Latino, 25% Black/African American, 16% Asian, and 1% American Indian. The school also has a sheltered English Language learning cohort, and there are 24% English Learners, and 76% not English Learners in the full student body. In my science class I do not teach the students in the sheltered English Language learning cohort, which is about ten students per grade. Students' home languages are 69% English, 10% Karen, 8% Other (largely Oromo and Amharic), 7% Spanish, 4% Hmong, and 3% Somali.

The Upper Campus has both Development and Cognitive Delay (DCD) and Learning Disability (LD) programs. The LD program includes students with Individualized Education Plans (IEPs) for LDs, Other Health Disabilities (OHDs) (most often ADHD), Autism Spectrum Disorder (ASD), and Emotional Behavioral Disorder (EBD). The DCD program goes through Federal Setting III, which means that I do not teach all of the DCD students in science class. The LD program goes through Federal Setting II so all students in that program are in my class as part of their time with general education peers. Within the building as a whole, we serve 17% Special Education students and 83% not Special Education students. Finally, 54% of students qualify for free and reduced lunch, while 46% do not.

The school is small, and as a result there is one team of teachers per grade, with special education teachers, and Multilingual Learner (MLL) teachers in branches working mostly with grade levels but with some variation as needed. There is additionally a full arts team that serves students in all four grades. There are classes offered in dance, theater, visual arts, ceramics, music, band, and physical education. The staff is majority white, with small numbers of Black, Asian, and Middle Eastern educators. Most non-white staff are not teachers. They are on the behavior team, work as paraprofessionals to support special education students, or as bilingual education assistants. There is a single principal for both the upper and lower campus, and a vice principal specifically for each campus. There is one school social worker, and 1.5 full time equivalency (FTE) of counselors. The school contracts with some out of school therapy providers to provide services in school, mostly to Black students.

The seventh graders in science class, beginning in spring of 2023, will participate in the unit designed as the ecology unit. That class of seventh graders has approximately the same demographic breakdown as the school as a whole listed above. Most of these students will have been participating in in person schooling for a year or more by the time they enter seventh grade next fall, and most will have attended the school for sixth grade as well. They will likely have more exposure to the arts than the current class of seventh graders, and therefore be better equipped to engage in an arts integrated unit based in science class.

Timeline

The unit will be planned summer of 2022 during the second course in the MAT sequence at Hamline University. The unit will be implemented in spring of 2023 for the final unit of 7th grade science. The unit will be based on the upcoming science standards, and so implementation may vary based on guidance from the district science department. In the case of a delay the unit will simply be modified to reflect the 2009 science standards rather than the 2019 ones, and students in spring of 2023 will still be the group the unit is first implemented with. The unit will also be edited and collaborated on with the band and music teacher during fall professional developments. During the unit students will likely share with peers, schoolwide, what they are learning in and through the arts.

Summary

I will be creating an arts integrated music and science unit to be implemented at a diverse urban public school during the 4th quarter of 7th grade in 2023 (and subsequent years). I will be doing this to answer the question: *how can music be integrated into life*

science teaching in a way that enhances both scientific and musical learning? The unit will include short lessons and activities that include music as well as projects that students will have to devote significant time and energy to create music to demonstrate their understanding. This unit will be a portion of the school's improvement plan to increase the number of arts integrated units that are occurring annually at our school.

The next chapter will be written after completion of the project. It will share my learning from the design process. It will also share the implications and likely limitations of my unit. Finally, I will also outline my plans for implementation of the unit moving forward.

CHAPTER FOUR

This chapter provides insight into the process and future implementation of the six week curriculum I designed. The curriculum was designed to answer the question *How can music be integrated into life science teaching in a way that enhances both scientific and musical learning?* The resulting curriculum is meant to span six weeks in the spring of seventh grade and engage students both through inquiry based science learning and a thorough exploration and comparison of music to ecological phenomena.

The first thing this chapter does is explore my major learnings from the process of creating the unit. In that section I explore the connections between the sources I analyzed in Chapter Two and my final project. I also address how the things I learned will impact and shape my future practices, and the ways that I plan my lessons moving forward. It also considers the numerous people who provided feedback on my ideas throughout professional developments and in hallway conversations, and what it means to have been planning something at such a distant time that I was able to incorporate so many ideas from others.

Then I discuss the implications of my project for myself, my school, my district, and the literature around science education as a whole. Following that is a section focused on addressing the limitations of my project both in terms of creation and potential implementation. Finally I conclude the chapter with a look at the long term benefits of my project, and the ways future research could be built in this direction. This ends with the conclusion of my arts integrated science curriculum project.

