

St. Catherine University

SOPHIA

Masters of Arts in Education Action Research
Papers

Education

12-2022

Integrating Montessori Curriculum with State Standards in a Public Montessori School

Brenda Green

Follow this and additional works at: <https://sophia.stkate.edu/maed>



Part of the [Educational Methods Commons](#)

Integrating Montessori Curriculum with State Standards in a Public Montessori School

Submitted December 12th, 2022

In fulfillment of final requirements for the MAED degree

Brenda Green

Saint Catherine University

St. Paul, Minnesota

Acknowledgements

During this research, I thank God and my family for your inspiration to accept this challenge. I appreciate my administrator and curriculum facilitator's support and knowledge given during this journey. Additionally, a heartfelt thank you to my cohort team. My journey was made possible through sharing many long nights of communication, reminders that we are in this together, and encouragement to continue. Thank you, I could not have completed this study or obtained my degree without your kindness. Thank you to everyone who supported me through this process.

Abstract

This action research aimed to highlight the benefits of integrating the Montessori Math Curriculum with State Standards in an upper elementary classroom. The performance of the action research took place over six weeks at a public Montessori school. There were seventeen upper elementary participants. Documentation used in this action research was a tally sheet for observable use of Montessori math material, school weekly lesson plans, teacher observation and reflection notes, and student and parent Pre and Post Math Interest Surveys. All lessons were given daily during the morning hours according to the school master's schedule. Some positive effects of this action research include changes in student feelings towards math and increased autonomy. For clarity in other areas, extend the action research period beyond six weeks to allow more students to practice with Montessori lessons meeting various standards.

Keywords: Montessori Mathematics, public school, upper elementary, standards, integration, math anxiety, constructivism

Introduction

My research intends to support students' mathematical understanding in a Public Montessori School setting. Integrating Montessori Math Curriculum with the State Standards provides students with additional learning opportunities and skills, particularly in the public-school setting. In this research project, I observed the integration of the Montessori Math Curriculum with North Carolina State Standards and its impact on student achievement. Students in this public Montessori school take district and state tests meeting North Carolina State Standards. In the words of McIntosh (2015), "As Montessorians, we seek to determine if our curriculum will address these state standards" (p. 3). Students learn mathematical concepts and strategies using Dr. Montessori's didactic materials and conceptual lesson design through phases aligned to the planes of development. These didactic materials offer students an opportunity to experience the concepts through concrete methods, which point to an abstract understanding of each passage or lesson. Doing this removes the primary focus on test-taking but highlights the success of understanding each concept and growing math competency.

The beauty of the Montessori methodology is the freedom of movement and the accessibility of the material. The prepared environment sparks the students' interest in engaging with materials and gives a student choice. This process allows the teacher to construct learning activities involving real-world scenarios, like the Montessori Bank Game or the Exchange Game. The Montessori Bank Game and Exchange Game aims to reinforce place value understanding and resemble the experience of going to the bank to receive cash and make change. Students receive a numerical representation to request that quantity from the banker. This transaction may be necessary to exchange for larger pieces to fulfill the desired quantity. These activities allow the students to experience real-world banking transactions. "Correct answers are not emphasized;

students must combine math content with developed habits of mind to solve increasingly complex problems" (Anderson, 2022, p. 4). Students can experience and relate mathematical concepts within their world using a conceptual understanding. Solving real-world problems and using these strategies throughout their learning process to view numerical information as it occurs in their everyday life. Making connections from the concrete experiences found in the classroom environment. Students build each layer of understanding from feedback, which develops a mathematical understanding that inspires a growth mindset. The use of feedback helps students understand that we build on what we know in mathematics. "While using Montessori material during the learning sessions, if a student makes a mistake or has any problem, he/she can refer to the material as a reference point" (Faryadi, 2017, p. 2).

I am conducting this study with upper elementary school children to assess their knowledge and feelings about mathematics. Students must not see math as something they get an answer for quickly to satisfy testing. Math is all around us, and students need to connect to its usefulness to understand the skills and strategies used in the classroom to move toward abstraction. I collected the impact on student achievement in this study of the integration of Montessori Methods and materials with state mathematics standards. Public Montessori school programs encounter many challenges, one being the gap in knowledge of Montessori Curriculum leveling. However, I am Montessori Certified at the lower elementary level but teach at the upper elementary level. The planning to integrate Montessori Methods at this level will take practice and preparation. The planning begins with a review of Montessori materials, presentation passages, and how the integration meets the expectation of state standards. "Another challenge for researchers studying Montessori is that most public Montessori Programs are choice programs" (Brown & Lewis, 2017, p. 4). Families of Public Montessori schools may be given

random assignments while the district and state standards set the classroom environment regarding the number of students. In this case, students may enter Upper Elementary without prior knowledge of the protocol for moving into the Montessori Setting.

Results of the year 2021 -2022 students' performance on standardized tests proved that this approach increased their knowledge of math concepts. Students scored seventy-seven percent above the fortieth percentile statewide. This class showed fifteen percent growth with the gradual integration of the Montessori Curriculum. It was clear that the added boost in achievement came from using the Montessori approach. This study is important to this public Montessori school. The effort is to implement and maintain the Montessori Methods' authenticity while meeting the state standard course of study expectations in mathematics. Being in a Public Montessori Setting, it is easy to lose focus and follow the district-provided curriculum as a script.

The action research took place with displaced students because a weather event destroyed their school. The students and staff were relocated to another school within the district. The class composition included seventeen students, nine girls and eight boys. This multi-age class had nine fourth graders, including one Nigerian, and all others were African American. Amongst the eight fifth graders, there was one Hispanic student. Two of these students were identified with Individual Educational Plans, and one student is currently being evaluated. Incorporating Montessori math materials from the previous grade reintroduced the Montessori philosophy and built community in the classroom. This research examined the impact of integrating the Montessori Curriculum with State Standards in upper elementary math lessons.

Theoretical Framework

The Montessori philosophy is the lens selected to conduct this research. According to Marshall (2017), two essential aspects of the Montessori Method are the learning materials and

the self-directed nature of children's engagement in constructing their learning (Marshall, 2017). In this student-centered environment, the teacher inspires, encourages, and guides students to self-educate, become independent, and own their learning (Alsharif, 2014). "Montessori is a holistic form of education that creates an environment that encourages the development of the whole child" (Pailoor, 2015, p. 1). "Montessori education provides children experiences in learning how to learn" (Pailoor, 2015, p. 1). Similar to the Constructivist approach to education. Constructivism Theory is where students use their world to construct knowledge of what is happening in the classroom as it relates to math. Constructivism goes beyond students constructing their learning, but it includes the teacher's skill who facilitates the student-centered learning environment. According to Vanhorn et al. (2019), Constructivism employs engagement moving from experience to learning rather than learning then experience (Vanhorn et al., 2019). "A constructivist teacher is open to change, teaching in a new light, and willing to combine good teaching strategies with federal and state accountability measures" (Brown-Joseph, 2010, p. 40).

Witnessing students' growth through subtly integrating Montessori math materials with the state standards and curriculums inspired further exploration of a more intentional integration. Theoretically, Dr. Maria Montessori's work to provide a child-centered approach to learning and the constructivist approach are pretty similar. The guide creates an environment where children have a sense of belonging, freedom of movement, and engaging experiences is core to the Montessori Philosophy. Constructivism Theory allows children to build knowledge in an environment designed specifically for their learning.

Environment design happens with the guide building relationship and observing children's movement in the learning environment. The theory for this research is to introduce Montessori math materials with intentionality to meet the material's aim and the State Standards'

goal. Dr. Montessori has scientifically designed hands-on learning materials based on her experiences with children. These didactic materials will grow with the child and are self-correcting. The constructivism theory of teaching and learning states that children construct knowledge using new experiences with what they already know (Bada, 2015). Dr. Montessori has designed materials to serve multiple purposes, and the guide will present them in various phases to align with the child's plane of development. Thereby encouraging the continued learning for students individually at their learning levels.

