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## The Effects of Self-Determination Theory on Montessori Kindergarten Student's Math Knowledge and Attitudes

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# The Effects of Self-Determination Theory on Montessori Kindergarten Student's Math Knowledge and Attitudes

An Action Research Report  
By Matthew Anderson

The Effects of Self-Determination Theory on Montessori Kindergarten  
Student's Math Knowledge and Attitudes

By Matthew Anderson  
Submitted November, 2013  
In fulfillment of final requirements for MAED degree  
St. Catherine University  
St. Paul, Minnesota

Advisor \_\_\_\_\_

Date \_\_\_\_\_

### Abstract

This action research examined how fostering student autonomy, competence, and relatedness as described in Self-determination Theory (SDT) improved the Montessori kindergarten student's motivation to choose work from the math curriculum? By increasing the kindergarten student's knowledge of the Montessori math curriculum sequence, an attempt was made to increase their autonomy, competence and relatedness as it pertains to choosing math work. The data collection consisted of a student survey and questionnaire that was administered before and after the introduction of the action research interventions. Teacher observations were also helpful when determining if students were choosing math works at a higher rate. This research found that introducing kindergarten students to the sequence of Montessori math work improved their knowledge of and attitude towards the Montessori math curriculum.

As a Montessori guide, I take notes on the interactions I have with my students during the work period. In my notes I found that I spent a good deal of my time directing kindergarten-aged children to check their weekly work contracts for appropriate work choices. The teacher and kindergarten student fill out the kindergarten contract together and the expectation is that the student will finish their contract in a week. The contracts include works from the language, math, art, geography, and science areas of the room. The Kindergarten contract is seen as a link between the children's house classrooms and lower elementary. Weekly work plans are used in the lower elementary classes to track the student's progress. The kindergarten contract is seen as a precursor to the practice of using work plans.

The kindergarten students react positively to their contracts at the beginning of the year. Maybe they see this as proof of their maturity and as a prize for being the oldest students in the room. By mid-year, it becomes harder to engage the kindergarten students in their contract work. It becomes the job of the teacher to ask the kindergarten students to do something from their contract. Perhaps they do not understand the work on the contract or have not been given a lesson. Either way, it is clear that the students are not intrinsically motivated to do the contract work and do not self-choose to complete their contracts in a timely fashion.

The school where I am employed as a primary Montessori guide for 3 to 6 year-olds has one toddler class, four primary or Children's House classes, two lower elementary classes, and one upper elementary class. The student enrollment at this time is approximately 113 students. Medicine and higher education are the primary industries

in the town where The Montessori Cottage is located. The cost to attend The Montessori Cottage is approximately \$10,540 for one school year. Twenty five percent of families receive some form of financial assistance.

As a member of a teaching team in a primary classroom, I share classroom responsibilities with three other teachers. We have between 18 and 24 students on average. The teaching team consists of three Montessori early childhood teachers and one assistant. The assistant and one Montessori trained teacher leave at 1:15 p.m. and I arrive to teach between 1:15 and 3:00 p.m. The lead Montessori teacher stays the entire day. The four primary classes are called the Red Room, the Blue Room, the Yellow Room, and the Green Room. The Red Room is the classroom in which we teach, and the location where the action research problem formation took place.

The reason why the kindergarten students are not self-motivated to choose works from their contracts became the seed of the action research question. To improve kindergarten student motivation across the entire Montessori curriculum seemed too large a task for this research, so the math area of the curriculum was chosen as the focus. Because of the quantitative nature of math, it is supposed that data on successful completion of math works would be easier to gather. A search of the literature on human motivation found several theories of motivation that have been researched over the last several decades. It is necessary that any theory of motivation used is in alignment with Dr. Maria Montessori's (1964, 1967) research on human development.

A theoretical framework mentioned often in research devoted to human motivation is Optimal Experience Theory (OES) (Csikszentmihalyi, 1990). Optimal experience, or flow, is a term used to describe the feeling of losing oneself in the activity

in which you are engaged. Time, effort, and self-consciousness drop away and optimal experience takes over. People who experience flow in an activity report a strong sense of well-being and this feedback encourages them to experience flow again. Each flow state changes the participant and can only be achieved again by the incremental improvements of knowledge and ability. If ability is much greater than the experience requires the participant may be bored by the activity, and if ability is far less than what is required by the activity then anxiety is produced, and flow is not achieved. Experiences must have the right amount of challenge relative to a participant's skills to induce deep concentration. In these instances flow is achieved.

Csikszentmihalyi (1990) proposes that the flow experience is so rewarding that it intrinsically motivates people to engage in activities that provide an optimal experience or flow. This correlates directly with Dr. Montessori's writings on normalization in which she describes how a child's experience of deep concentration on a work changes them and produces expressions of joy, discipline, and sympathy (Montessori, 1967). It is the responsibility of the Montessori teacher to present work that provides a challenge while using the student's previous experiences and knowledge which leads to deep concentration, or flow.