Major Learnings

This section explores the things I learned through the curriculum design process. I will describe the most significant scholarship from my own research and explore what ideas I was introduced to throughout the process that I want to continue to develop my own understanding of. Most of the learning I did is focused on what is a thorough example of music integration and how I could integrate music without having students fully create music. I went into this project feeling that musical creation would be the end goal of a strong unit, but through many conversations and articles I found that there is also a strength and validity to being able to analyze music, to explain it's cultural significance, and for students to be able to share the music that they are experts in.

I set out to create this curriculum with the knowledge that a set number of arts integrated units per teacher are in my school's continuous improvement plan. I felt that based on my existing knowledge I would be creating something that I would be familiar with. In my own experiences I have integrated art into projects, something students create and show science learning with. My biggest hurdle in creating this unit was considering how students could analyze and learn about something without creating their own. This hurdle then became the centerpiece of my learning.

In my process, which focused on backwards planning, I sat with each of the science standards and considered how they could connect to music. I was sitting at the Perpich Center for the Arts, in a Professional Development, with several members of my school's staff when I first saw the connection between analysis in science and analysis in music. The new science standard that is at the center of arts integration in my unit is 7L.2.1.1.1 - "Analyze and interpret data to provide evidence for the effects of resource

availability on organisms and populations of organisms in an ecosystem". I pulled ideas of analyzing and tracking change from this standard, and with a push from my peers at professional development the end goal of comparing two versions of a song alongside two versions of an ecosystem was born.

From the literature review I was able to spend a significant amount of time with my new curriculum which is created by OpenSciEd in conjunction with both NGSS and the new Minnesota State Science Standards. I was able to see the ways that inquiry and phenomena focused science education really look in a classroom. I only slightly modified the curriculum as it came to me from OpenSciEd, which was significantly less than I had anticipated. It came ready to ask questions that pushed students to think about how they do science. The ways that students do science overlap extensively with how students do art, a connection that just had to be pointed out for me to see it. Both Turkka (2017) and Ward (2018) introduced me to new ways of seeing both art and science as fields focused on creation, and imagination. The OpenSciEd phenomena focus, and enthusiastic use of a consensus model allowed me to build students' creativity and imagination in science content without them even fully understanding the connection to the arts.

Then in the second half of the unit I push students hard to consider music as a parallel to their science learning. Ward (2018) addresses that music adds to students' understanding of communication, and I built on that understanding in order to push students to communicate both about music and about science. Music is the jumping off point, the thing to make them comfortable, but I worked hard to create a unit where students could inject their own music taste, and their own musical knowledge while still learning new ways to communicate about music.

Based on my learnings, and what I hope students will learn, the next section will address implications of this project. I will go into detail about implementing my project as well as who else I think may be able to utilize my resources.

Implications

In this section I discuss the implications of my project for myself, my school, my district, and the literature around science education as a whole. I begin with my personal, local, and immediate and then explore further reaching implications. I designed this unit to be immediately practical in my own classroom in the coming school year. I will provide speculation and guidance for what could be added for implementation elsewhere, and potential significance of my work.

At my school the goal is for each teacher to have two or more arts integrated units throughout the school year. The products of those units are then shared in gatherings with the whole school. For me the importance of creating another full arts integrated unit began with wanting to have two complete units. I feel accomplished in this goal, and feel like I am adding something to the school community by having my arts focus be in music rather than visual arts, which is the most common.

I would like to additionally share my work with the science department at the district level as they work hard to develop our new curriculum to match new standards. Schools throughout the district have different goals and missions, so I can feel isolated at an arts school when I attend science meetings. It would be interesting to be able to share resources for things beyond just science with other teachers. Students at other schools, who do not have the strong foundational experience in the arts that my students do, would still benefit from a science classroom connection to music. Given the format my lesson

plans are in, and the ability to share resources in the district, this would be the easiest expansion outside of my own classroom for this unit plan. That said I do also believe it would be possible and impactful to move this unit beyond my district.

Outside of the district I think the biggest implications for my project would be in demonstrating the possibility of arts and science integration. I think in the push for STEAM science teachers can feel stuck without immediate support from an arts specialist. I think other districts could implement my unit, but without buy-in at the district or school level it would be difficult to execute. The photosynthesis inquiry exploration relies on utilization of the OpenSciEd curriculum, which assumes access to a specific set of materials, but access to the curriculum itself is free. The second three weeks would be more accessible to districts with fewer resources, but the unit does still assume students in a one to one technology setting who have some familiarity with the arts.

