COLLABORATIVE DIVERGENCE: ANALYZING THE INTEGRATION OF STEM AND VISUAL ARTS CURRICULA THROUGH DIVERGENT THINKING

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ABSTRACT

Students who have the ability to engage with others and approach ambiguity with confidence and originality have the potential to create lasting and positive change. This study explores how the peer social culture fostered in a visual arts classroom coupled with a problem-solving based science, technology, engineering, art, math (STEAM) lesson plan catalyzes collaborative divergence in the form of divergent thinking skills and creative thinking traits. Collaborative divergence refers to the small groups of peers that interact in creative problem solving as a team. Ideas were shared from each student, and as a group they synthesized their ideas and engaged in art making practices that moved away from the common starting point of the project and applied fluency, flexibility, originality, and elaboration. Observations from a three part lesson plan working with twenty fourth grade students in a public school visual arts classroom aimed to answer the research question: *How may the integration of the visual arts and STEM curricula enhance elements of creativity that lead to divergent thinking?*
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Chapter 1

Introduction

In every student there is an incredible amount of potential. Students bring life experiences, interests, and diverse talents into the classroom where they then have the potential to interact with material and produce thought provoking ideas and objects. In the visual arts classroom, students are often given freedom to explore different avenues of creativity and process while learning about and working with various materials and techniques. When pairing the diversity of different humans with an art classroom full of potential and opportunity, there are limitless paths that a student can take to create something impactful. This potential for originality and creativity is powerful. This research study explores the power of originality and creativity through the concept of divergent thinking. While convergent thinking requires one correct answer, divergent thinking entails producing multiple ideas, connections, and possible solutions to one problem or topic (Chermahini & Hommel, 2012; Guilford, 1967, Nusbaum & Silvia, 2011). Building divergent thinking skills can be essential for developing creativity in students (Guilford, 1967). To explore the production and fostering of divergent thinking within the visual arts classroom, I created a lesson plan that intertwined problem solving with creative freedom and opportunity, and I implemented this lesson in a classroom of twenty fourth grade students.

In this study, a majority of students engaging in divergent thinking were working in naturally formed groups. A large part of the learning environment was driven by peer socialization and communication, which I will hereto forward refer to as social practice.

The goal of this research is to identify How may the integration of the visual arts and STEM education enhance elements of creativity that lead to divergent thinking? This research
explores how the social culture fostered in a visual arts classroom coupled with a problem-solving based science, technology, engineering, art, math (STEAM) lesson plan catalyzes collaborative divergence in the form of divergent thinking skills and creative thinking traits. Collaborative divergence refers to the small groups of peers that interact in creative problem solving as a team. Ideas are shared from each student, and as a group they synthesize their ideas and engage in art making practices that move away from the common starting point of a problem or theme, whilst applying fluency, flexibility, originality, and elaboration.
Chapter 2

Literature Review

The place of the visual arts in education is often questioned. Art educators frequently find themselves fighting for the value of the art classroom and the skills that students discover as they explore materials and making. On the other hand, science, technology, engineering, and math (STEM) education are disciplines that are consistently sought after and given value. This value is due to the fact that STEM frequently aligns with industry and the job market. In recent years, educators from both the arts and STEM areas have begun to investigate STEAM education (Daugherty, 2013; Liao, 2016; Sochacka, Guyotte & Walther, 2016); adding the arts to STEM in the hopes of building creativity and innovation.

There are varying views upon STEAM education and the values that it holds, and a thorough review of literature led to four consistent themes within the STEAM discourse. These four themes are: STEAM as a method of national progress, STEAM devaluing the disciplines involved, STEAM as a tool to enhance creativity and innovation, and STEAM as a breakthrough in pedagogy.

STEAM as a Method of National Progress

Education drives discovery and knowledge, and knowledge drives the success of nations. The United States has always prided itself on being at the forefront of innovation and breakthroughs in education. However, research has proven that as a country the United States has
slipped in the rankings, thus highlighting a decline from the high that we hold for ourselves. Professor of STEM Education, Michael Daugherty (2013) states, “Where the US has historically ranked first in innovation it now ranks between third and eighth…” (p. 10). In the hopes of rising in rankings for innovation, politicians and educators alike have searched for the missing components that will drive further research and discovery. Daugherty (2013) argues, “many educators would argue that STEM is missing a key set of creativity related components that are equally critical to fostering a competitive and innovating workforce, and those skills are summarized under the letter A for the Arts” (p. 10). There has been a long tradition of artists turned inventors, and Daugherty gives a few examples of art driving scientific and technological innovation; electronic display screens resulting from a collaboration of painters, scientists, and post impressionist artists like Seurat; the first programmable device invented by J.M. Jacquard to control the looms that made his tapestries was later the same technique used to program the first computers; and computer chips made using a combination of etching, silk screen printing, and photolithography.

Some communities have begun to hold more value for the arts and the tools it provides. For example, a survey of 244 corporate executives and school superintendents led to 63% of employers indicating that they prefer the creative employee to the employee with technical skills related to the job. (Lichtenberg, Woock & Wright, 2008). These employers feel that an art training is crucial to developing creativity, as links between creativity and innovative success have become more apparent. In a study analyzing the connections between Nobel Laureates in the sciences and engagements in the arts as adults, Bernstein, Bernstein, and Garnier (1995) found that many laureates connected art with their scientific creativity, and argued that “One of the most important implications of [their] findings is the possibility that science education needs
serious revision…[the] study clearly demonstrates that words and numbers are not the main modes of thinking used by highly successful scientists…the best scientists have always argued that words and numbers are secondary in creative thought” (p. 133). Art educators are also in agreement with the notion that STEAM can positively affect the future growth of our country’s economy. Art educator Christine Liao (2016) found that “[the] link between creativity and productivity supports the connection between creativity and innovation-based economics, and creativity -although explicitly not art based creativity- gradually became associated with innovation”(p. 44). While innovation is not the sole benefit of a visual arts education, it holds value across disciplines.

One other argument for integrating the arts into STEM in order to further our nation’s economy is that “the USA has seen relatively small increases in young men and women choosing STEM fields in higher education and the work force” (Herro, Quigley, Andrews & Delacruz, 2017). In order to draw more learners into STEM disciplines, STEAM curricula has been emphasized in k-12 classrooms “as an engaging and more realistic learning experience than STEM because the arts and humanities purportedly allow for better integration of the disciplines while encouraging creativity and problem solving” (Herro et al., 2017). This is a viewpoint being taken by educators across disciplines, but some are concerned that reasoning for STEAM is devaluing the benefits of a stand alone art curriculum (Sochaka, Guyotte & Walther, 2016).