Self-determination theory (SDT) (Ryan & Deci, 2000) builds upon the research of Optimal Experience Theories and proposes that autonomy, competence and relatedness are three innate psychological necessities that when fulfilled boost intrinsic motivation and the sense of well-being in humans (Ryan & Deci, 2000). SDT uses the term autonomy for the feeling people have that their behavior is self-determined and has an internal locus of causality. Competence is bolstered by events external to the person that

provide feedback, rewards, contextual support, and experiences of efficacy. These events then amplify feelings of competence and intrinsic motivation. Relatedness becomes significant after you leave the stage of infancy and become a member of a society. A sense of being connected or belonging with others, or relatedness, can instill intrinsic motivation for some actions (Ryan & Deci, 2000).

School and work are social situations where the rules already exist and are naturally external to your motivation. Relatedness, feelings of competence, and experiences of autonomy can be helpful when trying to internalize or integrate these external regulations and extrinsic motivations. Do theories of motivation like OET and SDT fit into the pedagogy of Dr. Montessori? Lillard (2007) divides Montessori education into eight principles:

1. Movement is integral to learning.
  2. Choice and having control of one's life leads to feelings of happiness and improved learning.
  3. Having an interest in the subject improves learning.
  4. Extrinsic rewards and punishments negatively impacts learning.
  5. Collaboration and learning with and from peers improves learning.
  6. Providing a context for what is being learned enhances meaning for the learner and improves outcomes.
  7. Adults can have positive or negative effects on the learning environment.
  8. Beauty and order in the classroom environment greatly benefits the student
- (p.29).



In this list, we see that competence can be enhanced by the ordered environment, contextual learning and self-correcting materials; autonomy is derived from choice, positive adult attitudes to self-directedness, and the uninterrupted work cycle; and relatedness are fostered by positive adult interactions, mixed age groupings, multiple years in the same class, and collaboration with peers.

It is clear that Montessori teachers can use Montessori teaching practices in the context of current theoretical frameworks of motivation. The research discussed in this review has shown ways in which Montessori methodologies are in alignment with recent theories of what motivates humans. Montessori teachers must prepare themselves, and the classroom to provide opportunities in education for autonomy, interest/context, mastery/competence, and relatedness. The teacher has to be an active participant in preparing a caring environment that responds to the student's interest without rewards or punishment while the student achieves autonomy and competence. This is an ongoing cycle that requires continuous observation, assessment, and implementation on the part of the teacher. The question this research will ask is in what ways will improvements in student autonomy, competence, and relatedness as described in Self-determination Theory (SDT) motivate Montessori kindergarten students to choose and complete work from the math curriculum?

#### Description of Research Process

The first step in the collection of data was discussing the action research theme with the head of school at The Montessori Cottage. Consent was given by the head of school for the research on motivation among kindergarten students in the Red Room. The head of school asked that I submit a document to her detailing the extent of the

research. I submitted an Action Research Approval Form to her, and she approved the research.

To increase democratic validity and dialogic validity (Hendricks, 2013), I introduced my fellow classroom teachers to the action research plan, and they agreed to assist with the collection of data. Their involvement is especially important due to the fact that I split my days between two classrooms.

As an introduction and invitation to the action research, I prepared a packet of information containing:

- The scope and sequence for the math curriculum at The Montessori Cottage.
- The action research proposal containing the Problem Statement, Action Research Question, Data Collection Sources, and Timeline of Research.
- My essay on Contemporary Motivational Theories and Montessori Methodologies.
- A teacher observation worksheet of student organization and precision of math works (Appendix A).
- A kindergarten interview worksheet to determine the student's knowledge of math curriculum (Appendix B).
- A survey of kindergarten student attitudes towards math (Appendix C).

A fellow classroom teacher suggested that we take photos of the student's math works. We all agreed photos are a valuable addition to the data. Involving the stakeholders in the classroom with data collection increases the democratic validity (Hendricks, 2013) of the research. Opening the conversation about the action research to colleagues increases the dialogical validity (Hendricks, 2013) and adds another data collection source through

the use of photographs. An invitation to participate in the action research was extended to two additional classrooms. At this time, they are uninvolved in data collection.

Teacher observation worksheets (Appendix A) collect a baseline set of data of how well the students organize their math work, the precision used in the execution, and the ability of the students to clean up the math work and return it to its place. Providing a teacher observation worksheet for colleagues to use will increase neutrality/confirmability validity (Hendricks, 2013). Having teachers other than myself collect observations dilutes some of the bias on my part concerning math precision and organization.

The teacher observation worksheet allows my colleagues to know what I am interested in measuring. It is my hope that the grading scale of 1 to 5 will make collection of data simple. Allowing for additional notes gives the observer the opportunity to describe the work and any extenuating circumstances they feel are relevant. The section of the observation worksheet regarding how many students are working together provides information on whether students prefer to work together or alone in the math area. It also informs as to whether working alone or in a group adds to or detracts from precision. Acknowledging guide involvement allows for measurement of the level of independence of execution acquired by kindergarten students. Measuring guide involvement increases the general knowledge about the kindergarten students' ability to be autonomous and competent in the math area.

The Kindergarten Math Interview (Appendix B) measures the kindergarten students' knowledge of the math area prior to implementing the action research plan and after implementation of the action research plan. The simple nature of the first question

of the interview, “Can you show me where the math area is?” is the most basic of questions. This allowed the student to start with an affirmation of their previous knowledge. The open-ended wording of the interview questions 2, 3, and 6 give the student license to discuss the math area without concern for right or wrong answers. Question 4 and 5 allow the interviewer to ascertain baseline data as to how much the student knows about the sequence of Montessori math materials before implementation of the action research plan.

