Middle Grades Review

Volume 5 | Issue 2 Article 6

September 2019

# The Art of Science; An Exploration of Art Integration in a Science Classroom

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# The Art of Science: An Exploration of Art Integration in a Science Classroom

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## Abstract

This Practitioner Perspective examined how art integration in a science classroom affected student engagement and scientific understanding. The study took place over one school year in a 7th and 8th grade science classroom, with a total of 57 students and a focus group of 11 students. Collaboratively, the science teacher and a teaching artist designed purposeful integration of art into two science units and developed a culmination project where students connected their science learning throughout the year to a self portrait. Findings indicate that art integration increased engagement and understanding and allowed students to visually express their learning. However, supports are needed for students who may not consider themselves artists or are hesitant to participate in the art integrated activities.

## Introduction

As a scientist and artist, I am intrigued by how each discipline helps support each other. Art has been an integral part of human life, documented from ancient cave drawings, to infants experiencing the rhythmic heartbeat of its mother. It also struck me as peculiar that as a science educator, I had not *intentionally* and *purposefully* integrated art into my science curriculum. Yes, my middle school students have made posters, sculpted miniature clay neurons, and even performed charades to demonstrate organelle function. However, were they making the connection that they were participating in art related activities and were these activities helping them grow as scientists and learners?

Young adolescents are innately curious about the world. They question the world around them and have an immeasurable thirst for discovery. My hope as a middle level science teacher is that my enthusiasm and reverence for science and learning is contagious, and perhaps, my love of what I do and teach, would motivate and encourage their natural sense of wonder.

My mind flashed through my lessons, images of my students engaged, images of my students struggling to understand, images of excitement, and unfortunately, if I am being completely honest, images of students disengaged. I felt a little defeated, but I know that I reached some of the young adolescents in my classroom - I would hear them singing science songs in the hallways, proudly showing peers their “organelle memes” on our meme board, or intensely working on a poster or model for a science project. I tried to always incorporate student choice and had students’ questions drive investigations. However, when I think back to my successes, they all have an underlying theme - art. For me, this realization stimulated my own curiosity about art integration and how the fields of art and science are more similar than disconnected.

This action research study explored arts integration in a middle grades science classroom, with respect to student engagement and understanding of science concepts. Middle school students were introduced to art integration, and then had the opportunity to be involved in a fully integrated art and science unit. The study was framed around the following question: *How does arts-integration affect young adolescent engagement and understanding in the middle grades science classroom?*

## Literature Review

### The Benefits of Art Integration

The benefits of art integration are apparent through a wide selection of literature and studies. Nichols and Stephens (2013) highlighted a national study of arts integration and it was discovered that there are, “cognitive, physical, emotional, and social benefits of learning in and through the arts" (Smithrim & Upitis as cited in Nichols & Stephens, p. 2). In addition to these benefits, learning through the arts can enhance “critical thinking and problem-solving skills, empathy and tolerance for others, ability to work collaboratively in groups, and self

confidence" (Gamwell as cited in Nichols & Stephens, 2013, p. 2).

In researching the history of art education, Leysath and Bronowski (2016) uncovered many ways that art has been shown to have a positive impact on educational success. During a full integration of art and chemistry, Leysath and Bronowski (2016) discovered that students were engaged and able to make connections and transfer skills into other classes, and the chemistry teacher reported improved test scores. "The arts are a powerful way for students to express themselves as learners and recognize themselves as engaged in meaningful learning because the arts give sensory expression to cognition, making learning visible" (Burnaford et al., as cited by Leysath & Bronowski, 2016, p. 32). After the integration arts and chemistry project, Leysath and Bronowski (2016) concluded that art integration has "a positive impact on the learning and success of students from all lifestyles" (p. 29).

Art integration can be a powerful learning tool for young adolescents. Armstrong (2017) argues that "the wellsprings of creativity and artistic expression may reside in early childhood, but the actual mature manifestation of creative potential begins in adolescence, as teens acquire the ability to express in a variety of forms their growing understanding of the world," (p. 121). The exploratory and experiential nature of art integrated curriculum naturally lends itself different channels for young adolescents to engage in their education. Additionally, from a developmental standpoint, "Adolescents are neurobiologically primed to engage in creative and artistic behaviors" (Armstrong, 2017, p. 121).

Gullatt (2008) emphasizes that "physical sensation and emotion are essential components of the mind, as integral to thought and learning as logic is" (p. 14). The characteristic affective nature of art is what makes it so cognitively effective (Rabkin & Redmond, as cited by Gullatt, 2008). Dickinson (2002), like Gullatt, believes that when students have the opportunity to incorporate visual arts into their learning, their academic achievement increases. The visual arts "offer the means for helping students to understand and consolidate what they learn" (p. 10).

Arts integration can have positive effects across curriculums. Researchers have proposed that knowledge and skills can be gained through the arts and that they correlate with positive academic achievement in other discipline areas (Catterall, 2002; Deasy, 2002; Fiske, 1999; Hardiman, Rinne, & Yarmolinskaya, 2014; Spelke, 2008; Wandall, Dougherty, Ben-Shachar, Deutsch, & Tsang, 2008). Art can help with scientific understanding, and as Alberts (2010), states, "as student scientific understanding develops and grows, their curiosity will grow as well," and as a middle level science teacher, that is the ultimate goal, to enrich and cultivate our young adolescents' natural curiosity about the world around them (p. 80).

Education should not be cut and pasted into specific content domains, each autonomous from each other, but rather an integration of all the subjects interlinked together. Former President Barack Obama was quoted as saying, "In addition to giving our children the science and math skills they need to compete in the new global context, we should also encourage the ability to think creatively that comes from a meaningful arts education" (National Art Education Association as cited in Dhanapal, Kanapathy, & Mastan, 2014, para. 9). Through creativity, students cultivate ideas while strengthening their cognitive skills, and are able to interpret and understand the world in a different way (Dhanapal et al., 2014).

