

Arts Integration in Montessori Mathematics

By

Emily A. Carlson

A Master's Paper

Submitted in Partial Fulfillment of

The Requirements for the Degree of

Master of Science in Education – Montessori

Major Advisor's Signature

Date

University of Wisconsin – River Falls

2016

Abstract

This Action Research study incorporates key art concepts into Montessori mathematics. The purpose of the study was designed to measure student engagement in mathematics and whether engagement increased as a result of art integration. A ten-week study was conducted in a fourth, fifth, and sixth grade classroom in a suburban, public Montessori Charter school in the Midwest. The researcher, a Montessori teacher, discovered ways to integrate art concepts into Montessori mathematics lessons. Data was collected by having students fill out pre- and post-surveys about their general feelings towards math, follow-on work, and observations. The focus group of five students met twice a week for 30 minutes. One lesson focused specifically on math instruction, while the other lesson focused on math instruction with an emphasis on art. Portfolios of the students' artwork were created. The research showed that students' general feelings towards math changed throughout the study.

Keywords: art integration, Montessori, mathematics

Introduction

A number of studies have been conducted observing the relationship between art integration in mathematics. A study group of five students in fourth, fifth, and sixth grade in a suburban, public Montessori Charter school in the Midwest was created to focus on Montessori math instruction with incorporated elements of art. Students received math instruction on Mondays and art integrated math instruction on Wednesdays for about 30 minutes. Montessori math materials are hands-on, allowing the child to make the passage from the concrete to the abstract. Maria Montessori designed the math materials to be works of art themselves. These materials captivate the child's attention with their beauty, and create a desire to reach out and explore them. In Montessori mathematics color is used to represent place value. Green represents the units place, blue represents the tens place, and red the hundreds place. These colors are constant throughout all Montessori math materials.

This action research study examines how art integration in Montessori mathematics influences the students' feelings towards mathematics. Montessori thought geometry should be on an equal footing with mathematics and developed many lessons pertaining to geometry. She wanted the child to develop the skill of working with materials and to build their fine motor skills, just as an artist might use a brush or pencil.

I selected a small group of five students who struggled with math. My goal was to take these students who held negative perceptions towards math and show them a another side of math. Additional art lessons were added to the traditional Montessori curriculum. Art skills were practiced, and artists such as Paul Klee, Pablo Picasso, Frank Stella and others were studied.

I wanted to understand the feeling toward math among this group of students. Math presented through the lens of art could make a difference in the eyes of a child. The following questions were my focus throughout the course of the study:

Focus Question: Does student engagement in mathematics increase as a result of art integration?

Subsidiary Questions:

Are there other effects on student learning from integrating art into mathematics?

Do students' standardized test scores increase after integrating art and mathematics?

Literature Review

Arts Integration in Montessori Mathematics

Mathematics is one of the core subjects of education. Dr. Maria Montessori had a hands-on approach for teaching mathematics. She created beautiful handmade glass and wooden materials for the child to work with. "Children display a universal love of mathematics, which is par excellence the science of precision, order, and intelligence" (Standing, 1998). The materials on the shelves encourage children to explore beyond the classroom walls and venture out into the community and the world (Lillard, 1996). Art has always been a passion of mine and incorporating art into mathematics is something I was inspired to research. This paper examines current research on the topic of arts integration in mathematics and how arts integration affects upper elementary-aged students.

The Benefits of Arts Integration

Arts funding is constantly being cut in schools across the nation. These cuts continue despite current research which states that art helps prepare students for the future. It gives them a skill set they will carry with them for the rest of their lives. The arts inspire creativity and intellectual curiosity. Art encourages students' cognitive engagement along with offering them a sense of personal ownership. It provides numerous avenues for community involvement and can inspire and transform community and culture (Appel, 2006).

Art makes an impact on cross-curricular achievements. The hands-on nature of art builds bridges between the concrete and abstract in mathematics. Learning arts and mathematics together fosters a whole-brain development. Arts education energizes the school environment, develops critical skills for life and work, improves student performance, and exposes students to a range of cultures and perspectives (Parr, Radford & Snyder, 1998).