STEAM Devaluing the Disciplines Involved

The integrative approach of STEAM can hold immense value for students, but also can raise discomfort among educators across different disciplines. In a Journal of Engineering
Education article, educators Nicola Sochaka, Kelly Guyotte, and Joachim Walther (2016) claimed to be

…both unsettled by the competitive and utilitarian undertones that seemed to characterize arguments in favor of STEAM-inspired learning…[as well as] unsatisfied by what [is] considered to be a narrow and simplistic view of the arts as a panacea for increasing the creative abilities of STEM students [and the] assumption that engineering and other STEM fields are somehow inherently lacking in creative ways of thinking. (p. 32)

Throughout the literature collected to review STEAM education various authors cautioned about solely justifying the arts as a piece of STEAM education. Michael Daugherty, in the *Journal of STEM Education* (2013), noted that there has been a divide among different disciplines for a while in education, and that the divide was

exacerbated by the federal No Child Left Behind legislation that was passed in 2001 to improve school performance by setting standards of accountability. With mandatory standardized tests in mathematics, reading, and language arts administered each year, the focus of PK-12 schools shifted to improving test scores in these areas. (p. 11)

Furthermore, with this concentration on different areas, art advocates have felt pressure to argue the importance of the arts by linking its benefits to students’ performance in more traditional academic subjects, like reading or math (Daugherty, 2013). This method of arguing for the value of art by tying it to different subjects is successful in driving STEAM education but can also be detrimental to art curriculums to stand-alone. Some art educators are hesitant with this new approach to the validation of art education, “Creativity within education has become synonymous with what educational policy determines as prudent to economic productivity…under such rationalist logics, art education is reduced to promoting economic over
cultural and individual wellbeing…” (Harris & de Bruin, 2017, p. 56). Art advocates hold concern that the value of the arts has shifted to become solely economic.

**STEAM as a Tool to Enhance Creativity and Innovation**

The idea that integrating the arts could enhance creativity and innovation has drawn the attention of researchers for decades. Educators across disciplines have measured beneficial traits of STEAM education since the mid 20th century. In 1976, a study from the Pennsylvania Governor’s School for the Arts looked at their relevance to science education by investigating relationships between variables common to arts and sciences as a means for hypothesizing alternative approaches for growth in scientific attitudes and skills (Lutz, 1976). Researchers selected 255 artistically talented students and administered 4 separate tests. After spending 5 weeks in the program, students’ performance was evaluated looking at 9 sciences related variables and 18 art related variables. The study found that some art education activities negatively influenced personality factors important to the sciences such as control and self-assuredness. However, there were positive correlations between scientific creativity and artistic talent. Science educator John Lutz (1976) claimed “If art education activities can influence the development of certain affective and psychomotor skills required for better sciencing, then science instructional processes could become more efficient through transdisciplinary integration of science and art” (p. 14).

Research in STEAM has progressed to identify specific traits sharpened by art education that can work to the benefit of STEM curriculum. For example, Daugherty (2013) identified eight dispositions influenced by the arts that can be used in many academic arenas and in daily
life. These dispositions include: developing craft, engage and persist, envision, express, observe, reflect, explore, and understanding the art world. Daugherty argues that these dispositions would enable students to embrace problems of relevance, picture mentally what can not be observed, attend to visual contexts more closely than ordinary looking, question and explain, and reach beyond capacities and explore without a preconceived plan (amongst other things). Art educators Kantrowitz, Fava, and Brew (2017) further back this claim by analyzing studies done on the benefits of understanding visual and spatial cognition contributing to STEM disciplines. They conducted several drawing workshops, in which they discovered,

Participants gain insight into usually hidden cognitive and perceptual processes, through hands on experience. They draw for many purposes: to understand, inquire, explain, translate, be mindful, problem-solve, and reach a consensus. They use extended, embodied, and situated cognition to tackle real world concerns and questions, regardless of experience level. Aesthetic self expression alone is rarely the goal…when attention is directed toward process and purpose, rather than product, drawing provides an open space for making, collaborating, developing, and learning. (p. 54)

Through their drawing workshops, Kantrowtiz, Fava, and Brew determined valuable skills that heightened through communal making such as flexible purposing, improvisation, and transformation of experience into language.

The discourse surrounding STEAM and art education investigates creative practices, and the benefits that they can provide (Harris & de Bruin, 2017; Litchenberg et al., 2008; Root et al., 1995). Numerous studies and articles produce analyses of these traits and the ways they could interact with integrative disciplines (Fountain, 2014; Liao, 2016; Lutz, 1976; Sochacka, Guyotte & Walther, 2016). This reaches across the world as well. Australian art educators Harris and de
Bruin produced an article investigating fostering creativity in and beyond secondary schools. Harris and de Bruin (2017) write, “Various governments have investigated the importance and diversity of creativity in curriculum and pedagogy at the compulsory schooling level throughout Europe” (p. 55). However, the article goes on to point out the missed opportunity STEM curriculum has overlooked in relation to a creativity agenda.

**STEAM as a Breakthrough in Educational Pedagogy**

With all of the conversation surrounding the possibilities of a STEAM curriculum and the benefits it could bring, some literature cautions that there is a missed opportunity for the pedagogical opportunities schools could be engaging with. Harris and de Bruin (2017) support this claim as they write,

> Whilst multi-disciplinary teaching can involve a transfer of methods, an integration of content, and collaborative teacher efforts through the coordination of resources and pedagogies, it also engages learners with pedagogically little or no modification of knowledge of creativity…and further enhances teachers’ efforts to integrate content and method of various disciplines in achieving common goals. (p. 59)

STEAM curricula vary from other comprehensive curricula because a transdisciplinary approach is uncommon in the classroom due to the required expertise across content, difficulty of implementation, and varied interest from students (Herro, Quigley, Andrews & Delacruz, 2017, p. 2). While a STEAM curriculum is difficult to fit into the structured mold of public education, some educators have created spaces to work with STEAM and to analyze the outcomes.
Patton and Knochel (2017) analyze different spaces that have grown the ‘maker movement’ and explored STEAM curriculum.