Much of the literature concentrates on research articles that compare traditional and Montessori instructional approaches. Additionally, Peterman (2019) discussed the effects of movement on student math anxieties. The Montessori philosophy introduced math materials early, offering students a concrete method to make connections which helps to reduce math anxieties. Finally, becoming familiar with Jo Boaler's work to develop students' mathematical mindset offers some investigation ideas to best assist students in preventing math anxieties. Through this exploration, the goal is to determine how constructivist techniques, Montessori philosophy, and math tools help develop a mathematical mindset and lessen math anxieties. Also, using the results of this study to make recommendations on how to fill in knowledge gaps and eliminate math anxiety for my students. My goal is not to tell teachers how they are doing it incorrectly but to provide a tool for helping them regardless of their level of certification. This research aims to offer the best possible math education for children. The integration of Montessori math materials would help support mathematical growth in students. It is not the goal to correct teachers but rather to recommend how to fill in knowledge gaps with the findings.

Literature Review

Education has recently been challenged and targeted for various reasons. Stotsky wrote that accountability tests would drive the school curriculum until new mechanisms for accountability are adopted. Adopting curriculums closely related to authentic learning in K–12, standardized testing, and a range of coherent curricula that are frequently developed has happened (Stotsky, 2016). The No Child Left Behind Legislature has impacted public education by increasing the focus on tested subjects. The impact has contradicted constructivist practices derived from cognitive psychology (Mallett, 2014). Educators are cautioned not to teach "the test" and to prepare students to provide an answer to questions modeled after those found on the test. According to the National Council of Teachers of Math, "teachers prepare students to provide an answer to questions modeled after those found on the test" (Bartley, 2014, p. 31). The National Council of Teachers of Math, "Productive Beliefs states that "finding answers to a mathematical computation is not sufficient" (Bartley, 2014, p. 31). "Students need to understand whether an answer is reasonable and how the results apply to a given context" (Chapman & Mitchell, 2018, p. 2). However, it has become more commonplace for teachers to teach the test as provided in the curriculums supplied by school districts. Dr. Maria Montessori follows the child in her practice, teaching skills, and strategies. Using Dr. Montessori's method in this research will allow for a return that allows the standards to drive the instruction. Integrating Montessori math materials will help to change students' math mindset to learn the concepts instead of believing they must get an answer.

The field of education seems to be an ever-changing, evolving, and dynamic entity. However, two things seem to have changed very little over the years: assessments and grades (Ballard, 2010, p. 1). Ballard wrote, "little research exists to show if students are improving as a

result of the implementation of standards-based reporting systems" (Ballard, 2010, p. 2). The impact has contradicted constructivist practices derived from cognitive psychology (Mallett, 2014). Berube writes (2004) that teachers in high stakes testing situations felt more pressure to have their students perform well and, therefore, more closely aligned their teaching to the test (Berube, 2004, p. 266). While educators are cautioned not to teach "the test," it has become more commonplace for teachers to teach the test as provided in the curriculums supplied by school districts. According to Ballard (2010), the typical cycle of teach/test/repeat involves very little thinking on the Teacher's part, and the importance of standards-based reporting becomes evident (Ballard, 2010, p. 24). Draper stated, "While many mathematician teachers agree with the tenets of math reform in general and constructivist perspectives specifically, they may find them difficult to embrace because they represent a way of teaching and learning that is very different" (Draper, 2002, p. 4). Maria Montessori wrote, "Therefore, the education of even a small child does not aim at preparing him for school but life."

Schools of Education take on many forms, methodologies, and curriculums. Teaching and learning remain constant despite the methodologies, curriculums, and approaches. According to Faryadi, the unique methodology of teaching found in the Montessori approach must be applied precisely for positive outcomes (Faryadi, 2017, p. 4). Students will learn under the auspices of the Teacher's teaching. Lopata, Wallace, & Finn (2005) stated, "Montessori and traditional education programs reportedly differ in several ways, including physical environment, instructional methodology, and classroom attitude" (Lopata, Wallace, & Finn, 2005, p. 2). Montessori public and private schools have followed state standards and used district-provided curriculums/resources for decades.

Instructional Approach

Traditional schools search for ways to close achievement gaps by reevaluating adopted curriculums every few years and changing approaches (Kofa, 2017). Montessorians have strived to sustain a quality curriculum that adheres to and often exceeds the state standards while maintaining an authentic Montessori program. According to Harriston (2008), Montessori programs have grown considerably over the past 20 years. With growth comes concerns about outcomes, especially academic ones. “Many Montessori schools have shown evidence of high achievement levels, and such results can be difficult to interpret for various reasons” (Harris, 2008, p. 27). “Many Montessori schools have created curriculum maps that coincide with the state standards to show their commitment to excellence” (Driskill, 2014, p. 4). Draper stated, “Constructivist teachers observe to decide what each learner is capable of and willing to learn” (Draper, 2002, p. 4). In the Montessori philosophy, where teaching the whole child is a key factor, the guide observes to know how to stage the environment. The environment is designed to meet students' needs with enrichment and intervention activities that construct knowledge. Based on these observations, the constructivist Teacher creates an environment that will provide the learner with the opportunity to construct knowledge. “Rather than allowing the learner to wade through an unguided experience, the constructivist Teacher provides opportunities for the learner to question, probe, and ponder” (Draper, 2002, p. 4)

Part of the guide who creates the environment and knows the aim of the Montessori Math materials must build relationships with students to encourage students to continue working to build knowledge. Using Dr. Montessori's method and math materials integrated with State Standards in this research will allow for a return that allows the standards to drive the instruction.

Physical Environment

Dr. Maria Montessori suggested guides, the term she used to refer to teachers, also referred to in the literature as "guides." The guide follows the child and prepares the physical environment where all children can learn in their plane of development. In the Montessori classroom, children learn from experiences laid out by the teacher guide to teaching skills and strategies, which can affect student outcomes. Teachers use anecdotal notes to guide instruction. The goal in the classroom is to construct an environment with real experiences for children so that it engages the brain and builds social settings where conversations about learning can take place. The preparation of a Montessori classroom takes careful consideration. Montessori classrooms are designed to be student-centered. It considers placing materials at the appropriate eye level of the child, accessibility, and spiraling of concepts needed to construct the student-centered learning environment. Classroom guides must ensure freedom of movement, allowing the student to select materials without distracting others. Montessori materials developed by Maria Montessori are based on independent self-correcting activities to stimulate a student's natural ability and intellect and entice the child to want to learn (Kofa, 2017).

Classroom Attitude

Hearing more student talk and less teacher talk indicates that learning is happening. Also, helping to change students' math mindset to learn the concepts instead of believing they must get an answer. The choice of materials and movement throughout the classroom become another critical factor in educating children. Student choice in the Montessori classroom develops student ownership of learning (Brown, 2016). The Montessori Guide teaches students to ask for a lesson on materials they find interesting. In addition, teacher guides invite students to partake in lessons based on carefully observing students' needs and interests (Brown, 2017). Movement allows

students to determine where in the room they want to work. They may work anywhere in the room and purposely move around, engaging their curiosities (Mallett, 2014). Montessori students naturally engage in academic discourse with peers without the Teacher's permission. These practices are learned through grace and courtesy so that they can engage without disrupting others. According to Kofa (2017), the last step to building stamina for concentration is time. This uninterrupted time for independent student engagement and exploration. As noted, the Teacher is referred to as a guide in a Montessori classroom. Researcher Brown wrote, "The Montessori motto is "follow the child"; the role of the Teacher is to guide and facilitate activities for individual students and small groups rather than lead the class in whole-group, direct instruction" (Brown, 2017, p. 1).