By interviewing students concerning math sequencing before implementation and at other times during the action research, we measure how well the action part of the research plan is working. This is predominantly true of measuring knowledge of the sequence of the math curriculum. Knowledge of the math sequence may increase student autonomy and competence in precise completion of math works.

The survey of a kindergarten student’s attitude towards math (Appendix C) allows the researcher to measure whether the action research plan to increase student understanding of the math curriculum has increased the student’s enjoyment of the math curriculum. Will improving the student’s knowledge of the math curriculum increase the student’s desire to choose math work?

The survey works as baseline data that reflect how the student relates to the math curriculum. How often do you do the math? Are you good at math? Do you repeat math exercises? Do you work with others? Do you give lessons after you have mastered a work? Is math important? These are survey questions meant to analyze how the students relate to the math curriculum, their classroom, and their peers. By giving the survey and interview before and after implementation of the action research, I hope to know the level

of the kindergarten student's autonomy, competence, and relatedness in the Montessori math curriculum.

### Data Analysis

The subjects of this action research are kindergarten students in a Montessori school. There were 3 boys and 3 girls participating in the action research. The students have attended the school for a variety of years. Students 1 and 5 have attended the class for 1 year, students 2, 3 and 6 have attended the school for 2 years, and student 4 has attended the class for 3 years.

The school provides pull out sessions between 12:15 p.m. and 1:15 p.m. for kindergarten students. During the pull out session the kindergarten students participate in several arts programs. The programs are art, yoga, Spanish, and music. The Red Room kindergarteners attend with kindergarten students from the other children's house classrooms. When they return to the classroom, the 6 kindergarten students are involved in an after-kindergarten meeting run by a teacher. Normally this time is used for journaling activities, but I have been able to use this time twice a month for action research concerning the math area.

The action research began with a survey of kindergarten student's attitudes towards math (Appendix C). They were asked six questions to determine their frequency, repetition, importance, and feelings of success with math works. I decided question 4 was not useful for calculating attitude, so it was dropped from the equation. So in the end, only five questions were used from the Survey of Kindergarten Student's Attitude Towards Math. Table 1 details the kindergarten student's answers to the survey

questions when asked on September 17, 2013. The survey was taken before any interventions were established or implemented.

Table 1. Survey of Kindergarten Student's Attitudes Towards Math

	Student	Student	Student	Student	Student	Student
9/17/13	1	2	3	4	5	6
How often do you do math?	1	3	2	1	2	1
Are you good at math?	1	3	3	4	3	3
Do you do a math work more than once?	1	4	3	2	1	2
Do you give math lessons to others?	1	1	1	1	2	1
Is it important to learn math?	3	3	4	4	3	4
Total	7	14	13	12	11	11

Note: Answers are graded from 1 being the least positive and 4 being the most positive.

With 20 being the most positive attitude possible and 4 being the lowest, we had an average score of 11.3. This put the kindergarten students in the mid range for overall enjoyment of the math area.

After the initial survey and interview took place, I explained the math area of the room to the kindergarteners. I showed them that the shelves were laid out in sequence from pre-number to the math operation of addition. I also explained why the cards for the golden beads had green numerals, blue numerals, and red numerals repeating in a series. With the intention of increasing the students understanding of the math curriculum sequence and to make working through the sequence more interactive, I introduced a Montessori Math Sequence (MMS) (Appendix D) book. The students received a folder, which contained color copies of pictures of Montessori math works taken from catalogs. These photos are pasted to a sheet of paper that has the color that corresponds to the Montessori math curriculum for units, tens, hundreds, and golden beads. They were provided green sheets of paper for works dealing with 0 to 9, blue paper for work pertaining to tens, red paper for works pertaining to hundreds, and gold

paper for work with the golden bead materials (Appendix E). We started to work through the curriculum building individual math sequence books. After a student completed a math work, they cut and pasted the picture of the math work onto the corresponding color page and added it into their book. The students referenced the Montessori Math Sequence (MMS) master book to check the location of the work in the sequence before putting the color page in their own sequence book. For the first five days of after-kindergarten meeting we worked on our math sequence books and steadily put in one or two pages a day by doing works together from the beginning of the sequence. Even though the kindergarten students have experience with many of the early works in the sequence, I wanted to re-present the work with an emphasis on precision.

A picture book, The Math Work Layout (MWL) (Appendix F), was presented to the students that provided a picture of a math work. The photos present the math works as they appear at the start and at completion. The MWL was meant as a control of error when setting up and completing the math works. It was also intended to be used as a tool to increase autonomy and generate interest about the math sequence. To model its use, I referenced the Math Work Layout book (MWL) at the beginning and end of math work presentations. After a few days of using the MWL, I asked the kindergarten students to help me layout and photograph math works. We would photograph the beginning and the end and add new works to the MWL book. This was intended to increase the student's relatedness to the book by giving them a part in its construction. I also hoped to spark the interest of the younger students in the class as well. One drawback that features predominately in this research is that I am only with the kindergarten students for one hour a day. This is due to my acceptance of a position as head teacher of a half-day class

in the morning. I return to the Red Room every afternoon for the session from 1:15 p.m. until 3:00 p.m. At this time, we would talk about their work choices from earlier in the day.