The maker movement and STEM fields should work in equal partnership with art and design, coalescing around the availability of stuff, the ability to share, and opportunities to make connections…we see incredible opportunities to invigorate and expand STEAM curricula by embedding critical thinking in experiential learning… (p. 2)

By exploring different spaces for making and the connections that accumulate, Patton & Knochel argue that “all types of makers build community through creation, presentation, critical viewing, and discussion of making practices” (p. 42). These are valuable traits across disciplines, and bring value to an interdisciplinary pedagogical approach.

President of Rhode Island School of Design from 2008-2013, John Maeda similarly participated in an interdisciplinary collaboration, in which he inquired about pedagogy and the synergy of art and science. The experience caused him to suggest that, “Both [science and art] are dedicated to the big questions placed before us: What is true? Why does it matter? How can we move society forward? Both search deeply, and often wonderingly, for these answers” (Fountain, 2014). These are questions that educators across disciplines often ask themselves. It was with these questions in mind that I began to approach my research in the field of STEAM education.
Chapter 3

Methodology

My research aimed to integrate STEAM with a visual arts curriculum by analyzing the resulting elements of creativity with a focus on divergent thinking. I began this experience with the aim of exploring how divergent thinking could be intertwined with STEAM lessons in a visual arts classroom. I started working with a class of twenty 4th grade students in a median income, suburban public school. The class met once a week in the art trailer that was adjacent to the school. The class was comprised of twenty students that were divided between six collaborative tables.

Figure 1: The classroom where research was conducted
This study analyzes the specific work of ten participants.\(^1\) I started working in the classroom two months before beginning research and delivering my lesson plan. In the eight classes prior to teaching, I was an assistant to their teacher and I worked with students and developed a relationship with them as I aided them with the lessons they were given. Lessons in the classroom were often given in step by step tutorials, derived from a teacher sample created by their regular teacher. After spending a few months with the students, I became involved in their classroom social practice by understanding the personalities of the different students and how they interacted with each other, gradually gaining their trust and becoming a part of their dialogues. Shortly thereafter, I delivered a STEAM lesson over the course of three 40-minute class sessions.

The goal of this research was to look more in depth at the outcomes of a STEAM lesson plan in a visual arts classroom. The learning objectives of the lesson plan were: Students will understand the six simple machines and utilize two of them in their artwork; Students will experiment with the function of the six simple machines; Students will create two artworks as a culmination of their discoveries in machines and art media; and, students will utilize divergent thinking skills in the creation of their artworks. Students demonstrating success would utilize familiar machines in alternative functions, would should progression of their understanding of the word machine, would rework possibilities of limitations of a particular art medium, and would create two artworks that utilized their machines. The class was broken down into three 40-minute sessions.

In the first session, the students were given a pre-assessment that asked two questions. These pre-assessments asked for students to demonstrate divergent thinking as well as

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\(^1\) Participants were informed about the study, and parents provided consent for their children to participate.
determined the student’s familiarity with the concept of simple machines. After the pre-assessment students were given a short Power-Point™ that introduced the six simple machines and gave examples of artists using the machines in their artworks. There was a short divergent thinking activity in which students were exposed to the term “divergent thinking” and asked to construct a flower from pipe cleaner. As students finished their flowers they held them in the air and held a class conversation about the differences in their flowers, and what divergent thinking meant, and the advantages/disadvantages associated with the practice. After this discussion students were given instruction to build two of the six simple machines using the materials provided (cardboard, poster board, wooden dowels, masking tape, pipe cleaners, white yarn, and markers). Students constructed their machines until the class had run out of time.

Figure 2: Constructed simple machines
In the second session, students reviewed what had been presented in the previous class and recollected their simple machines. Instructions were given that the students who had finished their simple machines could move onto the next step, utilizing their simple machines in the creation of a 2D or 3D artwork. The class reviewed the term ‘divergent thinking’ and discussed what that would mean in the context of the project. Students who had not finished their simple machines resumed construction, and those that had finished began the project. They were able to choose from cardboard, poster-board, thick white paper, wooden dowels, masking tape, pipe cleaners, white yarn, markers, chalk pastel, and acrylic paints. There was a vast amount of choice in material so that students could explore diverse possibilities.

The third session involved students finishing up their 2D/3D projects utilizing their simple machines. Some students were able to complete up to five artworks, while other students spent both class periods in depth on one project. With 15 minutes left in the class period, students were given the opportunity to share what they had created with the class, and explain the machines they used and their process. Afterwards, students were given a post assessment that asked for a brief explanation of the process they had used for their work, as well as a few questions that would prompt divergent thinking skills.

Data from the field experience was collected through pre assessments, project work, and post assessments and evaluated alongside creativity measures from Ellis Paul Torrance’s “Torrance Tests of Creative Thinking” (TTCT). These creativity measures are fluency (lots of ideas), flexibility (many different ideas), originality (unique ideas), and elaboration (detailed ideas) (Torrance, 1980, pp. 1-19). Torrance legitimized the study of creativity with TTCT (Thota & Munir, 2011), and while creativity assessments continue to grow, the combination of TTCT’s assessment methods and indicators of creative aligned with the goals and structure of
this research and looking into the question: “*How may the integration of the visual arts and STEM curricula enhance elements of creativity that lead to divergent thinking?*”

After completion of consent documentation, the data set is comprised of ten students and their pre-assessments, project work, and post assessments. This contains all physical copies of worksheets, and photographs of all physical project work and process. The physical work included both the artworks completed by students as well as the machines they constructed to create the artworks.