**Learning Science Through the Arts**

With respect to integrating art and science, Riley believes that "the integration of visual arts into the teaching and learning of science show positive improvements in children's thinking skills, reasoning abilities and organizational levels (as cited by Dhanapal et al., para. 16)." Dhanapal et al. believe that students develop these transferable skills when "science activities are carried out using the integration approach in which teachers encourage them to use the elements of visual arts to understand science topics better" (para. 16). Art can help students better understand science, promote creativity, and help students develop cognitive skills, which "will then naturally prepare children for the future they will be living in" (para. 21).

An international school in Malaysia was examined to better understand how visual arts can motivate students to learn science. During this art integration study, the teachers observed that "students are more interested in learning

science when experiments and hands-on activities are carried out during lessons" (Dhanapal et al., 2014, para. 32). Dhanapal et al. (2014) also believes this integration "affects students' academic results as they get to develop their visual-spatial abilities, reflection, and experimentation skills as well" (para. 12).

According to Dickinson (2005, as cited by Dhanapal et al.), "Children tend to correlate the difficult science facts and concepts with visual representations that aid in easier understanding and long-term memory" (para. 33). Art integration can make "learning the hard sciences fun and interactive during lessons" (Dhanapal et al., 2014, para. 16). In correlation with Dickinson, Nichols and Stephens (2013) emphasized that "utilizing arts integration techniques in the science classroom can benefit the students in learning both artistic and scientific concepts, because there is overlap between the creative process and the scientific method" (p. 10). Integrating arts in the middle level science classroom not only enhances young adolescent engagement, but also contributes to higher order thinking skills and problem solving techniques, which can aid in student success, in and out of the school.

**Science and Art Reciprocity**

Similar to art, science is a way in which we interpret the world. "Research proves that it is good for people to have been acquainted with visual arts as it is a unique approach towards knowing and understanding the world we live in" (Mcdougall et al., 2011, as cited by Dhanapal et al., para. 2). Through both science and art, one can explore, create, imagine. "Art and science are intrinsically linked [as] the essence of art and science is discovery" (Alberts, 2010, as cited by Dhanapal et al., para. 3).

It seems natural that the two courses of study (science and the arts) be integrated as the arts "are primary sources of material with which to engage in scientific thinking. Moreover, they provide connections that allow lateral leaps between cognitive domains which can produce sudden scientific insights" (Shlain, 1999, as cited by Dhanapal et al., para. 2).

More often than not, the fields of science and art are often categorized and thought about in dissimilar ways; however, they are more alike than they are different. "Science and the arts often seem far apart from one another, but, in reality, the method scientists use to test hypotheses is quite similar to the process an artist experiences when creating art" (Nichols & Stephens, 2013, p. 1). For both of these fields, the processes are based in the foundation of inquiry. Nichols and Stephens (2013) emphasize that "arts and sciences can be taught together by using their similar processes which might improve student engagement" (p. 1).

Similarly, Alberts (2010) also believes that art and science are more similar than different, as their roots lie within the process of discovery. Building on the connection between the two fields of study, she adds that, "integrating science and visual art can provide students with the latitude to think, discover, and make connections" (Alberts, 2010, p. 79).

The way in which a scientist engages in an investigation is parallel to the way an artist might engage in art or create art. Both the scientific method and creative process are cyclical and similar to each other. There is a question or problem, followed by hypotheses, and then experiments are conducted in an effort to answer or express an understanding of the problem or question. The researcher, or artist/performer, then analyzes the results, which leads to more questions bringing the artist or scientist back to the beginning of the cycle. (Nichols & Stephens, 2013, p. 5).

Scientists and artists both use similar methods to interpret the world. The collaboration of both disciplines can provide powerful ways for young adolescents to engage in new material. The fields of science and art are natural counterparts, indicating that the arts can be seen as a positive learning tool in education.

## Methods

The goal of this action research study was to explore art integration in a middle level science classroom, with respect to young adolescent engagement and understanding of science concepts. Art integration was scaffolded slowly into the curriculum with the help of a local teaching artist from Artists In Schools (AIS). Three units were incorporated in this year-long study. Nature journaling laid the foundation as the first integrated art unit, followed by a more in depth Cells Unit. The final unit of the year integrated a self portrait where students made connections to their science learning throughout the year.

## Setting and Participants

The study was conducted at a 5-8 rural middle school located in northern Vermont. This school serves about 280 students, with the population being predominantly Caucasian, and 28% of the school qualifying for free and reduced lunch. This study focused solely on a 7th and 8th grade team, a total of 57 students, 28 males and 29 females. Within this team of 57 students, 15 students are either on an Individual Education Plan (IEP) or a 504. The 57 students completed an initial survey and a final survey at the end of the self portrait science/art unit.

Out of the 57 total participants, 11 7th and 8th graders were members of the focus group. The focus group developed after I received permission forms from parents of students who wanted to be involved in the study more formally. The focus group consisted of 11 students, 4 females and 7 males, none of which are on an IEP, and 2 are on a 504. All of the students in the focus group identified as enjoying art and were open to the idea of art integration. My initial hope for the focus group was that it would consist of a mix interest in art to understand how art integration affected not only students who like art, but from those who may not naturally consider themselves artists. This focus group highlights many positive aspects of art integration because of their high interest in art, but would also be considered a limitation because their viewpoints do not represent the diverse population.

## Intervention

Art integration intervention started in early September. I received two grants, one from the Across Roads Center for the Arts, which helped fund the art supplies needed, as well as a grant from AIS, which connected me with a teaching artist and paid for her time in my classroom. The teaching artist and I met before the school year and started to map out a timeline of the art integrated units in a way that fit both scheduling, content, and funding. We discussed how to gradually introduce art integration into the life science curriculum, building on skills and comfort throughout the year. Each of my four science classes (two 7th grade classes and two 8th grade classes), participated in the art interventions. The teaching artist, Rachel, came in twice for each unit, working with 7th graders one day, and 8th graders the next day, so each student was able to access the intervention. The first integrated unit was the "Nature of Science" unit. We started with nature journaling as the art integrated piece to this unit. The nature journaling lesson began by talking about what a nature journal is and discussing some famous scientists that used nature journaling as a way to collect data and observe the natural world. For the first activity, students picked an item from the natural world from Rachel's personal collection. Options included: feathers, rocks, bones, shells, small nests, beach sand, and various other items that someone may come across outside in the natural world. Students were directed to really investigate and observe their item and draw it while it was in front of them. Some students volunteered to share their work.