After 10 school days of exposure to the MMS and the MWL books, I again conducted the Survey of Kindergarten Student's Attitude Towards Math.

Table 2. Survey of Kindergarten Student's Attitude Towards Math

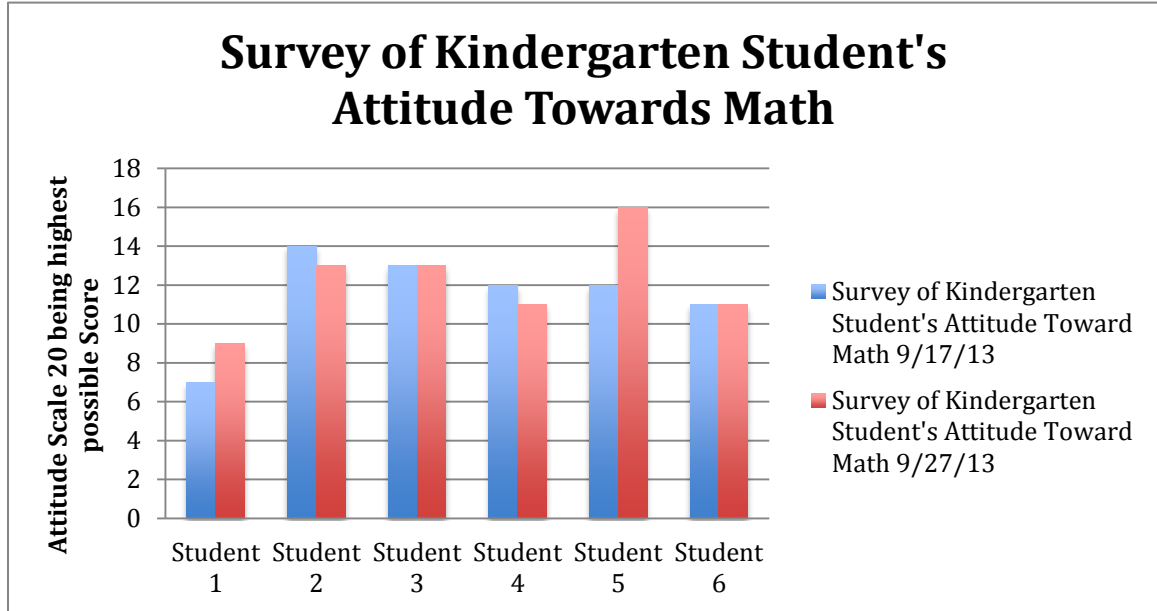
	Student	Student	Student	Student	Student	Student
9/27/13	1	2	3	4	5	6
How often do you do math?	1	2	1	1	2	1
Are you good at math?	2	3	3	4	4	3
Do you do a math work more than once?	1	3	3	1	4	1
Do you give math lessons to others?	1	1	2	1	3	2
Is it important to learn math?	4	4	4	4	3	4
Total	9	13	13	11	16	11

Note: Answers are graded from 1 being the least positive and 4 being the most positive.

The average for the students increased from 11.3 to 12.2 for their attitude towards the math work. This is an increase of less than 1 point. Figure 1 represents the Survey results for each student on September 17, 2013 and September 27, 2013.



Figure 1. Distribution of Results for Survey of Kindergarten Student's Attitude Towards Math



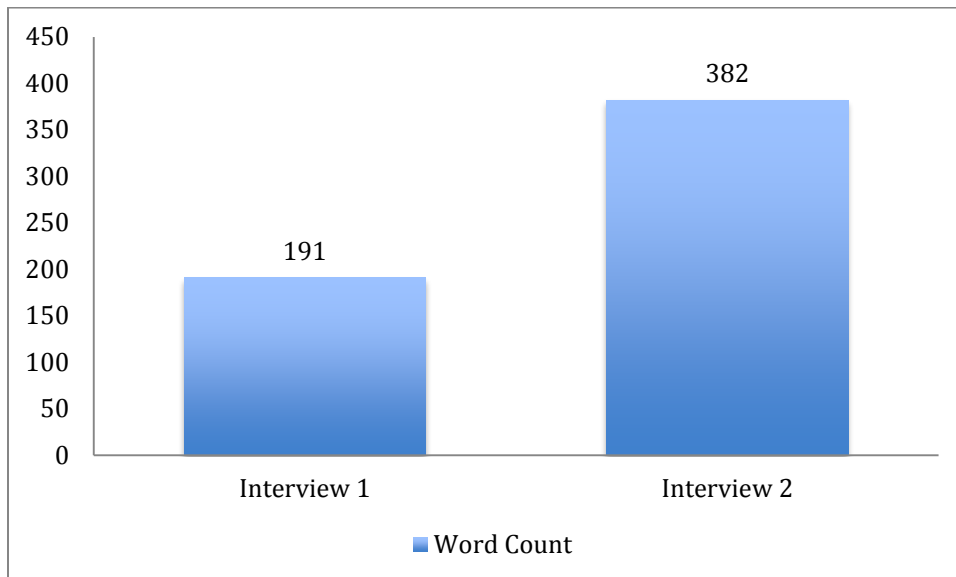
The sum of the scores for positive attitudes increased for Students 1 and 5, remained the same for students 3 and 6, and decreased for students 2 and 4. The increases occurred for the two students that had only one year of Montessori schooling. It is my belief that the results of the survey are inconclusive at this time. Further work with the kindergarten students may increase positive attitudes or the survey may have been poorly designed.