Data was organized by student and sorted by pre-assessment, project work and process, and post assessment. The data for pre-assessment and post assessment was significantly less comprehensive than the project work due to a general lack of participation by students. The project work was organized by photographs taken in the classroom. For each student’s work, photographs were organized into sections denoting fluency, flexibility, originality, and elaboration. Each label was given a short reasoning as to why it was placed in each category. This allowed for patterns to emerge in terms of which creativity skills were most utilized and which skills that students struggled more with using. Observing patterns emerge, I was able to analyze which groups of students experienced success in creative thinking skills, and link that success to the documentation of their work.
Chapter 4

Findings

Structured Chaos

“I’m just being silly!” The classroom was full of excited murmurs as one student sat staring in awe at the artwork in front of him. Each table held a separate world of students embarking on different adventures with material. Tools had been constructed, and making was occurring. This particular student, who I will refer to as Drew, found himself in a moment of shared reflection as I crouched near his table. The paper in front of Drew was filled with interwoven lines of various colors. Assorted scraps of material surrounded the paper and a small pulley constructed from cardboard, masking tape, and white yarn precariously dangled an uncapped thin-point marker over the edge of the table. I asked Drew to explain to me what he had created, and he eagerly agreed to tell me more about his piece. “I’m just being silly!” he cried, and went on to explain his process. Drew showed me how he had created a working pulley and pulled up the contraption, causing the marker to drag across the page. As he began to pull the string on the pulley with varying force, the marker slowly-then quickly dragged across the paper creating a wavering line of color. Suddenly entranced by the machine, Drew continued construction and began to attach new markers to the line of yarn.

Blank faces had met the beginning of this project. As I finished reviewing the simple machines, and our goals for class time together, the students had remained in their seats, tentative to stand up and begin by selecting materials. Accustomed to step-by-step projects, the students were confused by the amount of choice they had in the creation of their artworks. Slowly, one by one, the students rose, and hands started moving quickly. As confidence in their course of action
rose, so did the volume of the classroom. Each table held a group of students that began talking, making and collaborating with every step of the new project. In her book *Analyzing Productivity in American Corporations*, Rosabeth Moss Kanter claimed that in uncertain assignments, groups often function more efficiently and effectively (Kanter, 1983). While American corporations aren’t often compared to fourth grade art classes, both groups were tasked with innovation, and both groups were found to be more efficient and effective when working with teams. The structuring of the classroom aided this process in that each student was grouped between six tables in the classroom. While they were creating individual projects, they were facing two to three peers tasked with the same challenge.

**Communal Divergence**

The art classroom is often a social setting. With less restriction on talking during class time, students are able to share ideas and stories while they are making. As art educator Christine Thompson (1995) argues “The presence of other children, the possibility of dialogue, the sharing of perspectives that inevitably occurs around [art making], contribute significantly to early artistic learning” (p. 9). The structure of the classroom can be a key component of collaboration and socialization. The classroom in which we were working arranged students in groups of three or four. This setting caused six different worlds of thought and process within the classroom. Originally, the project had aimed to push students to achieve divergent thinking individually. By definition, divergent means, “moving or extending in different directions from a common point” (Merriam Webster, n.d., par 1). However, instead of having twenty diverse students moving in different directions from the lesson’s guidelines, there arose six compelling groups of thought
that explored different perspectives of the assignment. Each table came together in collaboration and emerged with a strong collection of projects that aligned in process and thought. As I paused at each table I would be emerged in the social practice of the students, suddenly given detailed demonstrations and explanations of process.

In the following sub sections, I will be analyzing the different, communally-based divergent experiences that students had with their respective tables. These are snapshots from the second and third day of the lesson, in which students were utilizing the simple machines they had constructed to create their 2D and 3D artworks.

**Cube World**

One table in the back corner dove into a three dimensional world. Pulling from inspiration, such as Minecraft and Pokemon, the students had begun to build cubes from cardstock, imitating an origami style of folding the
paper. One student took the lead and began a demonstration for the table on how to fold the cubes, and quickly they had all constructed a cube and they began to decorate using their simple machines in various ways. One student used a wheel and axel to roll a distinctive black line on her Pokemon themed cube, while another cautiously attached their cube to the opposite end of a pulley that held a paintbrush covered in a thick layer of paint.

Figure 4: Finished cube constructed with pulley

Assembly Line Abstraction

In the opposite corner of the room, four girls were standing around their table moving with ferocious confidence. Each girl seemed to be following the leader of the table in a series of dynamic movements with various simple machines. At one moment they all stood, arms
upstretched, clutching their cardboard pulleys that held multiple paintbrushes. The tips of the paintbrushes danced across their papers creating thick variations of paint and color. Suddenly, they all crouched down close to the paper to inspect the wet designs. Following each other’s lead, they grabbed their wedges and dragged the paint across the paper, leaving smooth lines of blank paper in their trace.

Figure 5: Students utilize wedges to scrape paint on paper

This process continued with intensity. For the next 15 minutes I was presented with multiple wet and colorful abstracted pieces of work. The girls talked excitedly about each piece, and slowly changed their process together. By the end of the lesson they were integrating their energetic marks with more realistic representations of environments and objects.
Figure 6: Student uses pulley to create abstracted marks

Figure 7: Student integrates reality with abstracted marks created with simple machines
Individual Divergence

For one table, there was significantly less collaboration and discussion. Three students sitting at the same table worked independently of each other and pursued different ideas. One of these students became engrossed in creating a machine with supplements in order to create her artwork. She quickly built a pulley, and then carefully cut out small shapes that she attached to one of the sides of yarn on the pulley. As I approached the table she was deep in her work, but after recognizing my arrival, was excited to share her plan. The student explained that she wanted to try a version of printmaking with her pulley. She had cut shapes that she would cover in paint, and she would use the pulley to lift and drop the shapes onto the paper in different areas. After a careful paint selection, and application to the stamps, she slowly began her planned process.

Figure 8: Student transforms a pulley to build a print making device
At the same table was a student who was significantly less interested in the project. It was a contrast to the excitement and collaboration coming from other tables, as this table worked more in silence. While the student working with her printmaking-pulley was very engaged with her process and the project, this student felt more lost and over the course of the lesson never successfully pursued any mark making that aligned with the project guidelines. After working with the class for a few months before this project, I was aware that he wasn’t the most engaged student when it came to art class, but it was interesting to observe the only student that was unsuccessful with the project was at a table lacking collaboration and a social environment.

Working with Force: The Catapult Table

One of the most collaborative tables was a table in the back of the classroom comprised of four boys. Not only did the students share a common interest in the lever, they halted their individual projects in order to construct one large lever-turned-catapult. Earlier on, in the building of their simple machines, they had come to question how they could possibly use a lever in order to make marks and create an artwork. We talked about the uses of a lever, and what was necessary for the lever to function: force. After spending some time thinking about including motion and action into their mark making, I arrived back at the table to find them slamming down on one side of their communal lever, launching paint covered scraps of cardboard across the table onto a gleaming white sheet of paper. With every forceful (and successful) launch, orange paint would splatter, leaving behind a trace of the dramatic landing. Each student at the table took turns using the catapult, subsequently cheering each time their paint landed with a splat onto the paper. The cheers were noticed by the class, and one student from the independent
table switched over to join the catapult table, eventually building a successful catapult of his own.