Their next task with this activity was to then draw another object without looking down at their paper. A two-minute time limit was given to complete the drawing and then they could look down to see what their final sketch looked like. This activity was designed to mimic a scenario of moving animals or insects they might encounter while nature journaling. Rachel emphasized that most creatures they come across while journaling will not sit and "strike a pose" so this skill of not looking at your paper while sketching is really important when in the field.

During the next phase of this nature journaling intervention, Rachel shared one of her nature journals. The students were in awe of her work and the mixture of entries in the journal; from flattened, collected samples of leaves and flowers, to simple and some detailed sketches. Each student received their own nature journal to use for the year, and the first entry we completed as a group in the front school yard. Rachel walked the students through what information should be recorded in each entry and how to expand the journal from there. Students created a map with their own point of view, recorded the time, date, temperature, wind and cloud coverage, and any additional data they deemed necessary. After they set up their map and data, they were tasked to find something within their vicinity to focus on and sketch. Students were given the rest of the class period (about 20 minutes) to complete the activity.

The following class, I brought students out to the brook by our school, set parameters and boundaries, reminded the class of expectations around being outside and respecting each

other's personal space. Each member of the class then chose a spot that would be theirs for the remainder of the school year; their own space to observe and record as the school year and seasons progressed. Over the year, students became comfortable with the routines and when weather permitted they would come to class, collect their journals and a pencil, and be ready to head to their space. Students would often ask to do this, and kept me aware of how long it had been since we last went to our spaces outside. Nature journaling, or "sense of place," as I referred to it in my lessons, became embedded into my life science curriculum, and organically grew into its own entity and supported mindfulness activities that the students often advocated for them together.

During our cell unit, Rachel came into our classroom again. Students had just been introduced to the microscope and how to operate one. This lesson also served as a hook into future investigations for our cell unit. Students understood the term "cell" but we had yet to investigate organelles or any cellular processes. Rachel prepared a Google slideshow showing scientists who use art to communicate their studies and findings, and also artists who use science as their subject in their artwork. Each student had a microscope to work with and could select from a mixture of prepared slides. Students could choose the slide they wanted to look at, and as Rachel progressed through the different examples of artists and scientists, a new medium for sketching was introduced to them. Students started by using just pencils, and then were introduced to watercolor pencils, and finally to oil pastels and chalk, each medium reflecting the artist or scientist's work that was featured in the slides. Once all three mediums were open for the students to use, they had choice as to which one they wanted to focus on, and which slides to create their artwork from. At the end of the class, students had the option to share and discuss their artwork. Students used this framework to create cell projects later in the unit as well.

The last formal art integrated lesson was self portraits. For this lesson, Rachel introduced still life drawing. Students went on a mini scavenger hunt within the classroom to find something that resonated with their science learning this year and placed it in front of them to draw. Popular choices included plants from our photosynthesis unit, clay neurons from our brain unit, and various DNA models from our genetics unit. After drawing their object, some students chose to share and explain why they chose their object and how it connected back to science. Rachel then acquainted the students with the artist, Giuseppe Arcimboldo, who often used still life to create portraits. Students saw examples of portraits made from flowers, vegetables, books, and even one made from items that a restaurant server would use. Their final project was then assigned - to create a "science self portrait." The goal of their self portrait was to create a self portrait that demonstrated their connection to their learning in science this year. Students had access to all the different mediums they used in the cell unit, as well as mixture of old science magazines they could use to cut items out of to make a collage (for students who were hesitant to draw). Their final art piece was completed on watercolor paper, framed on larger construction paper, and students developed artist statements to accompany their art. Their art was displayed at a local district wide art show at Lareau Farm in Waitsfield, Vermont.

While the formal art integration occurred with Rachel, more informal art integration occurred almost daily in my classroom. Students were sometimes asked to draw science concepts, such as the connection between cells, nucleus, DNA, chromosomes, genes, and traits, or students were asked to draw visual models to explain their initial thinking when we looked at anchoring events. Art was also used during summative assessments, where students were asked to draw the processes of respiration and photosynthesis in a hypothetical closed system with two plants and an animal of their choice. Other examples of art integration occurred during our new vocabulary lessons, where students were asked to draw an example of the new term and not just write the definition.

**Data Collection and Analysis**

I chose qualitative data collection for this action research project to assess engagement and learning. Glesne (2016) discusses qualitative inquiry as a way to "interpret, and share others' perspectives, as well as your own, on some aspect of the social condition, contributing to the multiplicity of voices and visions, and to the plurality of knowing" (p. 26). Through this study my goal was to share my students' stories of art integration, both successes and challenges.

I originally wanted to organize interviews with my focus group members individually and have

a group meeting at the end to discuss the art integration. Our school schedule was not conducive to interviews (no consistent study halls for all students), and I did not want to pull students out of other classes for interviews. To compensate for this, I sent the participant Google Surveys throughout the intervention. I was able to have six members of my focus group meet me during one lunch so we could have an informal discussion about the art integration.

Data collection took place over the 2018-2019 school year. All 57 7th and 8th graders took an initial survey and a final survey which included questions about their involvement in the arts, as well as their perceptions about arts-integrated curriculum. The focus group also took two questionnaires throughout the different arts-integrated units (nature journaling and cells), and met together for a final meeting where they discussed their thoughts about the art integrated science curriculum. Other methods of data collection included photographs of the middle schoolers participating in the art integrated activities, observations and notes in a field journal, student work, and exit tickets from the art show where their work was exhibited.

When I started to sort and code my data, it was important for me to reveal my middle schoolers' journeys of art integration. I wanted to construct a story from the themes that developed from my data. To do this, I used a thematic analysis of the data by writing to understand what I was finding. Glesne (2016) poses that "as a writer, you engage in a sustained act of construction, which includes selecting a particular 'story' to tell from the data you have analyzed, and creating the literary form that you believe best conveys your account" (pp. 218-219). As I slowly and purposefully integrated art into the science curriculum with the help of the local teaching artist from AIS, my goal was to track and understand how integrating art into my science curriculum would affect engagement and learning in my science classroom.