“Arts afford ways to organize, communicate and understand information, and most critically provide humans with what is needed in order to learn and thrive in a changing, global world” (Hartle, Pinciotti, & Gorton, 2014, p. 290). When art is integrated into the math curriculum, students develop skills they can use the rest of their lives.

A study by Katherine Smithrim and Ren Upitis states that involvement with the arts aided student engagement at school. Teachers, parents, students and administrators talked about how the child's level of engagement changed, not only cognitively, but physically, emotionally and socially. Learning requires emotional involvement.

The amount of arts integration can increase student testing scores. Results show that teachers who integrated lessons benefited from their students' increased performance. The intensity and frequency of art integration also could affect a student's learning. Scores showed that students did better when teachers focused on one or two disciplines instead of attempting to integrate art into all areas of curriculum. The boundaries of learning were stretched as to what the students were expected to learn (Ingram & Riedel, 2003).

Montessori education provides opportunities for students to become independent learners. This can come with their follow-on work. The child has the choice to work individually or with a group of students. "Integrating the arts provides pathways for personal meaning making and self-motivation" (Land, 2013 p. 552). By incorporating arts into the follow-on, each child is able to make their follow-on meaningful to them.

Arts are more than just expressive they develop cognitive reasoning. Integration of art can often lead to increased academic achievement. Using art in education builds a framework for cognitive development by offering skills which can be used throughout life. This framework focuses cognitive activities and improves student performance. Skills worked on by students included problem solving, reasoning, relationships, and creativity (Baker, 2013).

Increasing Arts Integration in Mathematics

Recent studies have compared other countries' education systems to those of the United States. Japanese students have been receiving instruction in both choir and musical instruments starting in elementary school and continuing in secondary. The

Netherlands have stated that both art and music must be part of the educational curriculum. Schools in England have required that all students take a theater or drama course (Gullatt, 2008).

Arts-integrated programs have seen academic gains across standardized test scores. These arts programs have also seen increased achievement by struggling students. Using art as a medium teaches skills that are transferable to other academic areas. (Gullatt, 2008). In order to restructure the curriculum, it is necessary to examine the older curriculum models. The structure and format of the new curricula must be based on the conclusions of this examination (Bickley-Green, 1995).

Educators worldwide are challenged to close the achievement gap. Teachers who integrate the arts into their curricula find they are better able to understand and meet the needs of their students. Arts integration offers a more effective avenue for at-risk students. The arts are universal and have spanned across culture and time. Humans have a biological need for beauty and harmony (Hartle, Pinciotti, & Gorton, 2015).

The Embodiment of the Arts

Embodiment of the arts means that the arts engage the brain and the body. Feelings and senses are connected. The arts provide many opportunities for the brain and body to be creative. Art requires discipline and practice. These skills can be intrinsically motivating. The arts allow children to rehearse life experiences that advance development (Hartle, Pinciotti, & Gorton, 2015).

Art is a shared engagement. Art is often used for self-expression. When art is used with other aspects of the curriculum, students are required to use higher-order thinking

skills. One's ability to use both left and right brain allows for both logic and creativity to take place. These merge art standards with the core curriculum. All learners are able to imagine, explore, experiment, create, reflect, assess, and share their work with others (Robinson, 2013).

Cultural transformation happens through art integration. Meaningful cultural change is evident in the values and beliefs of the individual who has practiced art integration. Students begin to exhibit new ways of learning and the role of learning takes on a new form. Teachers need to be ready for the pedagogical approach of integrating arts into various subjects. A shift takes place from seeing the pedagogy, discussing art, and applying the approach to the practice of teaching and learning (Charland, 2011).

Conclusion of Literature Review

The topic of art integration is studied in a range of ages from young children to high school students. Research shows that art integration in mathematics assists students in developing critical skills. Engagement in academics goes up as well as engagement socially. These are important life-long skills on which the child focuses. Integrating arts into the curriculum offers the student many opportunities to develop critical thinking skills along with higher level questioning.