"Supporters of process-based work argue that if students are given open-ended, practical, and investigative work that requires them to make their own decisions, plan their routes through tasks, choose methods, and apply their mathematical knowledge, the students will benefit in a number of ways" (Boaler, 1998, p. 2). Open-ended investigative work is where students choose their material and/or method to apply to solving mathematical problems based on the Montessori philosophy. Integrating Montessori Curriculum with States Standards will impact students' mathematical mindset, thereby increasing academic achievement in math.

Methodology

My action research began with an introduction letter given to the seventeen families currently in my class at the time of the study. This letter explained the purpose and process of the research and requested permission for student participation. All seventeen families received a math interest survey to complete, which would be given again as a follow-up to the action

research. Only nine of the seventeen families completed the initial survey, and only two families completed the follow-up survey.

During the action research, a few administrative accommodations were required and made available to students. One student required a separate test setting, extended time, and read-aloud. This student received these accommodations, when necessary, through the support of the classroom co-teacher and peer assistance. During lessons, this same student received preferential seating as stated in the Individual Education Plan and was paired with two other students for cooperative learning lessons during math.

In this multi-aged classroom, fourth- and fifth-grade lessons were presented in small groups. The North Carolina Fourth-Grade State Standards I addressed in the lessons are as follows:

- Standard 4.NBT.2: Read and write multi-digit whole numbers up to and including 100,000 using numerals, number names, and expanded form using Montessori golden beads and number cards for the expanded form. Generalize place value understanding for multi-digit whole numbers.
- Standard 4.NBT.1: Explain that in a multi-digit whole number, a digit in one place represents 10 times as much as it represents in the place to its right, up to 100,00
- Standard 4.NBT.7: Compare two multi-digit numbers up to and including 100,000 based on the values of the digits in each place, using $>$, $=$, and $<$ symbols to record the results of comparisons.
- Standard 4.NBT.4: Add and subtract multi-digit whole numbers up to and including 100,000 using the standard algorithm with place value understanding.

To teach these standards, I used a combination of the following materials:

- Montessori Place-Value Chart
- Small and Large Bead Frames
- Checkerboard (addition)
- Stamp Game
- Dot Board
- Golden Bead Material (used with dice)
- Numeral Cards
- Geometry Cabinet

The pairing of these materials with the standards is broken down in the Chart 1.

In terms of the fifth-grade lessons, I addressed the following North Carolina State Standards:

- NC.5.NBT.1 Explain the patterns in the place value system from one million to the thousandths place. • Explain that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and $\frac{1}{10}$ of what it represents in the place to its left. • Explain patterns in products and quotients when numbers are multiplied by 1,000, 100, 10, 0.1, and 0.01 and/or divided by 10 and 100.
- NC.5.NBT.3 Read, write, and compare decimals to thousandths. • Write decimals using base-ten numerals, number names, and expanded form. • Compare two decimals to thousandths based on the value of the digits in each place, using $>$, $=$, and $<$ symbols to record the results of comparisons.
- NC.5.NBT.7 Compute and solve real-world problems with multi-digit whole numbers and decimal numbers. • Add and subtract decimals to thousandths using models,

drawings or strategies based on place value. • Use estimation strategies to assess reasonableness of answers.

The Montessori materials I used in addressing these standards included:

- Montessori Place-Value Chart
- Small and Large Bead Frames
- Checkerboard (addition and multiplication)
- Decimal Hierarchy Board
- Stamp Game
- Decimal Stamp Game
- Dot Board
- Golden Bead Material (used with dice)
- Numeral Cards
- Geometry Cabinet
- Peg Board

(see Appendix A)

Math anxiety was a challenge for these students. I incorporated strategies to lessen these emotions during Grace and Courtesy lessons given during the first ten days of school. I continued this effort with our daily routine, which included Social Emotional Learning activities, and math mindset discussion to help reduce students' math anxieties and relearn social skills after returning from the pandemic. Students would also recite our class mantra and positive affirmation. The class mantra was: "I can do this; I believe I can, and I won't be defeated." The affirmation was: "I am Somebody. I was Somebody when I came. I am going to be a better somebody when I leave. I deserve the best education ever. I have important people to impress

and exciting places to go. Nobody is going to hold me back. I *am* somebody.” This is an excerpt from Rita Pierson's TED Talk of May 3, 2013. <https://youtu.be/m96F3rl6yyM>

Data Analysis

This action researches aimed to see effects of integration of Montessori math curriculum with the state standards in a public Montessori school. In this research there were seventeen upper elementary students at a public Montessori school. The children in this multiage classroom participated for the first six weeks during the beginning of school year 2022-2023. The action research began with a math interest survey given to parents at the school open house. The students completed the math interest survey once their individual school devices were received in class. Presentation of grace and courtesy lessons were given during the first ten days of school as students were introduced to the daily schedule and class expectations.

At the beginning of the research students complete a math mindset activity during grace and courtesy week. In preparation for this action research, it was stated that the pre-assessment would be provided through the district curriculum in a pre-unit quiz, to administer. According to the district expectations and guidelines, our school has adopted another process. Students were given a teacher prepared pre-quiz. This pre-quiz included standards that were on the first state assessment to be given. Additionally, students participated in the Northwest Evaluation Association (NWEA) assessment on September 27, 2022 as part of district guidelines. The pre-quiz was given as a post-quiz to close out the research project (See Appendix B).

All children were present in the whole group impressionistic lesson for place value understanding to meet the first state standard in Numbers in Base Ten (NBT). Daily data collection began following the first lesson. The lessons plans were written using North Carolina State Standards, Eureka Math curriculum, and Montessori Math Album for the 6-9 level as a

resource. Each day a lesson was given on place value concepts and a Montessori math material was used to give children a visual representation. This research was the children's first exposure to these Lower Elementary Math materials. Initial documentation started with the lesson given (see Appendix C) and recording responses with work-cycle observation tallies to note who was using the material, what material was being used, and if the materials were being used appropriately. Reflective notes were taken to plan future lessons and note thoughts of formative instructional practices. The following reflective questions were used daily:

1. What Montessori Math lesson(s) did I give?
2. Who received the lesson(s)?
3. Thoughts on how the lesson(s) went?
4. What are the next steps?

There were informal check-ups given for students to demonstrate mastery of the standards throughout the process. Check-ups are given on the standard taught after students have had a lesson, an opportunity to practice, and some students expressed that they were ready to demonstrate mastery. Check-up questions were written in order to unpack the standard by necessary skills. This determined if students were able to perform and meet the expectations of the standard. For example: I can read, write, explain, compare, order, solve, et cetera. Students were given multiple lessons thought out the weeks to keep up with district pacing. Struggling students were provided small group instruction to help clear misconceptions. My team held weekly data discussions and the quiz and classwork results were used to provide Tier 2 or 3 interventions.

Eureka Coaching visits will continue, students will participate in NWEA Assessments although the Montessori math materials and lessons will lead the instruction. Eureka and the

district pacing will be utilized as a secondary resource and intervention methods will be applied as needed.

Parents were asked to complete and return their math interest survey by September 6, 2022. Students completed their survey in class on September 6, 2022 using a google document through the schools learning management system. One response that I found to be very interesting was how students viewed themselves and the purpose of learning math (see Appendix E). Only three of my students stated they did not view themselves as mathematicians. When asked, “What is math?” the significant response was learning operations. Many students were explicit in that it was to learn addition and subtraction in the fifth year, including fractions and decimals. However, when asked why we learn math, the response was about getting a job. It became my mission to ensure that the students understood how numbers work and why math is necessary during the Social Emotional Lessons (SEL) each morning before going into our math lessons.