Figure 9: Catapult, Stage 1

Figure 10: Catapult, Stage 2
Figure 11: Catapult, Stage 3

Figure 12: Student creates catapult individually
Pre and Post Assessments

These stories were collected from the classroom while students were collaborating on their 2D/3D projects. A majority of the findings, which will be further analyzed in Chapter 5: Discussion are based upon project work and process. While pre and post assessments were administered and collected, the data from these assessments is inconsistent due to a lack of participation, a lack of time, and a disparity in consent from parents (Appendix B & C).

Students were very unfamiliar with the task of filling out a worksheet within the visual arts classroom. The structured worksheet was a strong contrast to the very open ended lesson that the students completed. When the assessments were administered, students felt rushed and overwhelmed by the formal formatting of the worksheet. A majority of students that worked on the worksheet (from the pool of students with parental consent for analysis) actually worked on the back of the paper and strayed from the initial questions. Instead, they wrote about what they had been working on, and some included illustrations. While the questions went unanswered, the work on the worksheets was still analyzed and considered within the data collection, as many students diverged from the initial intention of the worksheet and instead provided their own insight on the project without any questions prompting their thinking.

“I thought the best part of this thing is that we could make machenes and make things. I made a lever, pusher, and w a/ axle. I made a thing and a thing 😊
Thing= drawing
Thing= Pantheon 😊”

Figure 13: Post Assessment 1
“I made a pully, and attached little cardboard pieces to the string. I dipped the cardboard pieces in paint, and pulled the string to make the paint-covered cardboard pieces dance across the paper covering it with paint.”

“I loved this project”
Supplemental Documentation

Figure 16: Wheel Abstraction 1

Figure 17: Wheel Abstraction 2
Figure 18: Student begins to map out a model of the Pantheon

Figure 19: Student creates design using a constructed paintbrush
Chapter 5

Discussion

Outline

This chapter reflects on the findings from the research project and lesson plan. The main ideas that have emerged from data analysis have been grouped into the topics: Appropriation, The Role of a Teacher, and Collaborative Divergence. The findings used for these reflections are derived from project work/process analysis that happened during making in the classroom.

Appropriation

“Children freely appropriate images they admire and ideas they fancy” (Thompson, 1995, p. 8). Whether it is popular visual culture, or just the approach their peer is taking, children often copy images and methods. This appropriation was evident in the classroom throughout this study, in multiple forms. At the catapult table and the assembly line table, process was shared between the students and initially copied from one individual at the table who took the creative leap towards a new method of making. “[Some] utilize appropriation as a means to learn artists’ techniques such as their styles or manipulation of art media” (Sickler-Voigt, 2011, p. 30). While the original idea was appropriated, or borrowed, by other students at the table, the real discovery took place as each child took that process and enacted their own ideas on it. For example, after the assembly line table perfected their paintbrush-pulleys, each girl utilized the marks in different compositions and subjects.
The ‘cube-making table’ utilized appropriation in terms of direct content as opposed to process. “Some viewers of art see appropriation as copying because the artists’ appropriated objects look exactly like the inspirational work” (Sickler-Voigt, 2011, 30). While the cube making table directly copied images from Minecraft and Pokemon, they worked collaboratively to discover the process of building a cube, and utilized varied machines and techniques in order to design their cubes.

Initially I was concerned that appropriation would inhibit students from achieving in their use of the creativity measures used to analyze the data. Originality is not often a term that is cohesive with appropriation. Appropriation comes down to copying, sharing, and recycling ideas and images. However, the students that utilized appropriation were all successful in building off of the appropriated technique/image and using elaboration and flexibility. When facing a challenge with uncertainty, these students found comfort in starting from a place of familiarity through appropriation, before taking creative leaps in new directions.

**The Role of a Teacher**

Leading a lesson with the intent of having students practice divergent thinking required a balance of guidance and freedom. Thompson (1995) claims, “The ability to respond to particular children engaged in the onrushing flow of events…teachers follow where children lead. They react more than they direct. Frequently, they learn more than they teach” (p. 10). I needed to give the students enough choice that they could express originality, flexibility, fluency, and elaboration. However at the same time, I needed to meet the level of structure that the students were accustomed to so that they would not be inhibited by an overwhelming amount of choice.
“Freedom to learn and grow does not occur in the absence of structure…true freedom occurs when choices are made within a structure that is stable, reliable, protected from distraction” (Thompson, 1995, p. 11). The structure in this project originated from clear set of goals at different points throughout the three class periods. These checkpoints gradually increased with the amount of freedom and choice students were given; for example, starting from tasking the students with constructing two of the simple machines from the materials provided (structured) and moving towards students being asked to create a 2D or 3D artwork using the tools they had constructed (more freedom). By building up the amount of choice students had, they were guided into an open-ended assignment without much hesitation in their course of action.

There were students who struggled with the amount of autonomy they had over the final project. In these situations dialogue was the most important tool in guiding the student towards the next step. For example, the instance of the catapult table, in which students were questioning how a lever could be used for art making. It was important to me that I did not provide any concrete answers, but rather ask questions that could guide the student’s to their own ideas and choices. By talking to the students about the function of the machine and necessary components such as force, the students were able to choose their own course of action and start experimenting with force and the lever; eventually leading towards their catapult discoveries and subsequent making.