The first step was to organize the surveys by order of which they were taken. I typed up consolidated answers for each survey, recording the answers that were repeated or common words that were found in the responses. I kept a large margin on the side so I could start to discover themes within the data. I also kept track of which responses were from the larger group and which were from my smaller focus group. As I reread through the summarized surveys I first noted on each section whether or not the answer was related to art, science, art and science relationship, or art and science integration. I color coded the different categories and started to label each piece of data that connected to each category. I also wrote down repeated or common ideas/words that appeared in that section of data, and whether their responses were negative or positive.

After, I went through the surveys again and examined the different categories I created, and added in my data from my other sources - my field notebook, photographs of students at work, finished artwork, as well as exit tickets from the Science Art Show at Lareau Farm in Waitsfield, Vermont. I came across a few more themes that seemed to organically compose themselves - engagement, creativity, and communication of ideas.

I decided to construct overarching themes where the findings could reside and offer more depth within the themes. The codes collapsed into three themes: The Art and Science Relationship, Benefits of Art Integration, and The Self Conscious Artist. I originally had four themes with "The Purpose of Art and Science" as the fourth, but as the unit progressed, the results started to fall under the relationship category, so I combined both into "The Art and Science Relationship" theme.

**Limitations**

One of the limitations of my analysis can be found within my focus group. Working with 7th and 8th grade students as participants requires permission from their parents or guardians, particularly because I wanted to interview them. My initial hopes were to have a diverse group of students with respect to artistic abilities, academic abilities, as well as a mixed ratio of students who enjoy art and who do not. However, I did not receive back all the permission slips, and from those I did, I asked if they wanted to participate in interviews and be my focus group. Eleven students from my team agreed to be my focus group.

All of the 11 students identified as enjoying art, and all of them enjoyed art-integration in science. The results from my focus group may be bias because of this correlation. This group is not a valid representation of the school as a whole, or my 7th and 8th grade team. To compensate for this, I surveyed my entire team of students

again at the end of the final art-integrated unit. Additionally, I collected exit tickets at the art show to gather data from the larger community.

Furthermore, because of the compactness of our schedule and no study halls built into the day, finding time to interview the students was difficult, and I did not want to pull them from another class. Instead I created a series of surveys of the questions I would have asked them in the interviews. Unfortunately, surveys do not allow as much depth as an interview can.

Another limitation would be to investigate if the art-integration affected their summative assessment scores. I did not have scores to compare to a group of science students studying the same topics without art integration. This research was action research based, and I integrated into all of my science classes as best practice, based on the literature surrounding the benefits of art integration.

My action research was not done on a larger scale, and I would be curious to see if the art integration I participated in my room had any kind of impact in my students' learning in other classes. During their final art project time, students were taking SBACs in both language arts and math. I set aside the entire week for my science students to come in and create art, especially since so many of them commented that it calmed them down. I also wonder about content retention and art integration - will the students recall units that were distinctly art integrated more than others? I hope these limitations will open the door for more research.

## Findings

### The Art and Science Relationship

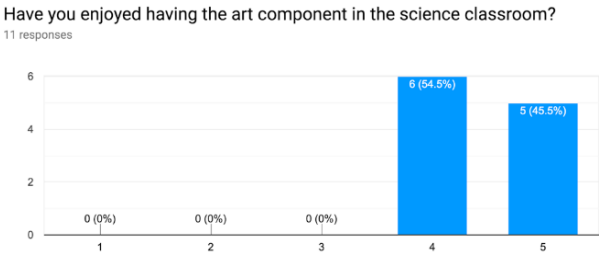
My first theme "The Art and Science Relationship," developed after reading students' answers from the first survey sequentially to the third final survey (both the focus group surveys and whole team surveys). At the start of the school year, the purpose of each respective discipline from the students' perspective was binary; art is art and science is science. Most middle schoolers fell into this binary idea, with the exception of a few who could see, or start to imagine the connection between the two disciplines. Most students thought that the purpose of art was to create or express, and the purpose of science was to understand and seek meaning.

As the art integrated units progressed, these thoughts changed, as the members of the focus group said they could recognize the relationship between them, specifically that they could be creative in both art and science and both are a way to communicate ideas. Within this theme, I found that students started to recognize art being utilized outside the specific art-integrated science lessons, but within our day to day lessons and activities. When students were asked in a Google survey, "How do you think art is being used in the science classroom?" students responded with models, sketching in science notebooks, and entrance tickets. One student shared that "art is being used in a multitude of ways - we're sketching in our science notebooks, making drawings for the word wall, and more!" (7th grade focus group student). Another student reinforced the idea that "I think that art is used in describing thinking in science. Mostly in models. Art skills can help convey ideas through models" (8th grade focus group student).

Additionally, all of the focus group members wanted more art integrated activities. It is important to note, however, that the focus group all indicated that they all enjoy art. On a scale of 1 to 5, 5 indicating they "love it and can't wait to do more," they all selected 4's and 5's, as seen in Table 1 below. Their reasoning behind their choice was because they enjoyed the chance to be creative and it allowed them another way to learn.

Table 1.

*Focus Group Final Survey*




With respect to the initial binary thoughts on art and science as two distinct disciplines, I wanted students to develop their own connection to both, and hoped that my art integrated units would start fitting the two content areas together like puzzle pieces. My hope was that the specific

and deliberate science-art lessons would start to establish the outside edge pieces of the puzzle, and their individual connections would fill in the remaining puzzle pieces. When both the 7th and 8th grade classes were asked at the end of the school year how their view on art-integrated science has evolved from the beginning of the school year, most students could identify their change in thinking. A 7th grader who participated in the study shared that, "At first I didn't understand why we were doing art in science but then I was like woah! This makes sense now." Another 7th grader stated that, "At first I wasn't sure how art and science could be mixed but now I am glad I could see how it does." Also, an 8th grader was brutally honest with me when he told me that, "I used to think it was stupid and a waste of time but after doing it more I found out it was helpful and I enjoyed it."