Week 1 math lessons began with Numbers in Base Ten strand in alignment with the North Carolina State Standards. Students reviewed the place value chart by building the chart, building quantities on it, reading digits placed on the chart, analyzing a given quantity with exchanges and comparing using a place value chart all before moving on to reading and writing in standard form. Next, I added the numeral cards and discuss how we read and write numbers. Students were challenged to read and write numbers larger quantities each time. This lesson transitioned into reading decimal numbers for my 5th-year students. Students could work with the bead frame and Montessori stamps to read and write numbers before engaging in a review assessment. Students were able to take the felt place value chart and begin to draw this chart as we use this chart to explain that digits move in powers of ten. As the math lessons progress and

new standards are being introduced the students are given work cycle time to practice these skills independently or with a partner. In the interest survey there were eleven students who preferred to work collaboratively and nine who wanted to work on the floor. This is expected in the Montessori environment. I observed students peer teaching and the type of discourse students were engaging in was inline and focused on the lesson.

Social Emotional Lessons were given every morning to help students feel a sense of community and build self confidence in the work they were about to engage in for the day. We shared the positive affirmation pledge each morning and now the students would take turns leading our class in this daily. We had a “mirror into self” activity to allow students to change the views they have of themselves.

Findings

The integration of the Montessori Philosophy, allowing the freedom of movement and has allowed students to engage at their own pace. My observation included watching students make the same choice of materials that were already mastered. The changed their views about keeping all their facts in their head to using the materials to problem solve and reduce the amount of times they asked the teacher for help. Additionally, Students have indicated their preference for working during work cycle (see Appendix F). The students became more confident and the need to ask the teacher for help decreased but the desire to write about math increased (see Appendix F).

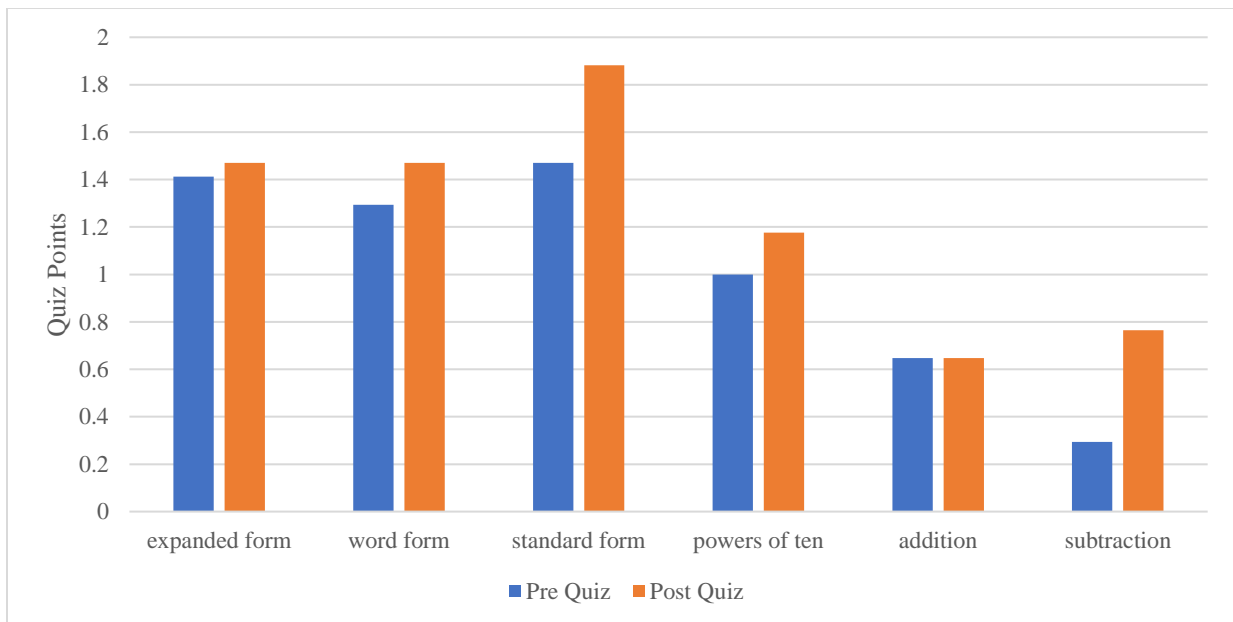
After giving the lessons as mentioned earlier, I found it very interesting that students would revert to materials they were familiar with even if that material did not serve the purpose of the work they were expected to complete for the day. It took repeated redirection for students to practice with the prescribed lessons and materials.

Data Analysis

Appendix A compares the data from the pre and post quiz. Students were able to answer more subtraction question correctly after the six-week integration. There was an increase understanding of writing numbers in Expand form, word form, and a significant increase with reading standard form. Students confidence with reading and writing numbers in these forms allowed them to develop an understanding of how numbers work and use the rule of power of ten.

Figure 1

Post and Pre-Quiz Results



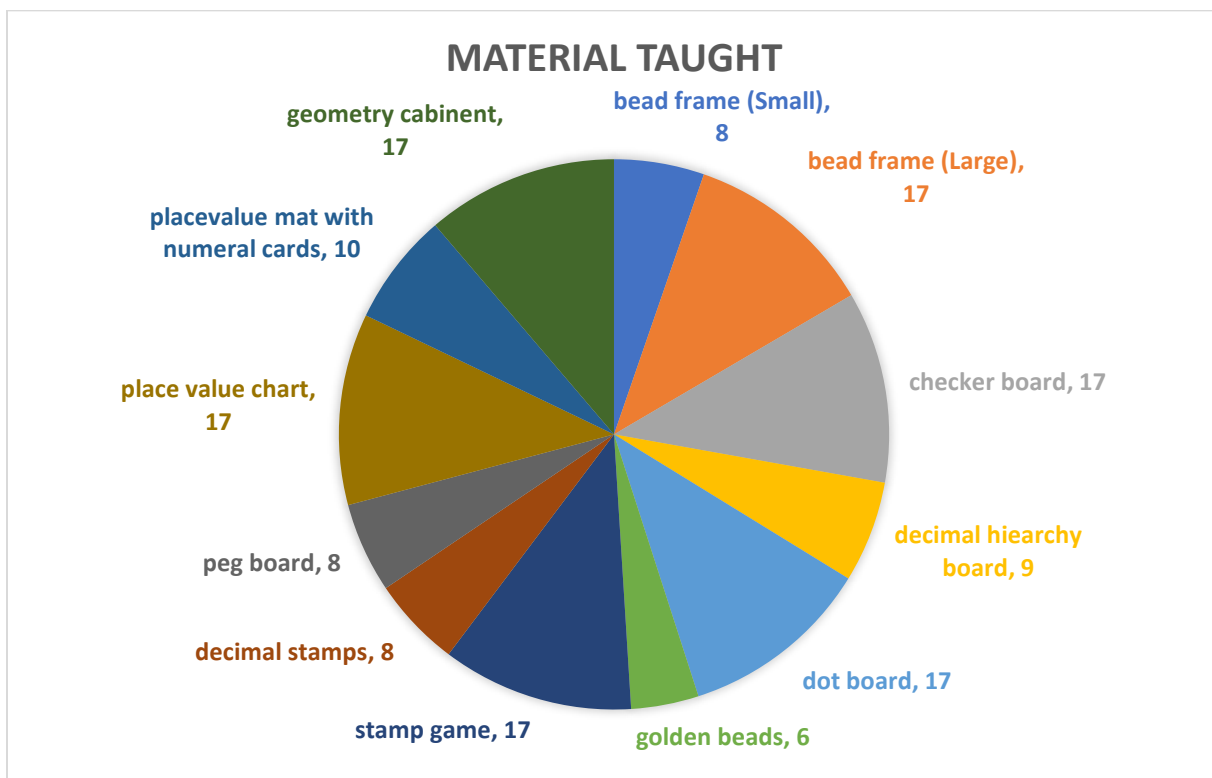
Appendix B

Figure 2 shows the Montessori materials taught and the number of students who received those lessons. See Appendix B to view the data collection tool used to complete Figure 2. Of the twenty-seven different materials that were taught the students were given the initial lesson and the various passages as the child developed through the three levels. Students were responsible

for determining when they were ready for the next passage. Some of these lessons were delivered individually and others were delivered in small group based on the needs of the students. Fewer lessons were given with golden beads as this was a remediation lesson to help students visualize concept of exchange and knowing that ten ones is the same as one ten. While there were geometry materials presented to prepare students for upcoming work and give them time to practice concepts. In the philosophy of Montessori, the peg board lesson was introduced to those students who demonstrated a need to move onto the next skill level and begin practice.