To gain an understanding of student development, it will be necessary to conduct a study examining techniques in arts integrated lessons as well as student engagement. Confidence in mathematical and artistic skills are factors that will be addressed in the study. Learning about influential artists and recreating some of the artist's pieces while focusing on key mathematical components comprises the study.

Methodology

Participants and Setting

The study took place in a suburban Montessori elementary and middle school in the Midwest. The school enrolls approximately 200 students. The students identify themselves as follows: African American 3.3%, Latino 3.3%, Asian/Pacific Islander 4.8%, Caucasian 88.5%. The school has three first/second/third grade classrooms, three fourth/fifth/sixth grade classrooms and four seventh/eighth grade classrooms. There are 13.8% students receiving Special Education services and 9.6% qualify for Free and Reduced Lunch.

Data was collected from five students from fourth, fifth, and sixth grade classrooms. The students in the study are a mix of students from all upper elementary rooms. The students were previously part of an intervention math group that met twice weekly for a half-hour each time. Of the five participants, one was in fourth grade, three in fifth and one in sixth (four girls and one boy).

All students had attended the Montessori school the previous year and a majority of the students had attended multiple years. They are all experienced with Montessori education.

Materials

Many Montessori math materials were used. Materials and lessons changed as the students practiced and mastered concepts. Students were familiar with the materials and had worked with them before. Figure 1 shows the decimal board which allows students to use manipulatives and add and subtract decimals. Figure 2 shows the decimal

checkerboard which aids students in multiplying decimals by whole numbers or decimals by decimals. Figure 3 shows the large bead frame which assists students in adding and subtracting, and multiplying large numbers. The materials were all kept on the math shelf and were accessible for student use.

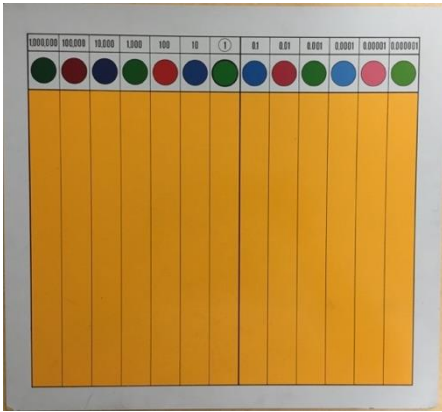


Figure 1: Decimal Board

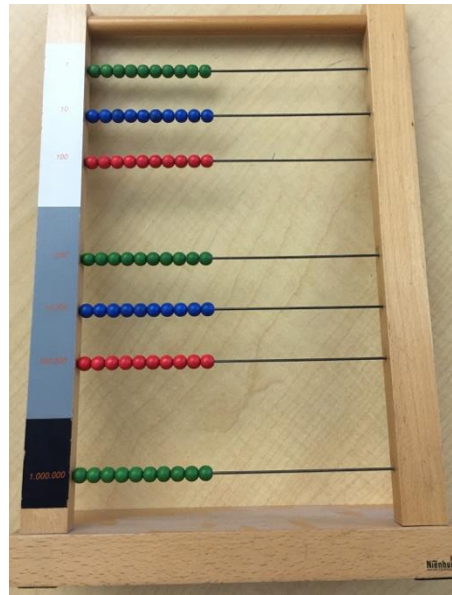


Figure 2: Large Bead Frame

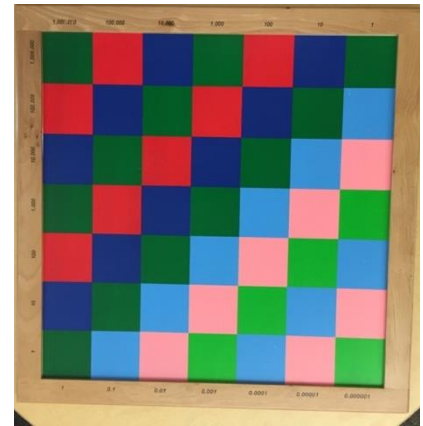


Figure 3: Decimal Checkerboard

Procedure

Before integrated art instruction began, the students were asked to complete a survey about their feelings towards math. The survey was taken from Beyond Traditional Math (See Appendix A).