The art and science relationship was further identified by guests who came to the Science Art Show. A teacher who visited the show stated that their views are "broadened and more connected," after seeing the students' work. A parent also mentioned that she "never imagined the 'blending' of art and science, but it makes sense." A community member emphasized that "art and science often compliment each other more than we think." Similar to art, science is a way in which we interpret the world. Establishing the art and science connection gives context art-integrated science.

It seems organic to me to integrate art into the curriculum, as it promotes creativity and discovery. Integrating science and art "allows students to attempt artistic science projects that enhance their imagination, higher-order thinking skills, creativity and knowledge on both arts and science" (Dhanapal et al., 2014, para. 13). Through both science and art, one can explore, create, and imagine. "Art and science are intrinsically linked [as] the essence of art and science is discovery" (Alberts, 2010, as cited by Dhanapal et al., para 3).

Visualization is integral to scientific thinking. "Scientists do not just use words; they rely on diagrams, graphs, videos, photographs, and other images to make discoveries, explain findings, and excite public interest. Scientists imagine new relationships, test ideas, and elaborate knowledge through visual representations" (Graham & Brouillette, 2016, p. 6). Similar to Graham and Brouillette, Alberts (2010, as cited by Dhanapal et al.) concludes that "visual arts and science are linked fundamentally as they both promote discovery learning" (para 11).

**Benefits of Art Integration**

My initial question I sought to answer was, "How does arts-integration affect student engagement and understanding in the science classroom?" I knew what the research indicated, but could I replicate these benefits in my own classroom? For me, science is about discovery, curiosity, and an innate quest to seek more and understand more about the world around us. Could arts-integration encourage these essential characteristics that could nourish a love for science?

The Benefits of Art Integration theme developed as I identified the positive responses I received from my students in their surveys, but also through looking at what I discovered and linked to what I observed as engagement in the classroom. I was seeing students working, asking for more art-integration, collaborating, and some of my struggling students thriving during the science-art lessons and activities. I observed engagement, but how could I identify what engagement looks like - it can be as subjective as someone's personal taste in music. For me, engagement was identified when students collaborate and talk, focus on their activity, and authentically desire more - more learning activities and more opportunities to express their learning.

During one activity, I observed 100% engagement from one of my classes that has been difficult for me because of behavior and regularly off task conversations, which led to many pauses in our time together because I would need to redirect and refocus the group. The class at the time was participating in a microscope and cell art activity. Different types of media were introduced to them, and they had choices as to what media to use (pencil, watercolor pencils, oil pastels, or chalk pastels) as well as a choice on which slide to observe under the microscope. With each introduction to new media, they were introduced to a new artist or scientist, such as Ernest Haeckel, David Goodsell, or Shoshana Dubiner, who either studied science or used science for artistic inspiration. Students were encouraged to play around with the different media and to have fun visually representing what they were viewing

under the microscope, using the artists' and scientists' work to spark ideas.

For nearly the first time this school year, I was able to step back and watch them all work, individually, but also collaborating with each other - sharing their artwork, or calling each other over to their microscope to share what they were seeing. Several students even called me over to try to take a photo through their microscope so they could have it documented as to which prepared slide they were recreating artistically. They were proud of their work and genuinely enjoyed the activity (see Image 1 below). This activity was in contrast to a "normal" microscope lesson where we would all be looking at the same organism and all drawing with pencil in pre-printed worksheet with circles to represent the parameters of what we see under the microscope. The freedom to experiment with different artistic techniques and media engaged the students, lending itself to collaboration and drive.

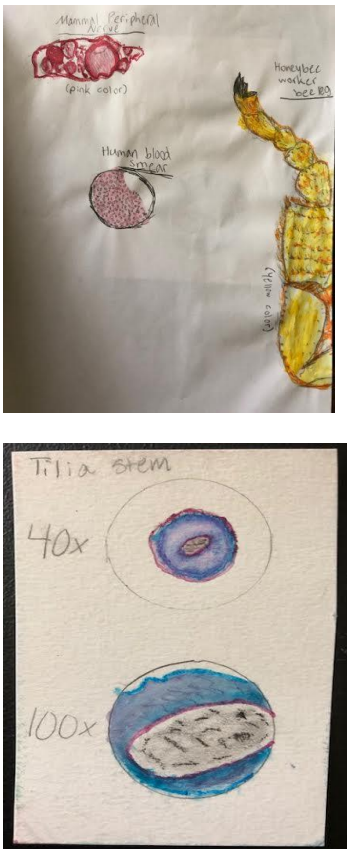



*Image 1*. Student examples from Microscope/ Art Lesson

The arts are used to create meaning, and the arts can be used to provide a pathway for students to "construct meaning for themselves by creating representations" (Catterall, as cited in Gullatt, 2008, p. 20). This also supports the dynamic of how student choice can allow students to represent their learning and establish their own connections to that learning. By fostering young adolescent creativity through arts-integrated activities and student choice, students were able to access the content through different platforms. Middle schoolers appreciated the "opportunity to be creative" (7th grade student) and share their learning by "drawing my thinking" (8th grade student). The Association for Middle Level Education (AMLE), 2010b, as cited in Kahn, 2017, p. 11) also recognizes that "arts-infused learning is integrative and exploratory, and assists the students to better relate the curriculum to their own experiences while reinforcing middle level constructs including creativity, problem-solving, communication, collaboration, and construction of knowledge."

One example of a way students were asked to draw their thinking was with an entrance ticket during our Genetics Unit. I asked students to draw the connection between the words: nucleus, cell, chromosome, gene, and DNA. Out of 50 entrance tickets, 40 students were able to correctly make a visual model of the relationship between the words. One example from this entrance ticket is seen below in Image 2. This particular student was not part of the focus group, and is currently on an IEP. Generally, this student struggles to stay on task and to complete work. Writing is also difficult for this student and often gets modified assessments to show his learning. However, during the art integration, this student thrived, often coming in between classes to work on his art-related projects (cell choice project and his final self portrait project). The arts can be a powerful tool for differentiation within the classroom as well. "The arts not only contribute richly to the development of human intelligence, but they offer the means to reach the great diversity of human beings in every school today" (Dickinson, 2002, p. 7). Arts are a means to reach diverse populations of students.