An important part of leading this lesson was having a conversation with the students about product and process. Accustomed to very step-by-step art pieces, some of the students were uncomfortable with their abstracted art they were creating. Several times throughout the three classes, students ripped up their work or threw it in the trash. The new process of making was exciting for students that were working with the Torrance creativity measures (Torrance,
1980, pp. 1-19), but other students questioned the value of the work and the reasoning behind the assignment. Often in art education, product is emphasized. Artworks are used to beautify schools or made to hang on refrigerators at home. Products are physical creations from the art classroom that can demonstrate to administration or parents the learning that is taking place in the classroom. However, process is what takes place in the classroom when learning is manifested. “In process based art education, the goal is to observe and monitor what experience and knowledge the child is gaining from the process during the activity” (Stone & Chakraborty, 2011, p. 1). When students threw out work or expressed their disappointment with their products, we talked about the process of the activity, and what the goals for learning were. When students were reminded about our divergent thinking class conversation, and asked about the choices they had made in their process, they often were able to see their projects through a new lens and would continue onto a new piece. Two out of the twenty students remained frustrated with the project for the duration of the class, but a majority expressed their excitement for a self-driven process. This ties in with the research question: *How may the integration of the visual arts and STEM education enhance elements of creativity that lead to divergent thinking*, in that it demonstrates the benefits of integrating the visual arts classroom with STEAM lesson plan. Due to the social practice and community within the classroom, many students were empowered to make creative leaps in their process and decision making. After being given a prompt in a classroom tied to a sense of creative freedom and liberty, while also engaging in a familiar social community, a majority of students were successful in engaging in divergent thinking. In this scenario, the integrated classroom pushed students towards collaborative divergence, using a strong communication network and social practice.
Collaborative Divergence

Early in my research I had assumed that the resulting data from this research would involve twenty different trains of thought, and individualized projects. With a lesson emphasizing divergent thinking and individual exploration, I had neglected to account for the power of collaborative structuring of the classroom as well as the social practice among the students. Initially I was alarmed by the course of action taken by my students. However, upon speaking with each of the groups and observing the explorations they each played a role in, I became fascinated with the divergence each group had taken. Each group developed into a working organism with evolving leaders and followers. Ideas were shared and explored, as students took advantage of the freedom of the lesson and the encouraged trial and error process within the art classroom.

The grouped creativity fostered within these six tables can be analyzed using the Torrance Tests of Creative Thinking (Torrance, 1980, pp. 1-19). A number of qualities besides indicators of fluency, flexibility, originality, and elaboration were identified including: putting ideas into context, combining and synthesizing, using movement and sound, keeping open through resistance to premature closure, etc (Torrance, 1980, pp. 4-5). These qualities can be identified throughout the classroom, stemming from the catapults’ construction to the abstraction assembly line. Students combined their varied ideas and put them into context. They physically constructed the manifestation of their creative thinking and continued to elaborate on their works after trial and error as well as feedback from their peers.

On the other hand, students at the more individualized table struggled to accomplish these qualities. These two students resisted extending boundaries and keeping open through resistance to premature closure. When they faced the ambiguity of the final stage of the lesson plan, they
felt inhibited and unable to decide upon a course of action. With this in mind, the social practices at other tables were valuable, as they resulted in collaborative creativity and projects rich in measures of divergent and creative thinking.

This collaboration was fostered by the peer culture of the visual arts classroom. Tables had been assigned to students at the beginning of the year, based upon personality, and what would be most effective for utilizing the short period of class time each week. Week by week, students became accustomed to working physically with their hands while also engaging in the social practice associated with a visual arts classroom. Conversation was accepted and encouraged, students often engaged with each other’s work, and influenced their making practice. Peer influence had been recognized within the classroom, but previously had been less susceptible, as students had followed structured projects which would result in aesthetically similar pieces. However, in the STEAM lesson, where final projects were significantly more up to student decision making, peer influence became much more transparent. The collaboration of the students was evident not only through conversation and interaction, but also by the work which remained similar within tables, yet was drastically different to work produced at alternate tables.
Chapter 6

Conclusion

Summary of Findings

By observing the interaction between students and a STEAM curriculum in a visual arts classroom, I investigated relationships of divergent and creative thinking among students engaged in the tasks provided. These observations aimed to answer the research question: *How may the integration of the visual arts and STEM curricula enhance elements of creativity that lead to divergent thinking?* To explore this question I analyzed the discoveries made by students partaking in my three part STEAM lesson plan in their weekly art class. I analyzed pre and post assessment worksheets accompanied by the process and product of the students’ art/machine making. The data was reflected upon using Ellis Paul Torrance’s “Torrance Tests of Creative Thinking” (Torrance, 1980), in order to determine the extent of divergent thinking and creative thinking that students had utilized in their processes.

The data was separated, unintentionally, by each table in the classroom, as the students began to work towards the ambiguous end goal of the project with the peers that surrounded them. The sets of data became organized as; “Cube World”, “Assembly Line Abstraction”, “Individual Divergence”, and “Working with Force: The Catapult Table”. These four different sets of data analyzed the process and divergent thinking utilized by each grouping of students. Sorting through this data, I identified Appropriation, The Role of the Teacher, and Communal Divergence as the three main categories rich in ideas for discussion. In the Appropriation section I discussed the inevitable factor of sharing in the art classroom, and the implication of borrowed ideas on divergent thinking skills. My role as the teacher struck an interesting balance between
freedom and structure and was challenged by the students who were unwilling to experiment within the lesson plan. This section also discussed the role of process and product in the classroom, and how different parts of the lesson plan held value. The Communal Divergence section explored the oxymoron of divergence and community. While the two terms appear to contradict each other, their relationship within this lesson plan served as an invaluable asset critical to the successful completion of the lesson plan and the relationship with divergent thinking within the classroom.

**Implications**

Through analysis of the process and product of art making in relationship to a STEAM lesson plan, I was able to acknowledge benefits of the social practice within an art classroom. Divergent thinking and creative practice thrived in environments of communicative peers engaged in art making and problem solving. Students in more individualized settings were inhibited by the daunting, ambiguous task, and were more likely to be unsuccessful in completing the project. In these students it was more challenging to observe traits of creative or divergent thinking.

Collaborative divergence refers to the small groups of peers that interacted in creative problem solving as a team. Ideas were shared from each student, and as a group they synthesized their ideas and engaged in art making practices that moved away from the common starting point of the project and involved of fluency, flexibility, originality, and elaboration.

While unexpected in the context of this STEAM lesson plan, collaborative divergence holds benefits for educators across disciplines as well as society as a whole. Innovation and
problem solving can be driven by divergent thinking and creative practices. Collaborative
divergence skills could positively affect students in varying classroom environments as it did
within this STEAM lesson plan. As referenced in the literature review, a common theme within
the STEAM discourse is how STEAM can drive national progress and innovation. While the
arts’ benefit to other disciplines does not define the value of an arts education, certain traits that
emerge from STEAM education hold enormous value outside of the visual arts community. For
example, the peer social culture fostered in a visual arts classroom coupled with a problem-
solving based STEAM lesson plan catalyzes collaborative divergence in the form of divergent
thinking skills and creative thinking traits.