Math lessons were designed considering individual student interests. Students made a list of five things they felt on which they needed to work on and three things with which they wanted to work more. Most lessons were taught using Montessori materials. Students were in the process of making the academic journey from the concrete to the abstract as they mastered the work on the materials. The goal was to ensure that the

children would be able to complete math problems using only paper and pencil, and that they would be free from relying on the Montessori materials.

The lessons normally lasted around 30 minutes. The children were introduced or reintroduced to a math concept, practiced the concept, and had a few additional problems to do as follow-on. The same happened for art. The art concept or artist was introduced, the students practiced the concept, and if they did not finish, they took the work as follow-on and brought it back at the next lesson. An example of incorporating art into math concepts would be using a compass with a paintbrush instead of a pencil.

During the study, children were exposed to a variety of math concepts and artist styles. Frequently, as a part of the child's follow-on, the student would naturally teach the art lesson to a classmate outside of the study group. The lessons were designed to incorporate art alongside math.

Students received instruction twice a week focusing on the impressions of artists and how their work related to math. Instruction was given on how to rotate a compass, how to measure angles using a protractor, how to hold a paintbrush, and how to draw a line using a straight edge, among other lessons.

Following the instruction, students kept track of their follow-on in their math notebooks and their art projects in a portfolio. I kept a log of student's work completion and art assignments. If the students finished their work at a later time, they were always allowed to bring it to the lessons. Students completed the same survey at the end of the study.

Results

Prior to the focus group meetings, the students participating in the study completed a survey on their feelings towards mathematics. The survey provided three choices for the students: agree, disagree, and I don't know. My hope was that throughout the course of the study students' negative outlook towards math would change. Integrating art into mathematics provided diverse opportunities for follow-on. The results of the pre-study survey varied among the students (Figures 1 and 2). 60% of students agreed that math was confusing. 80% of students said they get tired of working with numbers. Over the course of the study, opinions changed for many students.