Figure 2

Math Materials Usage Report



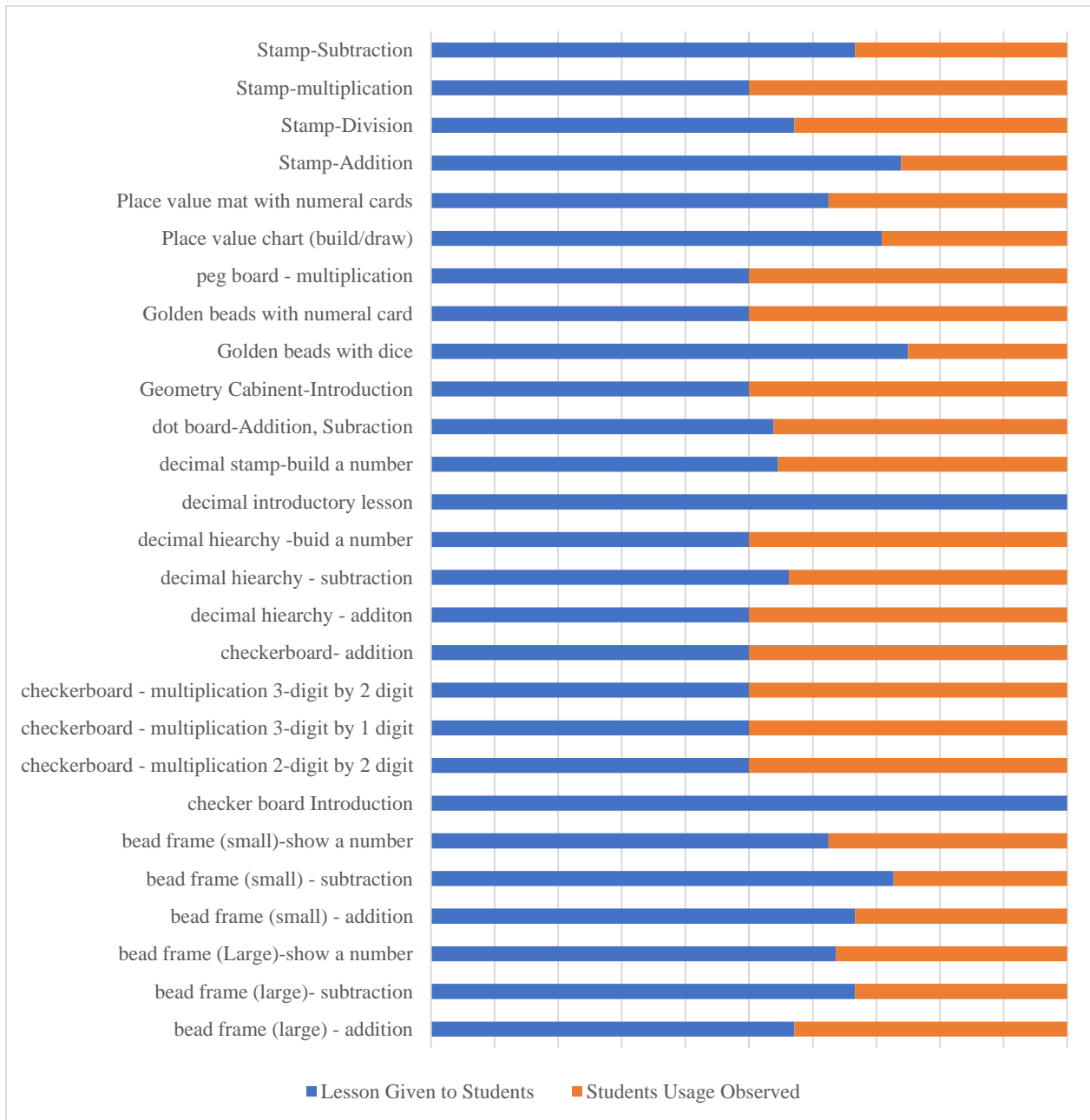
Note. Chart 7 was used to collect the work cycle observations and tallies of lessons given and material usage. Montessori Lessons given and how many students received those lessons.

Appendix C

Although there were twenty-seven materials taught. Students were presented passages for each concept as they demonstrated readiness. Looking at Figure 3 there were two impressionistic lessons which only show presentation without usage data. This lesson was given to bring student into an awareness of the future lesson that would take place later. Students were more likely to use the materials when solving multiplication than with addition. When solving addition and subtraction problems students used the more abstract methods to solve and less of the concrete methods. There were fewer students receiving the golden beads lessons. So, the usage report indicates low usage as well.

Figure 3

Montessori Lesson Given



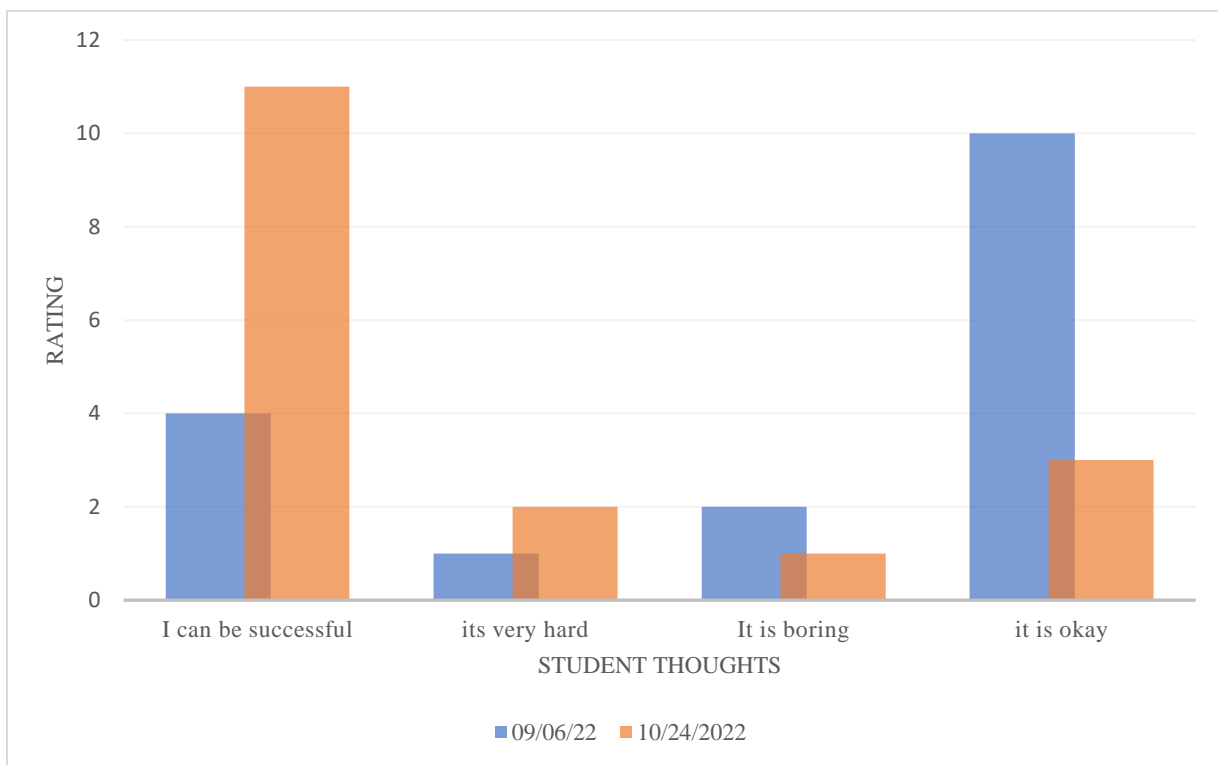
Note. This graph explains the lessons given with the twenty-seven materials taught. However, the lessons given include multiple passages with various materials. Standard expectation is found on Chart 5.