Concurrent with The Survey of Kindergarten Student's Attitudes Towards Math was the Kindergarten Math Interview. The Math Interview was designed to measure how much the students knew about the math works in the Red Room. The first interview was conducted September 17, 2013 (Appendix G), before discussion of the math curriculum and presentation of the Montessori Math Sequence and The Montessori Math Layout books. The interview is coded to count the number of times students made **negative statements** or **positive statements**. The interview is coded for references to **Montessori materials** and the **Montessori Math Sequence Master Book**.

The word count for the first interview is approximately 191 words. I have judged that here were 19 negative statements and 17 positive statements in the first interview. There were 3 references to Montessori math materials. There is of course no reference to the MMS or MWL, as they had not been introduced at the time. The interview was conducted again 10 school days after discussing the math sequence and introducing the MMS and MWL.

The word count for the second interview conducted September 27<sup>th</sup> (Appendix F) was approximately 382 words. This was double the amount of words used in the first interview. Figure 2 is a graph of the increase in word count from the first interview to the second interview.

Figure 2. Graph of Kindergarten Math Interview Word Count

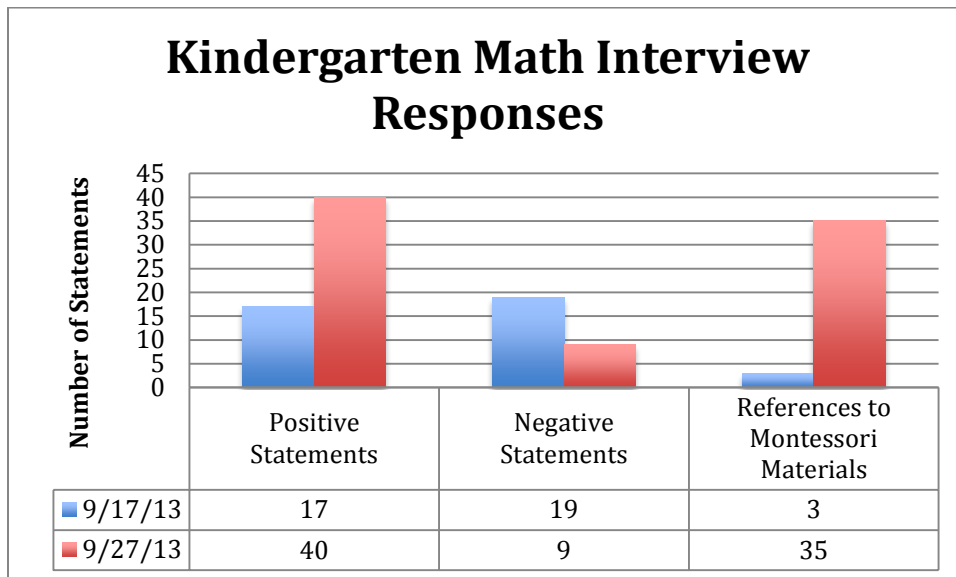


This increased word count may be due to having previous experience with the interview and therefore may be inconclusive.

It is clear that they understand more about the math curriculum as the references to Montessori math materials increased from 3 to 35, which was a 1067% increase. By

my assessment there were 9 negative statements in the second interview, which was a 111% decrease. I also assessed 40 positive statements in the second interview, which was a 135% increase after 10 days. Some statements were not counted because I asked leading questions or the statements appeared neutral. The increase in positive statements and references to the Montessori math materials, as seen in Figure 3, lead me to believe that the kindergarten students understanding of the math sequence had improved. This may be due to the lessons on the math sequence and introduction of the MMS and MWL. There were 5 references to the MMS indicating that some of the students are aware of the MMS and have been using it. It is also clear that some of the students were unaware of the location of the MMS in the classroom.

Figure 3. Graph of Kindergarten Math Interview Responses



I believe that the continued use of the MMS in the classroom will increase the kindergarten students understanding of the math sequence. Renewed emphasis and continue exposure to the MWL could increase precision with the math works. I began to enlist the kindergarten student's assistance when setting up work to photograph for the

MWL book. By giving them a part in the making of the MWL I intended to increase their relatedness to the work and the MWL book. Use of the Observation Worksheets (Appendix A) proved to be of no value for data collection at this time.

The interview exposed the fact that many of the children do not know the names of the Montessori math materials. To address this problem, I began adding a three period lesson to the beginning of math lessons to introduce only with the name of the work being shown. After they knew the name of the work, then I would give the lesson on how to proceed. I have added the names of the works to the MMS and MWL, and I believe this will increase the kindergarten student's knowledge of the nomenclature for the Montessori math materials. To address the student's difficulty finding the MMS and MWL I began sending them in pairs to retrieve the books from the math shelf whenever we needed them. Soon all the kindergarten students knew where the books were located.

The process of developing the MMS and MWL has increased my knowledge of the Montessori math curriculum. I have begun to replace the old photos in my math album with the copies of the photos from the Math Work Layout book.

The process of laying out the math works for before and after photos for the Montessori Work Layout book has been especially helpful in teaching me precision when demonstrating math work lessons.