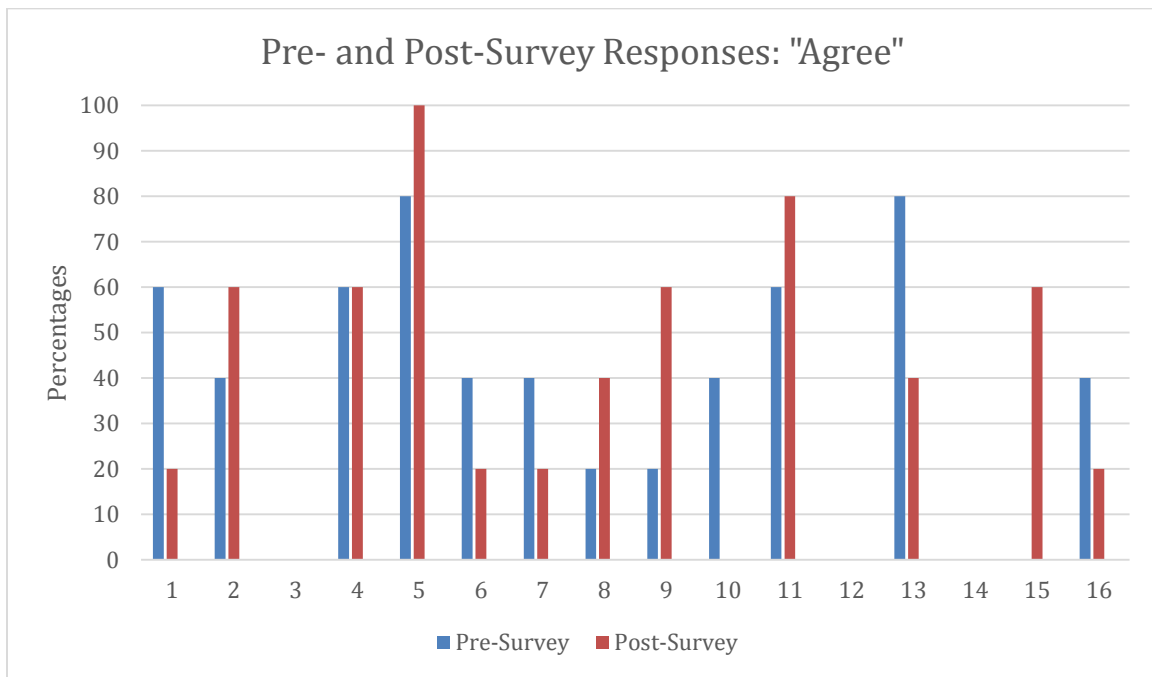


Figure 1: Students' Responding "Agree" in Pre- and Post-Survey

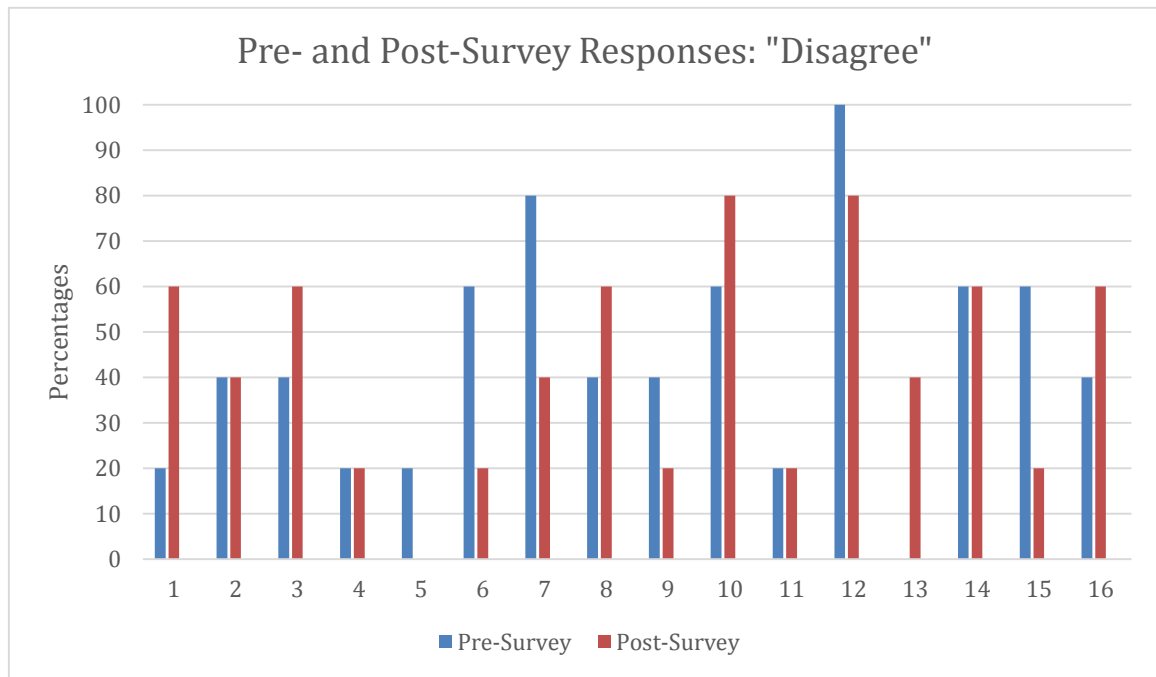


Figure 2: Students' Responding "Disagree" in Pre- and Post-Survey

The post-study survey results illustrates the students' changed attitudes regarding math (Figure 2). After the arts integration in math only 20% of students agreed that math was confusing. One constant was that 40% of students reported they grew weary of working with numbers.