The materials I have created likely serve the most purpose in my school, and then district but could potentially be utilized elsewhere. I will discuss additional limitations of exporting this unit in the next section along with the additional development that would be needed to execute this unit with students unfamiliar with arts integration. Student, staff, and administration buy-in will be key for this unit to make any impact outside of my own immediate context.

Limitations

This section will explore the limitations of the unit I have created. It will specifically look at limitations in implementation at my school and in other areas. It will also consider what modifications could look like in other contexts.

When looking at the scientific inquiry portion of the unit (weeks one through three) most limitations involve materials. Several aspects of the lab involve materials that will be used up. Even in my district where I will be provided with a kit there is concern about what will happen when parts of the kit are gone. The things that will be used up are mostly chemicals, and some plant material. Some are easy to replace, and some more difficult.

The additional limitation of doing something thoroughly phenomenon based in science is that students come in with different amounts of knowledge on a subject. Students may come in with different understandings of photosynthesis, and may feel like they have gained little additional knowledge through a very hands-on exploration. This is where teaching the process of inquiry is key for students to engage, and understand the importance of the process outside of the knowledge that they may or may not already have.

The limitations of the music integrated portion of the unit (week four through six) come from the fact that the unit is built on an assumption of one to one technology and the existence of school, student, and family buy-in. If families and students have a specific idea about what science looks like at school it may be necessary to do additional pre-teaching about the relevance of music to science, and the importance of art in students' lives. It would be possible to modify the explanation letter and questions during reflection for students and families to have more understanding of the unit and the positive outcomes to student learning that can come from arts integration.

While I undoubtedly will face my own limitations in execution I do feel confident that they will be either long term, or easily remedied by teaching students about arts

integration if they do not remember that from their past education or if they are new to the school. The next section will explore benefits for students who do engage in the unit, and future research that I could explore based on student outcomes, and the research I put into this project.

Benefits and Future Research

This final section includes suggestions for future research, the planned use for my project, and a description of how the project benefits the profession of teaching. The immediate plan for my project remains with me, and at my school. And most future research I propose also centers the experiences of students at my school, given my familiarity with it, and my personal investment in our arts infused curriculum at every grade level.

My project will be used first by me at my school in the coming school year. I will implement weeks four through six first as seventh grade is not yet ready for full implementation of the new science standards, and I will not have the curriculum kit needed for the photosynthesis inquiry. Then in two years I will add the photosynthesis inquiry (weeks one through three) as the district implements the new standards completely. I will edit and amend the unit plan in each subsequent year based both on my experience of it and student feedback.

I will also communicate with the Arts Integration Committee about what I am seeing from students as I implement the unit. I will also serve as a liaison of sorts between the arts team and the seventh grade team in order to help more teachers explore and create their own arts integrated content. After I have implemented the unit in my classroom I will then reach out to the district science department to have it made

available to other science teachers around the district who are interested in arts integration.

There are several more arts integrated units in my professional goals. The arts specialist I have yet to collaborate with at all is dance, and I would love to create a more active artistic unit for students once I am feeling more at ease with the new science standards. One of the eighth grade teachers told me that his masters research focused on information retention of materials taught through the arts and I would be interested in doing additional research to potentially support his work through my own classroom.

Within my school we have been focusing our PLC goals on Arts Integration. I believe this project shows some of what can be accomplished, planned, and revamped with enough time. I would love to take my learnings and research to my learning community so we are able to share the ways that we get students excited about learning in and through the arts across the grade level. I also think anything that works to connect disciplines rather than divide them serves to inspire teachers to bring all of their passions into the classroom, not just the siloed interest they are licensed in.

This chapter explored my key takeaways from working through this curriculum design project. The project proved to work to both show similarities in the art and science processes and to use the more familiar musical knowledge students have as an access point to understanding ecosystem models. I hope that students will interact with the unit in authentic ways that further their understanding of both science and music. I also hope that the steps I took to create this unit will resonate with my colleagues as we continue to strive for a diverse and engaging schoolwide arts integrated curriculum.