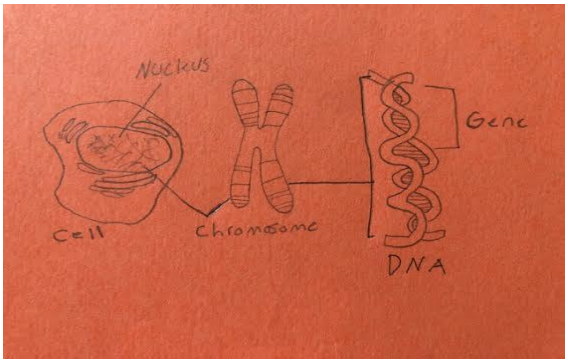
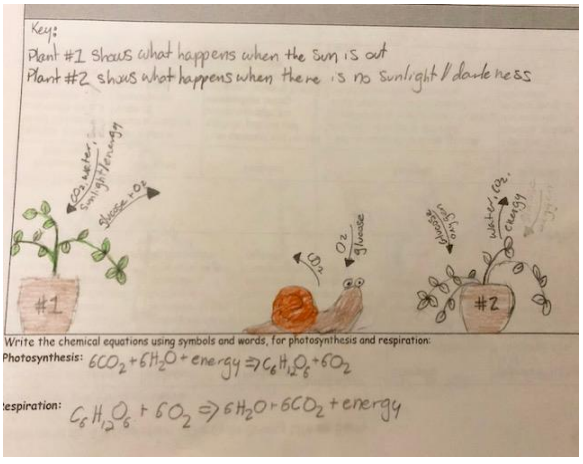
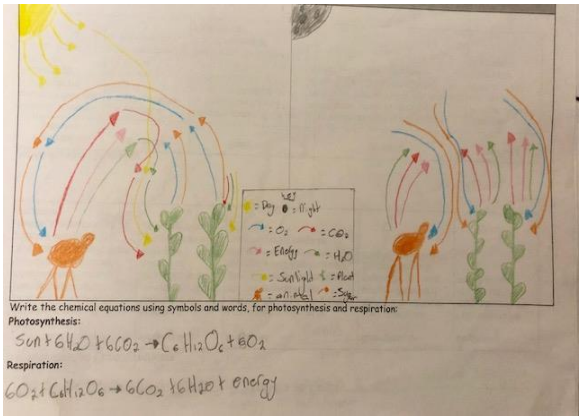



*Image 2*. Entrance ticket example. (7th grade student)

Another opportunity students had to draw their thinking was during a photosynthesis and respiration assessment. The unit started by having middle schoolers draw the plants I had placed on their tables and to sketch an animal or person next to the plant and to draw the connections or pathways between the two organisms. After a series of investigations around photosynthesis and respiration, students were asked for their assessment to draw a scenario in an empty, sealed tank. Inside this tank, they were asked to draw two small plants and one small animal that they might find living there. The students had to use arrows to show all the possible pathways carbon dioxide, oxygen, and glucose, could take inside the tank (see Image 3 for student examples). One member of the focus group commented directly on this activity and how it helped him learn.



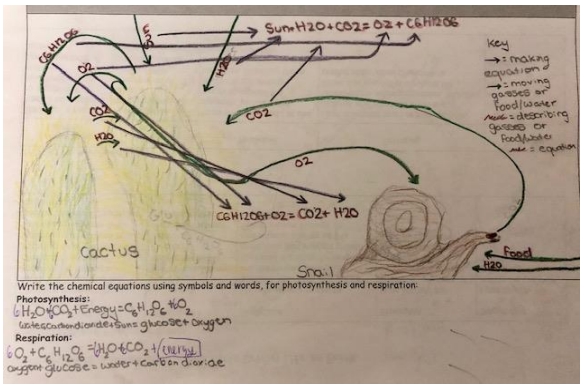




*Image 3*. Photosynthesis and respiration summative assessment examples.

"I think you just remember it. Like when we did the drawing about all the different ways oxygen and $CO_2$ goes. I think I remembered it better when we were doing the art and drawing it out, than just reading about it. I could visualize it" (focus group member, 2019).

When the focus students were asked, "What are your thoughts on the use of art in content based classrooms?" an 8th grade student commented, "I really like it because it makes class more fun and relaxing and allows students to express themselves besides written words. This allows for students to get a deeper meaning out of the class and the content that they are learning." This deeper connection was also expressed by another 8th grader who highlighted a specific lesson we participated in with cells: "I think that the cell drawing activity (with the microscopes) impacted my learning. It encouraged me to dig deeper into the appearance of the cells." Eisner noted that "in the constructivist classroom, the arts take on the role of both discovery and expression (as cited in Gullatt, 2008, p. 21). He stressed that "the arts as tools for discovery

should not be underestimated. Through the arts, students are able to journey through the aesthetic world to discover new information. This form of learning allows students the opportunity to expand their imagination and creativity while gaining new information" (Gullatt, 2008, p. 21).

Enabling student choice coupled with the creativity of the arts made positive impacts on student learning. An 8th grade student made a direct correlation between the two when she commented that "something that is different about art integration is that it was really personalized and open-ended. It could be catered to your own needs which was a bit different than art class, or any other class."

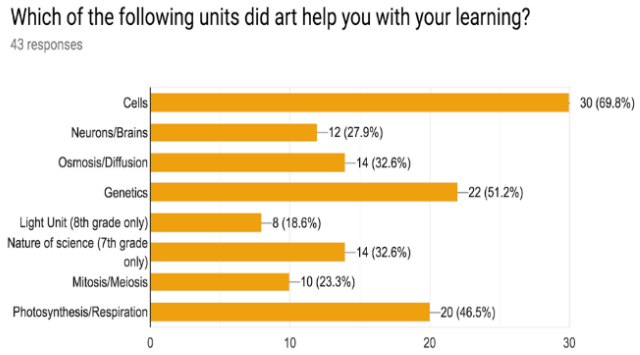
I witnessed and documented the benefits of art integration in my middle level science classroom and it was additionally observed through visitors at the Science Art Show. An art teacher in my district who came to the show disclosed that she has "always thought/known of the connections between these two disciplines - theory-practice - method. The art here embraces/illustrates the students' knowledge/learning." Another teacher who visited also disclosed that she "can see that the art enhanced the learning and didn't just check off a box 'I did art.'"