A positive experience took place for a student whom we will call "Eva She is a fifth grade student who struggles with attention and organization. At the beginning of the year, Eva knew that she needed help, but felt that other students in the class needed help more so she would never ask for it. In return her work load suffered and she fell further and further behind. Halfway through the year, Eva took it upon herself to ask for help. She would stay after from lessons and ask questions. As soon as she left the lesson table, she would begin to work on the follow-on since it was fresh in her mind.

Montessori is a good fit for Eva because she thrives in smaller groups. She struggles to maintain her attention at the lesson table, but it is easier for her to be a part of a smaller group which creates fewer distractions for her. The study also allowed Eva to become a leader. Since the rest of the students were from different classrooms Eva would politely remind the students to bring their notebooks and pencils when it was time for the lessons.

Art is something that Eva enjoys. When she fell behind in her classwork, she would always manage to complete her art integrated math follow-on. She would always finish her art lessons, but only sometimes finish her math. I noticed that she was only turning in her art follow-on and I asked her about it. Her response was, “The art lessons are so much fun and the math lessons are just more work.” Although for many of the art lessons Eva was using math components she may have not realized it since she was focusing on the art components.

In both Eva’s pre and post-study surveys, her answers mostly remained mostly the same. Here were some of her answers that remained consistent: “I don’t think math is fun, but I want to get good grades in it,” “Math is just as important as any other subject,” “I like to do math ‘In my head,’” “I enjoy doing problems when I know how to work them out,” and “I get tired of working with numbers.” Eva still disagreed with, “I have never liked mathematics.”

The views of some students did not change throughout the course of the study. A student whom we will call “Gabby,” a fifth grade student seemed to not be impacted throughout the course of the study. Gabby is a very bubbly student with strong opinions. Math is a subject that Gabby believes she is proficient in. Her follow-on work and test

scores show otherwise. Throughout the ten weeks, Gabby’s engagement in the study did not increase, she appeared to be withdrawn and not engaged. She would show up to lessons unprepared and not have her follow-on complete.

I sent frequent reminders to Gabby about what the follow-on was and when it was due. Gabby completed the majority of the art-integrated math assignments. She mentioned many times that she did not need help when it came to math. In both the pre and post-study survey results Gabby disagreed with the following statements: “math is confusing,” “math is boring,” and “I have never liked mathematics.”

In addition to the academic discoveries the integration of art also allowed me to observe the fine motor skills of the students. One student in particular showed difficulty in holding both a paint brush and a compass. In order to address these needs the student could be introduced to practical life activities that address his development of hand strength and fine motor skills.

Initial MAP tests were taken in the fall. MAP tests are state aligned adaptive tests that reflect the instructional level of each student and measures their growth over time.