This study has explored the elements of creativity and divergent thinking that emerged
from the integration of STEM and a visual arts classroom. STEAM education has the potential to
draw students together through creative problem solving and collaborative peer making. This
relationship can encourage students to pursue more daunting tasks without fear of ambiguity or
failure. At this point in time our society faces a daunting task in the need of innovative problem
solving. Current culture produces problems ranging from production/consumption to the
limitation of our natural world. The relationship between the need for creative problem solving
and STEAM education serves as a lens for the value of providing students with the skills such as
collaborative divergence. Students with the ability to engage with others and approach ambiguity
with confidence and originality have the potential to create lasting and positive impactful change.
Appendix A

Lesson Plan

Unit Title: Reflective Repurposing
Lesson Title: Simple Machines as Art Making Tools
Overview: Integrating simple machines into art making to inspire experimental STEAM methods

<table>
<thead>
<tr>
<th>GRADE LEVEL AND CLASS SIZE</th>
<th>DURATION</th>
<th>RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; Grade class 20 students</td>
<td>3 40 minute class meetings</td>
<td>Why this lesson for these students at this time? This class of fourth graders is beginning to work with interdisciplinary ideas. They are creating connections between the art classroom and their reading work in their general classroom. This lesson will introduce an interdisciplinary connection with a STEM curriculum, allowing students to connect their creativity with STEM concepts. These students will explore looking past preconceived notions on items in their daily life as they bring them into an art-making context. Students will experiment with the function of the 6 Simple Machines. The students will practice divergent thinking as they reform the expectations of tools and technology. This will allow them to approach situations outside of the art classroom with an open mind, as well as confidence in their creative choices.</td>
</tr>
</tbody>
</table>

| LEARNING OBJECTIVES |
Include NCAS or Pennsylvania State standards referenced by level with each objective |

1. Students will understand the 6 Simple Machines, and utilize 3 of them
   Standard 9.1.3 K Know and use traditional and contemporary technologies for furthering knowledge and understanding.

2. Students will experiment with the function of the 6 simple machines
   Standard 9.3.5 E Describe and use contextual criticism in the arts and humanities.

3. Students will create two artworks (one 2D, one 3D) as a culmination of their discoveries
in machines and art media

**Standard 9.1.3.B** Recognize, know, use, and demonstrate a variety of appropriate arts elements and principles to produce, review, and revise original works in the arts.

4. Students will exhibit their 2 Artworks for the class and engage in a critique.  
**Standard 9.1.3.D** Use knowledge of varied styles within each art form through an exhibition of unique work.

5. Students will utilize Divergent Thinking skills in the creation of their 3 artworks.

---

### ASSESSMENT

#### EVIDENCE OF SUCCESS

Outcomes that demonstrate meeting learning objectives. Match evaluative criteria to learning objectives.

#### ASSESSMENT INSTRUMENTS

Specify ways you will gather evidence of outcomes (ex. Graphic organizers, discussion, artwork, etc) Include both formative and summative assessments.

- Utilize a familiar machine in a new way once introduced to an art making context
- Show a progression of their understanding of the word machine, as well as its uses and relationships with other items
- Rework possibilities of limitations of a particular art medium
- Creation of 3 artworks that utilize machines

- Worksheet
- Reflective worksheet
- Discussion
- Artwork
- Observation

---

### TEACHER RESOURCE GUIDE

**RELEVANT RESEARCH & RESOURCES USED IN PLANNING THE LESSON.**

Include websites, books, etc that informed your research about the lesson ideas.


**VISUAL REFERENCES**

Include relevant thematically related images that support the lesson. Include citation information.

- PowerPoint
<table>
<thead>
<tr>
<th>INSTRUCTIONAL STRATEGIES AND LEARNING TASKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAY 1</strong></td>
</tr>
<tr>
<td><strong>LEARNING OBJECTIVES</strong></td>
</tr>
<tr>
<td>1, 2, 5</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

### INSTRUCTIONAL STRATEGIES
What will you do as a teacher to set conditions for student learning?

### MOTIVATION
10 minutes

- Complete Pre-Assessment
- Introduce project through PowerPoint (6 simple machines and divergent thinking)
- Divergent Thinking Activity and Conversation (each student receives a pipe cleaner and is asked to make a flower, talk about different arrivals to that point and WHY difference in thinking is important.)
- Will fill out pre-assessment
- Listen attentively to introduction
- Engage in class conversation, reflect on personal experience as well as immediate context
- Listen attentively on end of presentation

### EXPLORATION
25 minutes

- 6 tables each equipped with scrap paper, paint, chalk, markers, pens, pencils, and watercolor. Students receive cardboard, tape, wooden dowels, string, tasked with creating the simple machines and finding uses for them in making marks.
- Respect materials
- Engage in exploration of making techniques
- Respectful of classmates, share materials
- Experiment with different mediums/machines
- Begin to form plans for their 2 artworks
### REVIEW AND REFLECT
5 minutes

- Have students exhibit artworks and receive feedback from their peers
- Talk with class about what they wish they had done if they had more time
- Explain plan for next class period, encourage students to bring in materials they may want to use

- Participate in class discussion about experimental practice
- Reflect on work they created and look ahead to next week

### INSTRUCTIONAL STRATEGIES AND LEARNING TASKS

<table>
<thead>
<tr>
<th>DAY 2</th>
<th>LEARNING OBJECTIVES</th>
<th>EVALUATIVE CRITERIA</th>
<th>ASSESSMENT INSTRUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1, 2, 3, 4, 5</td>
<td></td>
<td>Critique, Project Work</td>
</tr>
</tbody>
</table>

### INSTRUCTIONAL STRATEGIES
What will you do as a teacher to set conditions for student learning?

<table>
<thead>
<tr>
<th>MOTIVATION</th>
<th>LEARNING TASKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 minutes</td>
<td>Actively listen to quick recap and artist example</td>
</tr>
</tbody>
</table>

- Remind students of what they did last class (quick review of simple machines have them name the machines I put on board)
- Explain that students will now be starting their 2 artworks using simple machines. Reassert importance of divergent thinking.