Appendix D

The students believed they could be successful in math following the six weeks of integration of Montessori Math Materials according to their pre and post Math Interest Survey results. Providing students with ore opportunity to use their hands to do math allowed for a change in their mindset. Initially students believed learning mat was just okay and boring. Through the Montessori practices more students began to believe they could be successful and less felt that math was boring.

Figure 4

Students Feeling Towards Learning Math



Note. Students’ feelings towards learning math from the math interest survey (see Chart 1).

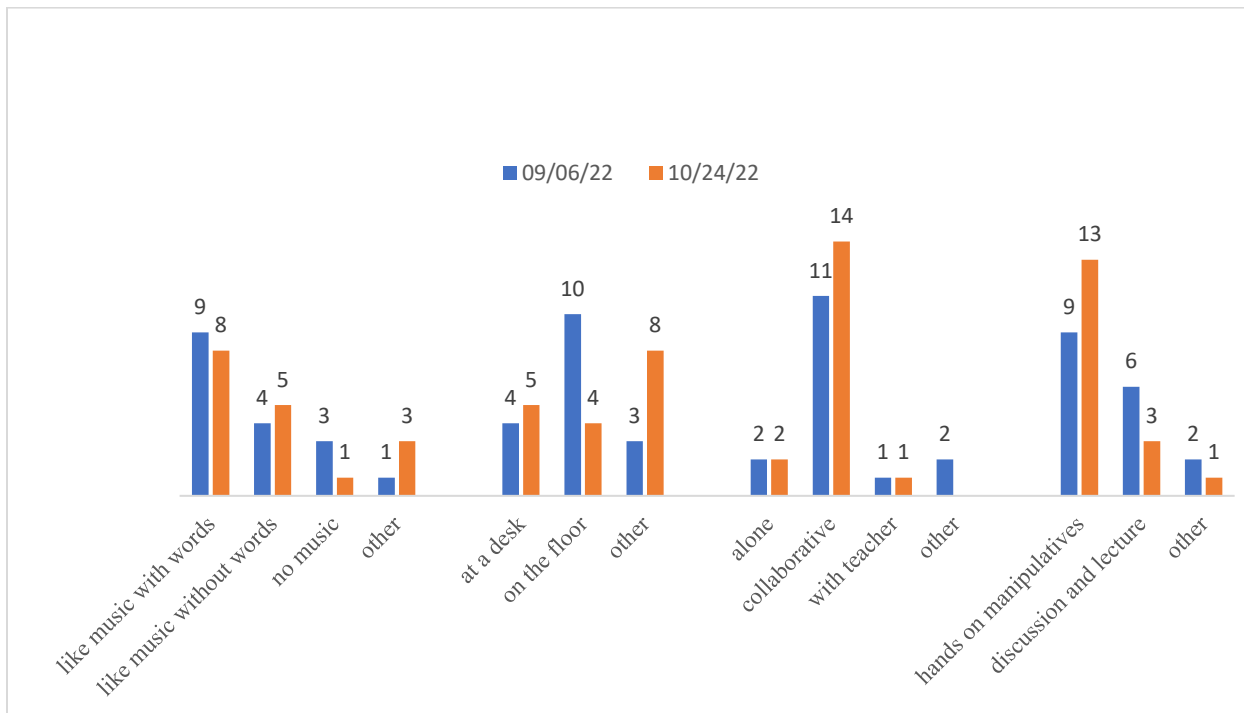
Appendix E

In a Montessori setting student are able experience freedom of choice which includes freedom of movement. This graph shows the choices and preferences for the students. Students have indicated that they enjoy working collaboratively and using math manipulatives. The

Montessori math curriculum creates a path that allows those students to move from concrete understanding of the concepts being taught to an abstract understanding. Results showed a decrease in the use of music with words it is my belief that the increase in collaborative work and focus used to solve problems with manipulatives.

Figure 5

Student Work Preference



Note. Students completed Math Interest Survey (see Chart 1) to indicate where and how they prefer to learn.

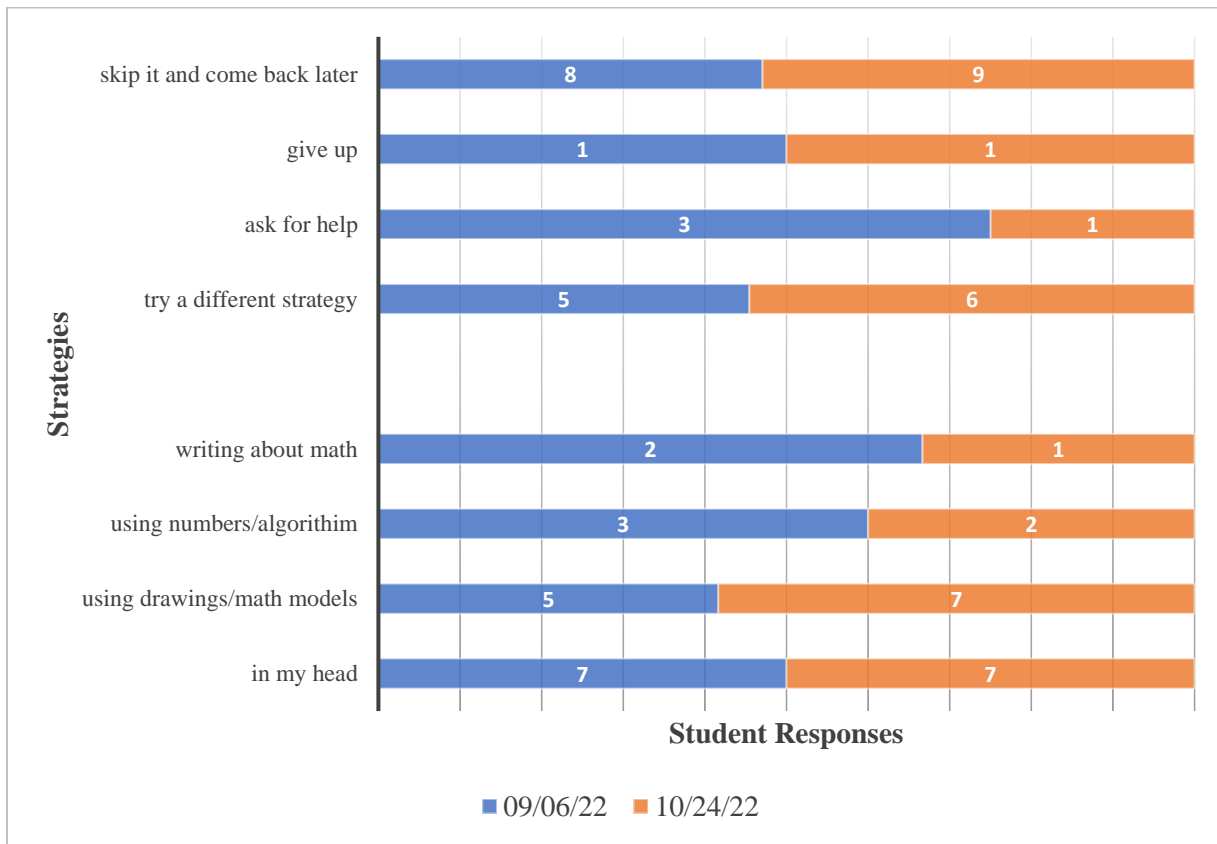
Appendix F

Following the six-week research the students were able to incorporate other methods to problem solve., Decreasing the number of students who would ask the teacher. More students were using the Read Draw Write Strategy to solve problems with math drawings. Strategy for Solving Problems figure 6 shows where the Montessori lessons created a scaffold for the

students who were up for the challenge more students would try a different strategy than ask the teacher for help. The more strategies the students were taught and relied on they began to attempt to solve problems on their own. There was a decline in the need for students to ask for help, possibly this is because they had received multiple problem-solving strategies.