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APPENDIX A - TABLES

Table 1: Minnesota Science Standards (2019) - Ecology Unit

Grade	Strand	Substrand	Standard	Content Area	Benchmark
7	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	LS: Ecosystems: Interactions, Energy, and Dynamics	7L.2.1.1.1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.** (P: 4, CC: 2, CI: LS2) *Emphasis is on cause and effect relationships between resources and growth of individual organisms and the number or organisms in ecosystems during periods of abundant and scarce resources. Examples may include populations of MN deer, moose, wolf, scavengers or aquatic populations in Lake Superior or algal blooms in lakes and ponds. Examples of evidence may include the use of flow charts to organize and sequence the algorithm, and to show relationships.*

7	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	LS: Ecosystems: Interactions, Energy, and Dynamics	7L.3.1.1.3 Develop and use a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (P: 2, CC: 5, CI: LS2) *Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems.*
7	4 Communicating reasons, arguments and ideas to others	4.1 Arguing from evidence	4.1.2 Students will be able to argue from evidence to justify the best solution to a problem or to compare and evaluate competing designs, ideas, or methods.*	LS: Ecosystems: Interactions, Energy, and Dynamics	7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations.* (P: 7, CC: 7, CI: LS2) *Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes and/or impacts to ecosystems. Examples of physical components may include human-built structures like urban developments, or dams.*

7	4 Communicating reasons, arguments and ideas to others	4.1 Arguing from evidence	4.1.2 Students will be able to argue from evidence to justify the best solution to a problem or to compare and evaluate competing designs, ideas, or methods.*	LS: Ecosystems: Interactions, Energy, and Dynamics	7L.4.1.2.2 Evaluate competing design solutions for maintaining biodiversity or ecosystem services.* (P: 7, CC: 2, CI: LS2, ETS2) *Emphasis is on evaluating a solution that reduces environmental harm while still benefiting humans. Examples of ecosystem services (natural processes within ecosystems that humans also benefit from) may include water purification as it cycles through Earth's systems, nutrient recycling, climate stabilization, decomposition of wastes, and pollination. Examples of design solution constraints may include scientific, economic, and social considerations.*

7	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	LS: Ecosystems: Interactions, Energy, and Dynamics	7L.4.2.2.1 Gather multiple sources of information and communicate how Minnesota American Indian Tribes and communities and other cultures use knowledge to predict or interpret patterns of interactions among organisms across multiple ecosystems. (P: 8, CC: 1, CI: LS2, ETS2) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions may include competition, predation and mutualisms.*

Table 2. Minnesota Music Standards

Code	Arts Area	Grade	Strand	Anchor Standard	Benchmark
3.7.2.2.1	3. Music	7	2. Create	2. Generate and develop original artistic ideas.	1. *Create* or *improvise musical ideas* that can be combined into a ***melody*** with **expressive *elements*.** *For example:* ***Dynamics*, *articulation, tempo*.**
3.7.2.3.1	3. Music	7	2. Create	3. Create original artistic work.	1. Develop a *composition* consisting of a ***melody*** with **expressive *elements*** using a system of ***notation*** or recording technology.**
3.7.2.4.1	3. Music	7	2. Create	4. Revise and complete original artistic work.	1. *Revise a composition* to include **expressive *elements*.**
3.7.3.5.1	3. Music	7	3. Perform	5. Develop and refine artistic techniques and work for performance.	1. Demonstrate an understanding of various *genres* and *styles* of music by applying musical ***elements*** to prepare for a *performance*.
3.7.3.6.1	3. Music	7	3. Perform	6. Make artistic choices in order to convey meaning through performance.	1. *Perform* music for an audience by responding to ***notation*,** using **expressive skills.** *For example:* Audience being a classmate, friend, online platform, or a large group.
3.7.4.7.1	3. Music	7	4. Respond	7. Analyze and construct interpretations of artistic work.	1. Identify the musical or *technical skills* needed in *musical selections* to convey meaning or possible *intent* including *cultural* or *historical contexts*.

3.7.4.8.1	3. Music	7	4. Respond	8. Evaluate artistic work by applying criteria.	1. Identify and use a variety of techniques to evaluate the qualities of a musical *performance*. *For example: Student generated criteria*; *rubric*; rating scale.
3.7.5.9.1	3. Music	7	5. Connect	9. Integrate knowledge and personal experiences while responding to, creating, and presenting artistic work.	1. Describe why various musical choices are made when *creating* or *performing* music.
3.7.5.10.1	3. Music	7	5. Connect	10. Demonstrate an understanding that artistic works influence and are influenced by personal, societal, cultural, and historical contexts, including the contributions of Minnesota American Indian tribes and communities.	1. Identify *cultural* or historical influences on musical *compositions*.