#### Action Plan

The research demonstrated that an increased focus on the Montessori math curriculum sequence has a positive effect on the kindergarten student's knowledge of the Montessori math sequence. The introduction of the Montessori Math Sequence book increased the kindergarten student's knowledge of why the math area is sequenced the

way it is. They also learned about the series of numeration relating to the units, tens, hundreds, and thousands. The color-coding found in the Montessori materials for the series of numbers was mirrored in the Montessori Math Sequence books the students made to track their progress through the curriculum. This mirroring was a valuable way of solidifying the concept of green for units, blue for tens, and red for hundreds. The kindergarten students are now able to discuss and decide what color page a math work would be placed on in their sequence books. They have also become aware of where the work would go in the sequence by making use of the Montessori Math Sequence master book that is available in the classroom.

The increased attention I have put on teaching the names of the math materials seems to have increased the student's knowledge of the math material nomenclature and function. Work share is a time when parents are invited into the classroom to observe a work of their child's own choosing. A mother told me recently that her daughter informed her that she would be doing the demonstration tray number 1 at work share. The mother said this was the first time her daughter had mentioned the name of the work she would be choosing. Her daughter also told her of the demonstration tray 2, what the difference is, and why it comes after demonstration tray 1. The student's have internalized the layout of the shelves and are choosing to discuss where a work would go in the sequence and on the shelves. As Montessori teachers, we agree that learning the names of things is important to brain development. We provide an environment that is rich with the naming of geometric shapes, parts of a flower, the planets, etc. Increasing the student's knowledge of the math nomenclature is a logical extension of this practice.

The Blue Room has mentioned an interest in implementing Montessori Math Sequence (MMS) books and a Math Work Layout (MWL) book. Their inclusion in the research would present the opportunity to measure student's knowledge of the Montessori math nomenclature before and after implementation of the action research. It would be wise to compare my kindergarten student's knowledge of the math nomenclature with the knowledge of the kindergarten students in the Blue Room. By using the Blue Room as a control group, I will be able to test the validity of the assumption that the kindergarten students exposed to the action research have increased their knowledge of the nomenclature of math works. The Blue Room's participation will also increase validity as it pertains to neutrality/confirmability, consistency/dependability, and applicability/transferability (Hendricks, 2013). That is to say, we will be able to test for bias on my part, accuracy of data analysis, and how well the action research works in a classroom with a similar kindergarten population.

It is normal that the children's knowledge of the math area would increase as the amount of attention given to the math curriculum increased. My understanding of the math curriculum has grown as well. As I revisited my math album to make sure I was presenting and photographing math works properly, my knowledge of the math curriculum grew and became more precise. The sequence of the math curriculum is something I have begun to understand in a way I had not before. By reading through the directions for presenting math works, I began to unearth and eradicate many bad habits and shortcuts that I had picked up through the years. My presentations have become more precise as I have begun to focus on the details of a presentation and take more time to show just the movements necessary to execute the math work. Making these books

has increased my knowledge of the math curriculum in ways I never predicted, and I will continue to add to the MMS book and MWL book.

Talking with my fellow Red Room teachers about how they would do a math work and comparing our math album lessons increased our dialogic validity for the research project. This practice of discussing how we would present work increased the consistency and precision of math work presentations by teachers. This then increased the competence of the students, which increased their autonomy.

While laying out the 10 boards set up with the kindergarten students, it occurred to me that the MWL book is actually a math album for the classroom. It has no words and separate pages for each extension, but in essence it is a math album. The morning teacher has informed me that the kindergarten students have been taking the MWL book out and referring to it in the morning. She has also overheard the kindergarten students explaining to younger students where the works go on the math shelf and why. By including the kindergarten students when setting up math works to photograph, I believe I have increased their relatedness to the MWL book.

As I continue the action research, I would like to collect data on the following:

1. Are kindergarten students choosing math works more often?
2. Is their precision in executing math materials improved by the interventions of the action research?
3. Has the kindergarten student's knowledge of the math sequence, layout, and nomenclature increased as compared to kindergarten students in other children's house classrooms?

The bulk of the data for this research was taken after only 10 days of the action research interventions with the kindergarten students. I would like to continue the research and implement more ways in which autonomy, competence, and relatedness can be fostered in a Montessori children's house classroom. The process of sharing the action research has started a dialog at our school that I will continue to pursue. The doors that separated the classrooms and teachers have been opened, and I plan to continue the discussions about pedagogy with my colleagues. During the process of making the Montessori Math Sequence book and Math Works Layout book my Montessori math album was reborn. I intend to continue to add to it, making it a living document that grows along with my knowledge of the Montessori math curriculum.



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## Appendix A

## Observation of Math Work Organization and Precision

Student's Name	Math Work Chosen	Organization		Precision		Clean Up		Guide intervention Needed?	
		Poor	Great	Poor	Great	Poor	Great	Yes	No
		1 2 3 4 5		1 2 3 4 5		1 2 3 4 5			

Notes	
Name of Observer	Date

## Appendix B

## Kindergarten Math Interview

The goal of this interview process is to discover the depth of the kindergarten student's knowledge of the math area and curriculum. Thank you for your participation. Participation is voluntary and the student may stop at any time.