Figure 6

Strategies for Problem Solving



Note. Strategies offered and student choices form response of the Math Interest Survey (see Chart 1).

Limitations

There are some limitations found in this research exist while attempting to involve parents with the response to the math interest survey. There were seven parents who responded to the pre survey. There were several reminders delivered to help parents access the survey (see Appendix G) to complete. During the collection of the post survey a warning message went out to remind parents that their help is needed and appreciated in advance. I received three complete post parent surveys. Two of those surveys were from the same parent. This limits the ability to assess the change in how parents feel about the incorporation of Montessori in the Public Montessori classroom.

Schedules for specific content instruction can become a limitation when Montessori allows an allotment of time for student uninterrupted focus work cycle. The public Montessori school schedules limits the uninterrupted work cycle with daily interruptions and limits to the amount of time to deliver and engage in instruction within district non negotiables.

Recommendation

It would be beneficial to perform this action research within an extended time frame for better data on academic growth. By extending the time spent observing students' responses to the introduction of Montessori lessons and collecting data to gain a more detailed read of the impact, this practice would have on children in a public Montessori setting. Getting a baseline of how parents learned math and how they can assist their students could have been included in the math interest survey to address the needs of students. Having parents complete the initial math survey during a parent meeting. Then using more definitive communication to distinguish the difference in the final math interest survey may have produced more responses from parents. In a public

Montessori school setting, there is a need to use long-range planning to collect lessons to include in this type of action research.

References

- Alt, & Itzkovitch, Y. (2019). The Connection between perceived Constructivist Learning Environments and Faculty Uncivil Authoritarian Behaviors. *Higher education*, 77(3), 437–454. <https://doi.org/10.1007/s10734-018-0281-y>
- Anderson, D. (2022). The Impact of Discourse on Math Learning in Upper Elementary, *MAED Paper*. (P 1-45).
<https://sophia.stkate.edu/cgi/viewcontent.cgi?article=1436&context=maed>
- Bada, S.O., & Olusegun, S. (2015). Constructivism learning theory, A paradigm for teaching and learning. *Journal of Research & Method in Education*, 5(6), 66-70.
- Ballard, A. C. (2010). *Student achievement, personal achievement goal orientations, and perceptions of classroom goal structures in a standards-based reporting system* (Order No. 3434231). Available from Education Database. (841471918).
<https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/dissertations-theses/student-achievement-personal-goal-orientations/docview/841471918/se-2> My Senior Seminar - Blogger.
<https://tcknight08.blogspot.com/>
- Bartley, J. (2014). MediaSOS@medialiteracy. *AMLE Magazine*, 1(9), 31.
- Berube, C. T. (2004). Are Standards Preventing Good Teaching? *The Clearing House*, 77(6), 264-267. <https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/scholarly-journals/are-standards-preventing-good-teaching/docview/196862471/se-2>
- Boaler, J. (1998). Open and closed mathematics: Student experiences and understanding. *Journal for Research in Mathematics Education*, 29(1), 41.

<https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/scholarly-journals/open-closed-mathematics-student-experiences/docview/223518596/se-2>

Brown-Joseph, L. (2010). *Public Montessori educational instructional practices: A deeper look into accountability* (Order No. 3412471). Available from Education Database.

(743816475). <https://www-proquest-com.pearl.stkate.edu/dissertations-theses/public-montessori-educational-instructional/docview/743816475/se-2>

Brown, K., & Lewis, C. W. (2017). A Comparison of Reading and Math Achievement for African American Third Grade Students in Montessori and Other Magnet Schools. *The Journal of Negro Education*, 86(4), 439–448.

Diamond, A. (2010). The evidence base for improving school outcomes by addressing the whole child and by addressing skills and attitudes, not just content. *Early Education and Development*, 21(5), 780-793. doi: 10.1080/ 10409289.2010.514522

Draper, R. J. (2002). School mathematics reform, constructivism, and literacy: a case for literacy instruction in the reform-oriented math classroom: incorporating literacy instruction with mathematics lessons can improve students' ability to learn and understand. *Journal of Adolescent & Adult Literacy*, 45(6), 520+.

https://link.gale.com/apps/doc/A84052426/SUIC?u=clic_stkate&sid=bookmark-SUIC&xid=73e70d06

Driskill, Melanie. (2014). Authentic Montessori Math Assessment and Common Core. Retrieved from Sophia, the St. Catherine University repository website:

<https://sophia.stkate.edu/maed/50>

Harris, M. (2008). The Effects of Music Instruction on Learning in the Montessori Classroom. *Montessori Life*, 20, 24-31.

<https://pearl.stkate.edu/login?url=https://www.proquest.com/magazines/effects-music-instruction-on-learning-montessori/docview/219944465/se-2>

Kofa, L. (2017). Elementary Teachers' Perceptions of Mathematics Instruction in Montessori and Traditional Classrooms. *ProQuest Dissertations Publishing*.

Lillard, A. S., & Else-Quest, N. (2006). The early years: Evaluating Montessori. *Science*, 313(5795), 1893-1894. doi:10.1126/science.1132362

Lopata, C., Wallace, N. V., & Finn, K. V. (2005). Comparison of Academic Achievement between Montessori and Traditional Education Programs, *Journal of Research in Childhood Education*, 20(1), 5-13.

Mallett, J. D. (2014). *Longitudinal academic achievement outcomes: Modeling the growth trajectories of Montessori elementary public-school students* (Order No. 3620830). Available from Education Database. (1540787748).

<https://www.proquest.com/dissertations-theses/longitudinal-academic-achievement-outcomes/docview/1540787748/se-2>

Marshall, C. (2017). Montessori education: a review of the evidence base. *NPJ Science of Learning*, 2(1), 11–19. <https://doi.org/10.1038/s41539-017-0012-7>

McIntosh, K. L., (2015). Montessori Mathematics Curriculum and Lower Elementary Students Understanding of Length Measurement. Retrieved from Sophia, the St. Catherine University repository website: <https://sophia.stkate.edu/maed/148>

Peterman, C. J., & Ewing, J. (2019). "Effects of Movement, Growth Mindset and Math Talks on Math Anxiety," *Journal of Multicultural Affairs*, 4(1), Article 1.

<https://scholarworks.sfasu.edu/jma/vol4/iss1/1>

Pailoor, S., M.Ed. (2015, 14). Why Montessori Education is Priceless. *Montessori Life*, 26, 56.

<https://www.proquest.com/magazines/why-montessori-education-is-priceless/docview/1654946471/se-2>

Schmidt, R. A. (2008). *From report card to standards-based progress report: The teacher's change process* (Order No. 3320347). Available from Education Database. (194031341).

<https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/dissertations-theses/report-card-standards-based-progress-teachers/docview/194031341/se-2>

Stotsky, S. (2016). Testing Limits. *Academic Questions*, 29(3), 285–298.