Students were making connections to science through their art and were also able to identify specific examples where the art helped their learning. Out of the 43 responses I received from the students, 32 students recognized art activities (drawing, nature journaling, modeling) as activities that positively impacted their learning in science.

The science units and connections that most students incorporated into their art work directly correlates with the units they identified as helping their learning as seen in Table 2. Most students identified the cell, genetics, and the photosynthesis and respiration units, where art helped with their learning. When an analysis (see Chart 1. Self Portrait Analysis) of their self portraits was done to identify which science units the students incorporated into their final art project, those same three units (cells, genetics, and photosynthesis and respiration) were among the top four units represented (nature journaling was a common theme as well).

Table 2.

*Science Units Where Art Helped Learning*



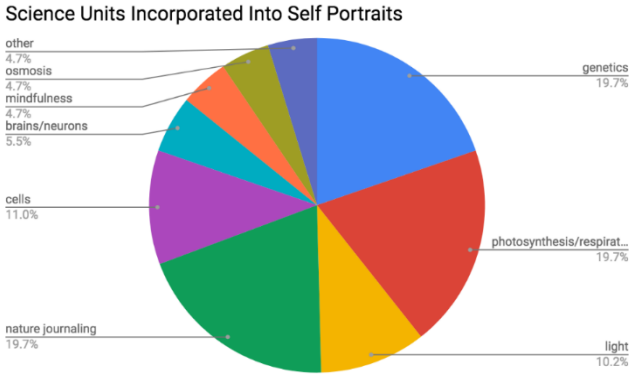




*Chart 1.* Self Portrait Analysis

Below are a few examples of student's self portraits from the art show. See Image 4 "Science Person," which was drawn by an 8th grader. In this self portrait, the student chose to represent many different units we covered in science this year. In this student's artist statement that accompanied the portrait, he explains why he chose the different images to compose his drawing (seen below next to Image 4).

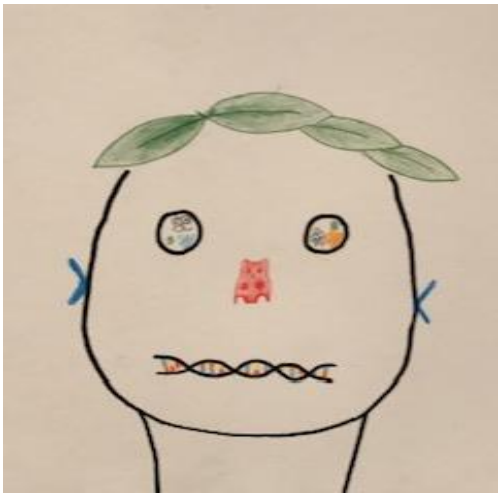


*Image 4.* "Science Person"

"This is a selfie that includes units we've studied for the past few months. Leaves represent the unit we did about light and if leaves change color because of it. The gummy bear represents the osmosis unit and the cell eyes are the cell unit and the cell eyes are cell unit we did. Last, the DNA mouth and chromosome ears is from our genetics unit" (Artist statement, 8th grade student).

Even within the eyes of this portrait, there are little details that demonstrate his understanding and the learning which stuck with him. For example, he drew organelles within the cell eyes and even matched up the bases in the DNA strand so that only certain colors are paired with other colors represent the base pairing in DNA strands. Additionally, he tied in an example from a specific lab we did during the osmosis unit with the gummy bear.

Another example, (see Image 5) "Seasons Self Portrait," was completed by a 7th grader. This portrait depicts her connection to science through nature, and specifically the nature journaling we practiced throughout the year. She also connected the flowers to a specific unit, explaining that she "drew flowers because that relates to the photosynthesis and respiration we did" (7th grade student).

In Image 6, "Science Dreamer," an 8th grader depicts the learning that took place for her over the course of the entire school year. It is clear in her picture the different units we did, such as a light unit, genetics unit, cells, and even the photosynthesis and respiration unit. Even the lessons within those units and activities are represented in her self portrait, such as the green light and red apple phenomenon that anchored our Light Unit and guided our class' investigations. Her artist statement supports my interpretation of her self portrait as well, as it says:

> I didn't want to focus as much on myself and my self-portrait as much as I wanted to show what I learned. In the drawing you can see all the units that we have covered in science this year. The drawing shows me reflecting and thinking back on (almost) everything I've learned in science. I drew myself sitting under a tree as a reference to the nature journaling that we did outside by the river. (Artist statement, 8th grade student)

*Image 5.* "Seasons Self Portrait"

*Image 6.* "Science Dreamer"

The benefits of art integration are fluent through a wide selection of studies. Nichols and Stephens (2013) discuss the history of Learning Through the Arts (LTTA), which began in 1999. LTTA experimental schools showed increase student engagement (Nichols & Stephens, 2013). When students are engaged, they are more likely to be excited about learning, take ownership of their learning, and more likely to retain information (Nichols & Stephens, 2013). Nichols and Stephens (2013) emphasize that "arts and sciences can be taught together by using their similar processes which might improve student engagement" (p. 1).

Gullatt (2008) embraces a brain-based science approach as an argument to why arts should be infused in the school's curricula. He states that "recent developments in cognitive science and neuroscience help explain the power of the arts as enhancing teaching and learning in numerous ways" (p. 14). Connecting with Gullatt's brain-based approach, Dickinson (2002) highlights that "the human brain has a visual cortex that is five times larger than the auditory cortex. Is it any wonder that words alone do not reach all students? A picture is indeed worth a thousand words" (p. 9).