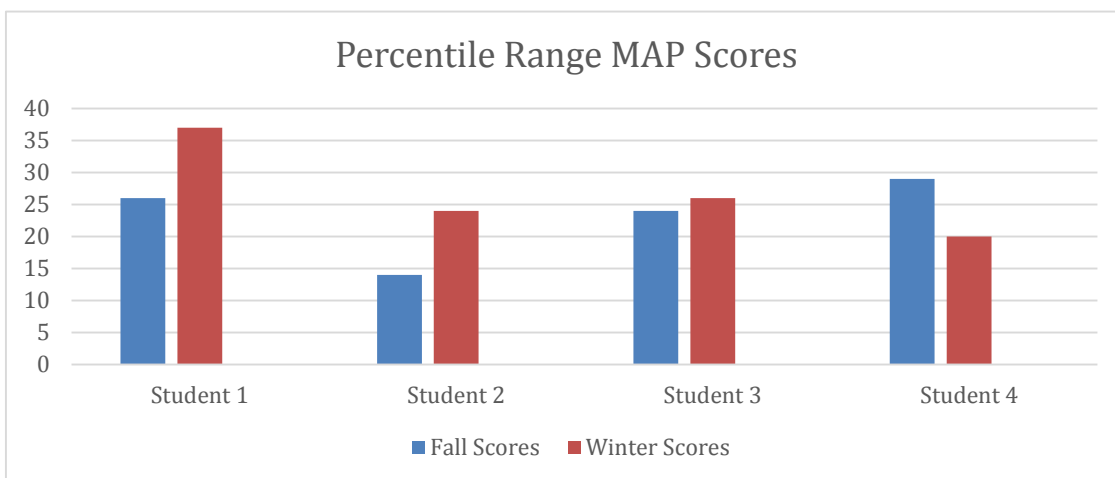


Figure 1: Percentile Range MAP Scores

Four out of the five students took the MAP test in the winter. The same four students' RIT (Rasch Unit scale) scores improved, however one student's percentile decreased (Figure 1). Because the standardized test covers more than the specific material of the intervention, a direct correlation cannot be made between the study and the improvement in the standardized test scores. However, based on observations, student surveys and student work, it appears that further research may establish a connection.

Throughout the course of the study students created portfolios of their art work. The following elements of art were reviewed: color, form, line, shape, space, texture, and value. Students took the elements of art and applied them to math practices. Patterns, facts, and illusions were also heavily focused on. In geometry there is a lesson about the concept of the line. The lesson was given and the students created a follow-on utilizing art elements. Each child displayed different abilities in art. Throughout the course of the study the children's art skills advanced.

A variety of styles of art and artists were covered. The students looked at the different ways to define details of a painting or the different media that could be used. They experimented with using different media. Paper, colored pencils, acrylic paint, markers, and other materials were used by the students while making their art follow-on. Below are some examples of student work from the study.

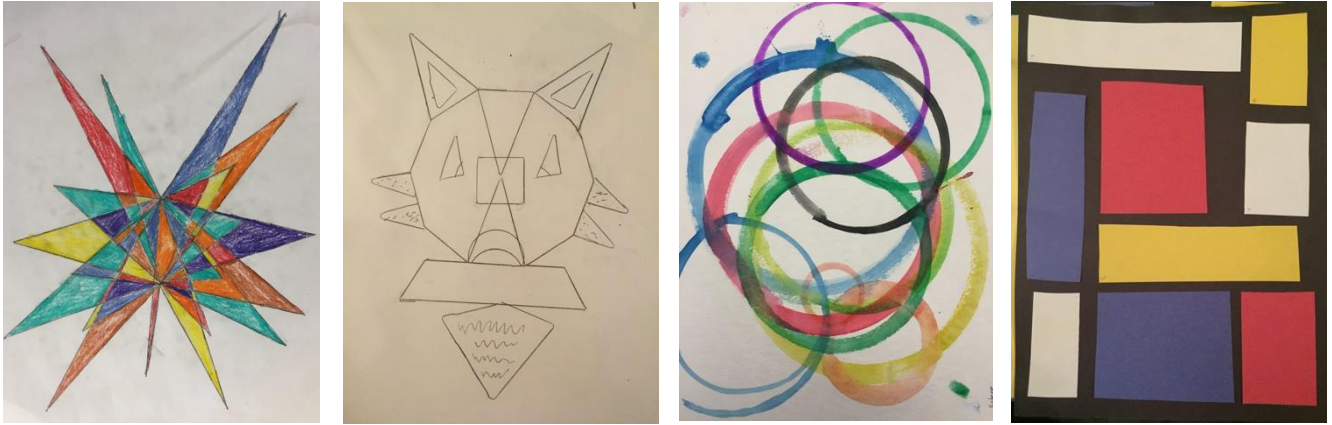


Figure 1: Geometry Star (Medium- colored pencils)

Figure 2: Picasso Polygons (Medium- pencil)

Figure 3: Kandinsky Compass Circles (Medium- water colors)

Figure 4: Mondrian Quadrilaterals (Medium- construction paper)

Discussion and Action Plan

The purpose of this action research was to establish whether arts integration in Montessori mathematics was a contributing factor to student engagement and an increase in standardized test scores. Based on observations and student work, student engagement in lessons increased. Standardized test scores also increased; however, there is no evidence to indicate that the intervention was the sole reason for the increase in scores. Other factors being classroom math lessons, homework and math follow-on.