Interviewers name \_\_\_\_\_

Student's first name \_\_\_\_\_ Date\_\_\_\_\_

1. Can you show me where the math area is?

---

2. What is math about?

---

3. What is the last math work you chose to do?

---

4. What math work comes before that work?

---

5. What math work comes after that work?

---

6. What do you know about the math work in your classroom?

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## Appendix C

## Survey of Kindergarten Student's Attitude Towards Math

Interviewer \_\_\_\_\_ Student \_\_\_\_\_ Date \_\_\_\_\_

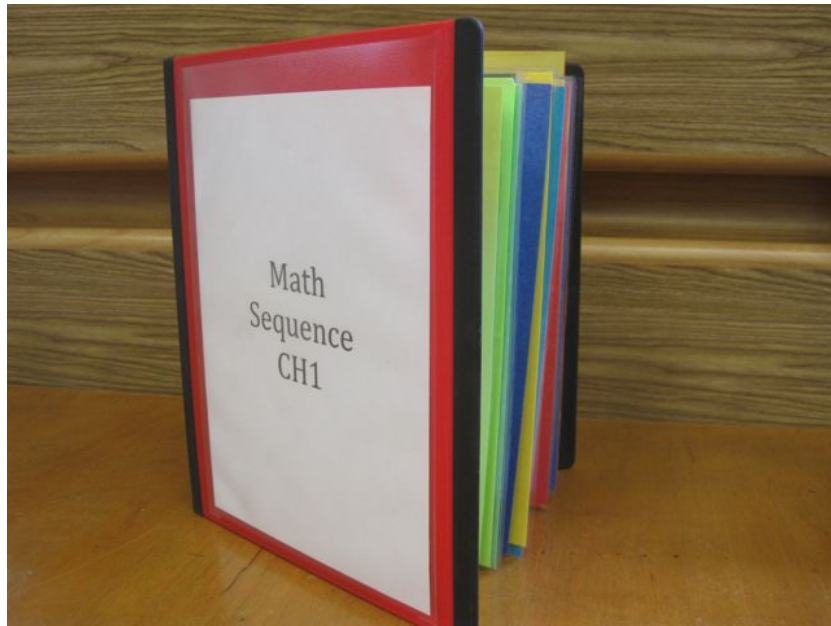
Thank you for participating in this survey. Participation is voluntary and the student may stop at any time. If you as the interviewer have anything of interest to add please make a note next to the question. All information and input is welcome. You may circle the answer or write it on the line provided.

1. How often do you choose math work?
  - a. Very often
  - b. Often
  - c. Sometimes
  - d. Not very often, almost never
  
2. Are you good at math?
  - a. Very good
  - b. Good
  - c. Not very good
  - d. Not good at all
  
3. Do you do a math work more than once?
  - a. Always
  - b. Often
  - c. Sometimes
  - d. Not very often, almost never

4. When you do math work, which do you prefer?
  - a. To work alone
  - b. To work with one other student
  - c. To work in a small group
  - d. To work with a teacher
  
5. Do you give math lessons to other students after you have mastered a math work?
  - a. Always
  - b. Often
  - c. Sometimes
  - d. Not very often, almost never
  
6. Is it important to learn math?
  - a. Very important
  - b. Kind of important
  - c. Not very important
  - d. No

Appendix D

Montessori Math Sequence Book



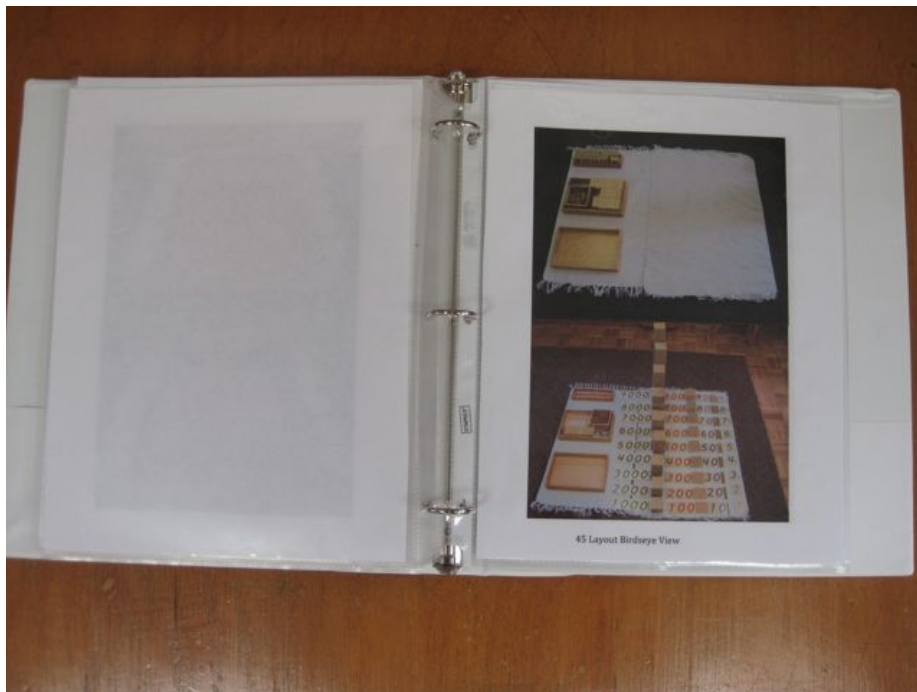
Appendix E

Kindergarten Student's Montessori Math Sequence Books



Appendix F

Math Work Layout Book





## Appendix G

Kindergarten Interview September 17, 2013

1. Can you show me the math area?**Students 1-6:** Yes2. What is math about?**Student 1:** Learning. *Learning what?* I don't know. *What is this work called?* I don't know. *Show me a work you know the name of.* Puzzles (point to a caterpillar puzzle). *Any others?* No.**Student 2:** Numbers and counting.**Student 3:** I don't know. *Any of the things in the math are remind you?*

Counting stuff like that caterpillar puzzle.