<https://doi.org/10.1007/s12129-016-9578-4>

Vanhorn, S., Ward, S., Weismann, K., Crandall, H., Reule, J., & Leonard, R. (2019). Exploring Active Learning Theories, Practices, and Contexts. *Communication Research Trends*, 38(3), 5.

Appendices

Chart 1

Math Interest Student Survey

Student Interest Survey will be completed in class during the first three days of school. It is my hope to allow them the opportunity to complete it using the school LMS (Canvass or google document) to complete before parent survey goes home.

1. What is math? (Essay question)
2. Why do people learn math? (Essay question)
3. Are you a mathematician?
 - a. Yes
 - b. No
 - c. Maybe
4. What kind of learner are you?

<ol style="list-style-type: none"> a. Choose one: <ol style="list-style-type: none"> i. I learn best with music with words on ii. I learn best with music without words on iii. I learn best with music off iv. other b. Choose one: <ol style="list-style-type: none"> i. I learn best seated at a desk ii. I learn best seated on the floor iii. other 	<ol style="list-style-type: none"> c. Choose one: <ol style="list-style-type: none"> i. I work better alone ii. I work better in a group or partner iii. other d. Choose one: <ol style="list-style-type: none"> i. I learn best with manipulatives, tools and hands on ii. I learn best through discussion iii. other
---	--
5. How do you feel about math class?

5 ☺ - ☺ - ☹ - ☹ - ☹ 1
6. What are your feelings towards math?
 - a. Easy to understand (Everyone can be successful.)
 - b. Difficult to understand (Math is hard.)
 - c. Boring and uninteresting (I get tired of working with numbers.)
 - d. It's okay
7. How do you choose to complete math problems? (check all that apply)
 - a. I like to do math "in my head."
 - b. I enjoy drawing to solve math problems.
 - a. I like using numbers.
 - b. I like writing about math.
8. What do you usually do after you realize you made a mistake, or something is hard on a math problem?
 - a. I use a different strategy (try again)

- b. I ask the teacher for help (before trying again)
 - c. I give up and don't try (skip it and move on to something else)
 - d. I go on to another problem and come back to this problem later.
9. Select the topics that are easy for you:
- place value
 - addition
 - multiplication
 - subtraction
 - division
 - measurement
 - geometry
 - fraction
 - decimal

10. What other information do I need to know about your math ability to help you learn? (Essay question)

Chart 2**Math Interest Parent Survey**

Dear Parents or Guardians: Thank you for your support in completing this Interest Survey. This survey will be given twice, once at the beginning and again at the end of the study. Please complete the parent survey from your observation of our child and their interest in math. All students have completed this survey in class independently. The Parent Survey can be returned to school with your child by September 1, 2022.

1. What is math? (Essay question)
2. Why do people learn math? (Essay question)
3. Does your student see his/herself as a mathematician?
 - a. Yes
 - b. No
 - c. Maybe
4. What kind of learner is your student?
 - a. Choose one:
 - i. I learn best with music on
 - ii. I learn best with music without words on
 - iii. I learn best with no music
 - iv. other
 - b. Choose one:
 - i. I learn best seated at a desk
 - ii. I learn best seated on the floor
 - iii. other
 - c. Choose one:
 - i. I work better alone
 - ii. I work better in a group or partner
 - iii. other
 - d. Choose one:
 - i. I learn best with manipulatives, tools and hands on
 - ii. I learn best through discussion
 - iii. other






5. How does your student feel about math class?
- a. 5  -  -  -  -  1
6. What is your students current attitude towards math?
- Easy to understand (I can be successful.)
 - Difficult to understand (Math is very hard.)
 - Boring and uninteresting (I get tired of working with numbers.)
 - It's okay
7. How does your student choose to complete math problems? (check all that apply)
- I like to do math "in my head."
 - I enjoy drawing to solve math problems.
 - I like using numbers.
 - I like writing about math.
8. What does your student usually do after he/she realize they have made a mistake, or something is hard on a math problem?
- I use a different strategy
 - I ask the teacher for help
 - I give up and don't try anymore
 - I go on to another problem and come back to this problem later.
9. Select the topics that are easy for your student:
- place value
 - addition
 - multiplication
 - subtraction
 - division
 - measurement
 - geometry
 - fraction
 - decimals
10. **What are your feelings about your ability to help your child learn math?** (Essay question)

Chart 3

Reflective Observation Journal

Directions:

The reflective notes get recorded at the end of the day in the designated space on the lesson plans. In response to the following questions.

1. What Montessori Math lesson(s) did I give?
2. Who received the lesson(s)?
3. How do you think the lesson(s) went?
4. What are the next steps?

Chart 4

Pre -Unit Quiz

The District Curriculum will provide the Pre-Unit Quiz, which I will administer according to the district expectations and guidelines. The results of that Pre-Unit Quiz inform future lessons that ensure students can succeed. The standards of the Pre-Unit Quiz are cumulative for the entire unit. I can adjust to include all measures covered within the duration of this study according to the timeframe.

Chart 5

Standards Check-up

These will be informal check-ups for students to obtain mastery of the standards. These are given on the standard after students have had a lesson opportunity to practice and feel they are ready to demonstrate mastery. Questions will be provided in the form of the standards, “are you able to perform the action of the standard, for example: read, write, explain, use, solve. . . This check-up will indicate that the student is ready to move on to the next lesson or standard.

Chart 6

Observable Talley Tracker

Observation tallies will be recorded by responding to the following questions:

Keeping track of what materials is being used and who is using the material. Also are they using the material appropriately?

Day of week	Time of Day	Tally Use of Montessori Materials <i>{Insert the Montessori material after lesson given then monitor usage with Talley marks}</i>
Monday	AM	
	PM	
Tuesday	AM	
	PM	
Wednesday	AM	
	PM	
Thursday	AM	
	PM	
Friday	AM	
	PM	

Chart 7

North Carolina State Standard	Montessori math materials used	Presentation style
NC.4.NBT.2 Read and write multi-digit whole numbers up to and including 100,000 using numerals, number names, and expanded form.	Place value chart, numeral cards, three-part cards	Whole group lesson (4 th and 5 th years)
NC.4.NBT.1 Explain that in a multi-digit whole number, a digit in one place represents 10 times as much as it represents in the place to its right, up to 100,000	Place value chart, numeral cards, place value mat and golden beads	Small group lesson
NC.4.NBT.7 Compare two multi-digit numbers up to and including 100,000 based on the values of the digits in each place, using >, =, and < symbols to record the results of comparisons.	Numeral cards, Stamps and symbols	Whole group lesson (4 th and 5 th years)
NC.4.NBT.4 Add and subtract multi-digit whole numbers up to and including 100,000 using the standard algorithm with place value understanding.	Stamp, bead frame, stamp and checkerboard	Mini Group Lessons given.
NC.5.NBT.1 Explain the patterns in the place value system from one million to the thousandths place. • Explain that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. • Explain patterns in products and quotients when numbers are multiplied by 1,000, 100, 10, 0.1, and 0.01 and/or divided by 10 and 100.	Place value mat, Place value chart and decimal board and materials	Small grade level group
NC.5.NBT.3 Read, write, and compare decimals to thousandths. • Write decimals using base-ten numerals, number names, and expanded form. • Compare two decimals to thousandths based on the value of the digits in each place, using >, =, and < symbols to record the results of comparisons.	Montessori Stamps and symbols, Decimal Stamps, three-part cards	Small group (grade band) lesson and mini lessons provided as needed.
NC.5.NBT.7 Compute and solve real-world problems with multi-digit whole numbers and decimal numbers. • Add and subtract decimals to thousandths using models, drawings or strategies based on place value. • Use estimation strategies to assess reasonableness of answers.	Decimal Board, Montessori Stamps	Mini group (three students) lessons given.