### EXPLORATION
30 minutes

- Desks will be set up with paper, paint, chalk, markers, pens, pencils, and watercolor. Each student will have the machines they created, as well as the option to share. When they finish one artwork, they write a quick reflection of what machines they used and how.

- Utilize materials and simple machines to begin to create their 3 artworks.
- Respect materials and other classmates (share, keep tidy)
### REVIEW AND REFLECT

**5 minutes**

- Pick students that use multiple machines/functions and ask them to explain their work (what they used and how)
- Talk with class about what they wish they had done if they had more time

- Participate in class discussion about experimental practice
- Reflect on work they created and look ahead to next week

### INSTRUCTIONAL STRATEGIES AND LEARNING TASKS

#### DAY 3

<table>
<thead>
<tr>
<th>LEARNING OBJECTIVES</th>
<th>EVALUATIVE CRITERIA</th>
<th>ASSESSMENT INSTRUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 3, 4, 5</td>
<td></td>
<td>Discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project (x3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post Assessment Worksheet</td>
</tr>
</tbody>
</table>

#### INSTRUCTIONAL STRATEGIES

**What will you do as a teacher to set conditions for student learning?**

- **MOTIVATION**
  - **5 minutes**
    - Remind students of what they worked on last week and what we will be doing today (reminder of machines and divergent thinking)

- **LEARNING TASKS**
  - Actively listen to instructions
<table>
<thead>
<tr>
<th>EXPLORATION 15 minutes</th>
<th>Desks will be set up with paper, paint, chalk, markers, pens, pencils, and watercolor. Each student will have the machines they created, as well as the option to share. Students will finish their one 2D and one 3D artwork.</th>
<th>Utilize materials and simple machines to begin to create their 3 artworks. Respect materials and other classmates (share, keep tidy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REVIEW AND REFLECT 10 minutes</td>
<td>Students exhibit their work, chose students who have used different machines. Engage in critique of divergent thinking skills and function of the tools. Talk with class about what they would be interested in doing with more time/materials. Have students fill out post-assessment.</td>
<td>Participate in class discussion about experimental practice Reflect on work they created Complete post-assessment</td>
</tr>
</tbody>
</table>

**INSTRUCTIONAL SUPPORT MATERIALS**
- PowerPoint
- Worksheets

**SUPPLIES**
- Scrap paper
- Markers
- Tempera Paint
- Watercolor paint
- Chalk
- Pens/Pencils
- Thick white paper
- Simple machines (6x6)

**SAFETY PROCEDURES**
- Review student expectations when cutting cardboard/ using scissors
Appendix B

Pre Assessment

The 6 Simple Machines:
Label each Simple Machine
Pre-Assessment

The 6 Simple Machines
Open Ended Questions

1. **How do we use machines in the art classroom?**

2. **Pick one of the simple machines and list 10 things you could do with it:**
Appendix C

Post Assessment

The 6 Simple Machines

Open Ended Questions

1. **How do we use machines in the art classroom?**

2. **List the 6 Simple Machines and one use for each machine**

   1) ________________________________________________________________

   2) ________________________________________________________________

   3) ________________________________________________________________

   4) ________________________________________________________________

   5) ________________________________________________________________

   6) ________________________________________________________________

3. **Pick one of the simple machines and list 10 other uses:**
REFERENCES


ACADEMIC VITA
CLAIRE E. PICARD
clairepicard5@gmail.com

EDUCATION

Pennsylvania State University, Schreyer Honors College, University Park, PA

Candidate for Bachelor of Science, Major in Art Education; Bachelor of Arts, Major in Painting and Drawing

Relevant Coursework: Art History, Art Education, Diversity Training, Pedagogical Theory, Visual Culture, Public Speaking, Painting, Drawing, Sculpture, Photoshop, Special Education, Psychology, Commentary on Art, Curriculum Building, Printmaking

Studio Arts College International, Florence, Italy

Italian Studio Art Program

PROFESSIONAL EXPERIENCE

Pennsylvania Art Educators Association Conference, Pittsburgh, PA

October 2017

Presenter

“Field Work Ecosystems: Cultivating Intergenerational Professional Learning Communities in Art Education”

New Canaan YMCA, New Canaan, CT

May 2015 – Present

Director of Specialists, Arts Specialist

Managed a team of 7 specialists, communicated and facilitated expectations of work ethic and habits
Created and implemented inclusive art lesson plans for 150 students ages 5-13
Balanced a budget and tracked inventory for 150 projects each day

See Design, New Canaan, CT

August 2014 – Present

Customer Service Liaison, Salesperson

Oversaw colleagues to provide customer-focused client services, addressed problems and complaints
Managed money and sales transactions

Department of Athletic Tutoring, University of Miami, Coral Gables, FL

November 2014 – May 2015

Tutor

Assessed progress of 10 students to develop individualized schedules for learning
Supported development of effective time management skills and provided helpful study strategies

ARTISTIC EXHIBITIONS AND SKILLS

Professional Exhibitions: “The Enchanted Gate”, solo exhibition at Patterson Gallery, University Park, PA (Jan. 2018)
“Art on the Move” solo exhibition presented by Penn State Student Affairs (Jan.-May 2018)
“Optics of the Poles” collaborative exhibition with Penn State Polar Center (Jan. 2016)

Technical Skills: Adobe Photoshop, Illustrator; Final Cut Pro; Microsoft Word, Excel, PowerPoint; iMovie; InDesign; Sewing; Woodworking; Painting (Acrylic, Oil, Watercolor); Drawing, Printmaking, Silkscreen, Sculpture, Embroidery

VOLUNTEER SERVICE AND ACTIVITIES

Penn State Dance Marathon, University Park, PA

September 2015 – Present

Dancer Relations Captain, Dancer Storage focus

Led a committee of 38 college students and educated them on handling the physical and mental needs of 700 dancers during a 46-hour no-sitting, no-sleeping marathon, as well as spreading THON’s mission: fighting pediatric cancer by fundraising for the Four Diamonds

Arts for Healing, New Canaan, CT

August. 2013 – June 2014

Intern

Guided 10 children with special needs through art and music based therapy programs
Supported the growth of students’ communication and social skills through conversation and art-based activities

Carnegie Pollak, New Canaan, CT

August 2013 – June 2014

SAT Math Tutor

Assisted course leaders by giving individualized attention to students struggling with various concepts and problems
Accommodated students’ personal learning styles through varied instructional methods