**Student 4:** Counting and writing numbers.**Student 5:** It's numbers like 1, 2, and 3.**Student 6:** Basically counting, it's just about counting.3. What is the last math work you chose to do?**Student 1:** (Points to teen bar hanger) *Do you know the name of that work?* I don't know.**Student 2:** (Has a hard time finding the work on the shelf). These beans for adding like 3 plus 5.**Student 3:** I used beans. *What is the name of the work?* I don't know.**Student 4:** Acorn addition.**Student 5:** I don't remember.**Student 6:** Squirrel math, you roll the dice then you write your number down with a + in the middle. You take as much acorns as you are supposed to, one number in a basket and then the other basket then an = and your answer.4. What math work comes before that work?**Student 1:** I don't know.**Student 2:** I think it's just any work.**Student 3:** I don't know.**Student 4:** I don't know.**Student 5:** (Shrugs)**Student 6:** I don't know.5. What math work comes after that work?**Student 1:** No.**Student 2:** I would use the complex addition stuff with a teacher.**Student 3:** I don't know.**Student 4:** The one and the two chain until the hundred.

**Student 5:** (Shrugs)

**Student 6:** I don't know.

6. What do you know about the math work in your classroom?

**Student 1:** Nothing.

**Student 2:** They're fun and they help you learn stuff.

**Student 3:** I have no idea.

**Student 4:** I like to write numbers. That umm...that umm...actually, no.

**Student 5:** Kindergarteners can help little kids if they don't know how to do it.

**Student 6:** That umm...I don't know.

## Appendix H

Kindergarten Interview September 27<sup>th</sup>, 20131. Can you show me the math area?**Students 1-6:** Yes.2. What is math about?**Student 1:** I've been learning this (teen bead hangers) and the puzzles. Here you have to shake the dice and the bottom comes off. It makes a lot of noise and I like shaking them.**Student 2:** Math is learning lots about numbers. Each of these math works has something that comes before it. Also they have stuff that go after it. The Masters Book tells us what comes next. The different shelves are different. The first things (0-9), second things (points to golden beads), and third things (points to 10-100 and addition) some are hard.**Student 3:** Numbers and your eyes, because you are looking at the math. I can write a three. You can learn high numbers.**Student 4:** Adding things together, there is the number shelf (points to something I didn't catch). Numbers help you learn.**Student 5:** Math is like the numbers 1, 2, 3, 4, 5, (looks around). There's the teens on that side with the 100 board. This is 0-10 on this side. In the middle is like the 100's and 1000's.**Student 6:** Counting. Learning.3. What is the last math work you chose to do?**Student 1:** I did the teen hangers.**Student 2:** I did the bead hanging with teens and the 1 to 10.**Student 3:** Chalkboards (sandpaper numerals) with 7, 2, and 1.**Student 4:** A paper 100 board.**Student 5:** I think that (points to addition strip board but doesn't know it's name)**Student 6:** Counting pigs with even and odds.4. What math work comes before that work?**Student 1:** I don't know. Why is the cabinet not turned around for the big long bead things? I think I would do those.**Student 2:** Odds and evens (numbers and counters) and red and blue rods.**Student 3:** Red and blue rods because they are in our books.**Student 4:** I don't know.**Student 5:** Very first is the red and blue rods, but I didn't do this work in order.**Student 6:** The red and blue rods, and that (bead stair), and tens.

5. What math work comes after that work?

**Student 1:** (Points to bead cabinet). I can do those. Remember the little kids couldn't do big chains, but I could I'm a kindergartener now. I'm getting better at math.

**Student 2:** That (points to chalkboards), tens board, making ten different ways (addition strip board) I don't know the name of it.

**Student 3:** I don't know. *Could we find it?* Yes, in the book. Where's the book? (MA shows the book location on the shelf) Even and odds.

**Student 4:** I don't know.

**Student 5:** What is this thing called (points to a bowl of plastic turtles), also this with the teens (teen board with cards and beads) and this teen hanger.

**Student 6:** (Checks Master Sequence Book) I have no idea what that is, ten boards?

6. What do you know about the math work in your classroom?

**Student 1:** I don't know much about math. But, HEY! (Goes and puts the sandpaper numerals in order from 0-9 saying the names of the numerals to get them in numerical order)

**Student 2:** Maybe after teen hangers would come squirrel addition. We could check the Masters Sequence Book (student looks in book) yellow bead area.

**Student 3:** I like to count and draw numbers and do things with math.

**Student 4:** (Shrugs)

**Student 5:** I heard you say we do things in order.

**Student 6:** There is a lot of counting stuff and things with addition. Number counting with those (points to bead cabinet).