I discovered that over time the students became more confident in both their art and math skills. Towards the beginning of the study, students were very quiet and unsure of their abilities. As time went on, the students' engagement in the lessons showed significant growth. The students benefited from working in small groups and from building a sense of community and trust with one another.

The art lessons were always the students' favorite lessons. Each art integrated lesson still focused on a math concept. During the lesson I would often tell the students details about the artist's life and would ask them what they thought about his/her work. This allowed the children to develop diverse appreciation for the art by looking at it through different lenses.

I feel that the art integration in the math lessons made an impact with these students on their mathematical journey and am excited to share the results of this study with my coworkers and collaborate to incorporate these lessons in a broader way. Based on what I learned from the study there are some things I would change. I would incorporate a unit on individual artists and focus on more than one of their artworks. Art integration would be added in every math lesson instead of math one day and art the next. Larger projects would be integrated for ongoing work instead of focusing on one project for a brief period of time and switching to another.

Further action plans would also include a larger sample size. It was helpful to have a small group because I was really able to individual my instruction, however the small sample size means that it was difficult to draw conclusions to the data. Having a larger sample size would confirm whether or not the data holds firm for a broader range of children. Gender of the students and their predispositions about math could also be a further topic to investigation. Art integration could also be a choice independent work for students to choose during the daily work period.

APPENDIX A

Math! Math! Math!
How do YOU feel about Math?

Name:	Agree	Disagree	I don't know!
1. Math is confusing.			
2. I like math, but I like other subjects just the same.			
3. Math is boring.			
4. I don't think math is fun, but I want to get good grades in it.			
5. Math is just as important as any other subject.			
6. I like to do math "in my head".			
7. I enjoy the challenge of a hard math problem.			
8. I have always been afraid of math.			
9. I use math every day (outside of math class).			
10. I don't like math and avoid using it at all times.			
11. I enjoy doing problems when I know how to work them out.			
12. Math is my favorite, and I like it better than any other subject.			
13. I get tired of working with numbers.			
14. I am afraid of problem solving (word problems).			
15. Math is very interesting.			
16. I have never liked mathematics.			

References

- Appel, M.P., (2006). Arts Integration Across the Curriculum. *Leadership*, 36(2), 14-17.
- Bickely-Green, C.A., (1995). Math and Art Curriculum Integration: A Post-Modern Foundation. *Studies in Art Education*. 37(1), 6-18.
- Baker, D., Art Integration and Cognitive Development. *Journaling for Learning Through the Arts*, 9(1).
- Charland, W., (2001). Art Integration as School Culture Change: A Cultural Ecosystem Approach to Faculty Development. *International Journal of Education and the Arts*, 12(8).
- Gullatt, D.E. (2008). Enhancing Student Learning through Arts Integration: Implications for the Profession. *High School Journal*, 91(4), 12-25.
- Hartle, L.C, Pinciotti, P., & Gorton, R.L. (2015). ArtsIN: Arts Integration and Infusion Framework. *Early Childhood Education Journal*, 43(4), 289-298.
- Ingram, D., & Riedel, E., (2003). What Does Art Integration do for Students?. *Center for Applied Research and Educational Improvement*, 10, 1-42.
- Lillard, P.P., (1996). *Montessori Today: A Comprehensive Approach to Education from Birth to Adulthood*. New York: Schocken.
- Parr, N., Radford, J., & Snyder, S. (1998). Kaleidoscope: Building an Arts-Infused Elementary Curriculum. *Early Childhood Educational Journal*, 25(3), 181-188.
- Robinson, A. H., (2013). Arts Integration and the Success of Disadvantaged Students: A Research Evaluation. *Arts Education Policy Review*, 114(4), 191-204.
- Smithrim, K., & Upitis, R., (2005). Learning Through the Arts: Lessons of Engagement. *Canadian Journal of Education*, 28(1/2), 109-128.

Standing, E.M., (1998). *Maria Montessori: Her Life and Her Work*. New York. Hollis & Carter.