**The Self Conscious Artist**

There were many benefits to integrating art; however, there were some challenges associated with the art-integrated activities. One finding I discovered through my coding process was the negative mindsets around whether the students thought they were artists or not. These negative mindsets directly related to whether or not they enjoyed the art activities and revealed frustrations around producing art work. Even the students who believed the purpose of art was to create and express, found participating in the art-related activities frustrating because they could not express their ideas because of their skill level (7th grader). In pre-adolescents (11-12), students' competence in art relates to their fear of failure (Pavlou, 2006). In addition to a fear of failure, "the level of engagement and effort was linked with perceptions of competence" (Pavlou, 2006, p. 197).

In the initial science and art survey administered to all my students on the team, their interest in art and confidence in art directly related to how they rated themselves on a scale of 1 to 5 (1 being "not at all" and 5 being "very much so!). When the students who rated themselves lower on the scale were asked in the final survey if they enjoyed the art-integrated units, they admitted they were fun but that "it is hard when you are not good at art" (7th grader). Those students who rated themselves lower on the scale also had reservations about displaying their work, and asked to remain anonymous at the art show. Pavlou (2006) highlights that "having negative attitudes towards art is highly likely to limit their learning in art. It is common to observe 'indifferent' pupils during art lessons who avoid making art because of fear of failure," (p. 195).

Even though I stressed that I was not judging their artistic abilities, but the process and what they are trying to communicate through art is what is important, the self conscious artists did not want to share their work and became more isolated and secretive of their work because they felt it was not up to par of what they thought their classmates were creating. While explaining the final art project - a science self portrait - my self conscious artists often mumbled, "I'm not good at art" or bluntly, "I suck at art." Aware that middle school students are already self conscious beings whose identity often lies within how they think they are perceived by their peers, Rachel (teaching artist) and I structured the self portrait with more options for those who are resistant to drawing, such as collages and whimsical examples of portraits - as I was examining their connections to the science learning and not their art skills.

My hesitant artists did not know where to start with the self portrait but going around and talking to them I could see they were thinking of connections and about what we did in science. However, taking that next step for some was difficult, the process of execution onto paper was frightening to them. Adolescents are naturally self conscious and are worried about what others think of them. There is so much value in collaboration and sharing ideas, but for my self conscious artists their negative mindsets about the value of their own work prevented the collaboration.

According to Hobbs and Rush (1997), "the period of pre-adolescence (11–12 year olds) is of special interest because at this age pupils start to doubt their abilities in art; they become less confident in their art making and need special support from their teachers to continue to be involved with art and art making" (as cited in Pavlou, 2006). To accommodate and boost confidence with art projects, I provided extra

support by offering different scaffolded assignments. For our cell unit, the art-based projects choices included drawing, cooking, song writing and poetry as options. For our self portrait project, students were allowed to use photos and magazines to collage a self-portrait, or to show their connection to science through a different lens other than a portrait. For this option, some students drew landscapes to show their connection to mindfulness and nature journaling. One 8th grade student decided to draw mountains with an artist statement that read "science isn't just lab work. It's also about seeing the world from a different point of view."

To carry this into next year, I will start with a drawing activity, and not have students put their names on it. Students will do a gallery walk and celebrate ourselves as artists using art as a way of communicating and learning. I hope that introducing students to being open about art as a way of making meaning in our science classroom will lessen the stress about being "good at art."

## Conclusion

Data analysis and regular reflections as this action research project unfolded have led me infer that art integration is one of many ways to effectively engage students in learning in the science classroom. I think back to my successes - a quiet, anxious young adolescent, who normally has her head down, was the first to volunteer and share her artwork during a still life lesson. For her, art integration in science gave her the freedom to be creative and find her own interpretation; a new way for her to access science. I also think back to my challenges - students who did not want to put their names on their art because of fear of who might see it. Or students who struggled with the execution of creating on paper what they envisioned in their minds.

I was able to purposefully integrate art during three occasions with the help of a teaching artist, and folded it into the daily lessons between her visits. I understood that when the teaching artist was visiting, I would be donating my class time to students to practice the artistic skills needed for each lesson. During this time, my direct science instruction would be paused until students were versed in the artistic skills needed for the science activities. When it feels like time is an invaluable resource during the school year, setting some aside for the art lessons felt challenging, but proved to be advantageous in the long term. Once students felt comfortable using the different media, they would advocate for themselves to use it as a tool in projects in and out of my classroom. I believe art integration is one of many ingredients that can contribute to an engaging classroom. Yet, a resonating factor that still needs to be considered when integrating art: What supports are there for students who struggle with art and do not consider themselves competent in artistic skills?

We do not live in a compartmentalized world, and the way we teach and learn should mirror that. Science is so much more than lab coats and awe-inspiring explosions. Science is about exploration and wonder, interpretation and creativity. My goal was to challenge the stereotype of what science is and instill the perspective that science can be a creative endeavor. Science needs creative thinkers to help move our understandings forward.

Integrating art into the curriculum can help students develop the 21st century skills they need to be successful, such as creativity. Furthermore, "researchers have argued that experimental learning in the form of arts-infused experiences at the middle level fosters resiliency, enhances reasoning and engagement, and provides students with culturally relevant, real-world connections," (Bernard, 2004; Diket, 2003; Gay, 2000, as cited in Kahn, 2017, p. 11).Young adolescents are at an age of expanding cognitive abilities and interests and "require opportunities for exploration throughout their educational program" (Manning & Butcher, as cited in Caskey & Anfara, 2014). The exploratory and experiential nature of art helps to nurture creative expression in adolescents.

It is important to consider education as a continuum that is an integration of all subjects woven together. "Living and functioning in the world is a complex activity, students should be encouraged to participate in the process from multiple perspectives" (Martin, as cited in Gullatt, 2008, p. 21). The arts can support students by offering diverse ways to interact with the world around them and naturally present different ways of problem solving (Gullatt, 2008). Through creativity, students cultivate ideas while strengthening their cognitive skills, and are able to interpret and understand the world in a different way (Dhanapal, 2014).

It is the creative thinkers of the world that move us forward. As Albert Einstein once famously said, “Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution.” Creative thinkers do not look at what we already know, but look at what we do not know and try to look at it creatively with an open mind to try to figure it out - to problem solve. Integrating art into science may help to build that foundation by engaging students and helping them visualize and understand the content in new ways, and help them develop creative thinking skills.

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