Full Transcript for An Introduction to the Montessori Math Curriculum

A young girl's small hands… grasping beautiful objects… sensing the world around her. Shapes… dimensions… relationships… amounts… all represented by concrete objects that prepare the mind for a deep understanding of the principles of mathematics.

Maria Montessori discovered that children understand the world, through all their senses, and that only by making use of this knowledge can their understanding be developed to its fullest potential.

Nowhere is more evident than in the Montessori mathematics curriculum. As the child progresses from early childhood through the elementary years, the Montessori Math curriculum moves from the concrete, to increasingly abstract concepts of mathematics.

As with all Montessori materials, the mathematics curriculum is performed by the individual, using self-teaching and self-correcting materials. These materials are presented to the child as interest is expressed or observed and then the adult moves away, to allow exploration through repetition, until the concept is mastered.

In small sequential steps, each learner develops a mathematical mind at his or her own pace. The Montessori sensorial materials form the foundation, in preparing the child for the abstract world of numbers.

Sensorial Materials:
Developing the Mathematical Mind

Montessori gave the Sensorial equipment the credit for helping the child explore his environment and also for developing the mathematical mind - the mathematical structures necessary for the order, sequencing and precision of mathematics.

During the day-to-day manipulation of concrete objects the child builds her concepts of numbers and the ability to concentrate. Montessori emphasized that all materials must be beautiful, and stimulating to the senses, inviting children to take them from the shelves to explore them again and again. Small children naturally love repeating activities and thoroughly absorb the intended concepts.

The formal mathematics curriculum begins with activities to teach sequence, recognition and quantity of numbers 1 through 10. Two parallel lessons formats build on this knowledge: operations with numbers (addition, subtraction, multiplication and division) and memorization of mathematical facts. Eventually used together, these two disciplines form the foundation for working complex math problems. Other lessons introduce math concepts and skills, such as: counting-by-multiples, the squares and cubes of numbers 1 through 10, and fractions. All of these activities are available to young children in a Montessori early childhood program.

Lets take a closer look at a few of the activities and the materials.

Numbers to Ten and the Number Rods

A child needs to know numbers to 10, in order to be able to work in the decimal system.

The red rods introduce the concept of comparative length. Through laying out the rods one-by-one, the child learns, at the most basic

concrete level, how the numbers one to ten relate to one another.

The red and blue segmented rods, add the concept of one-to-one correspondence and allow for the memorization of the 1 through 10 counting sequence.

Each rod represents a given number and the relative difference between each number is clearly seen.

Sandpaper Numbers

Sandpaper numbers are the sandpaper cutouts of the numbers zero through 10 glued to individual boards. They teach the numerical symbol of the quantities the child has already learned from the number rods. This is the beginning preparation for number writing. Sandpaper makes the process of tracing out the number both more interesting to the child and more effective in absorbing the mental image of the number.

Number Rods and Sandpaper Numerals

Number rods and sandpaper numerals are used together to associate number with quantity. A variety of exercises allows for accurate association of number and quantity and introduce the quantities of greater than, less than, addition, subtraction and multiplication.

Spindle Box

Spindle boxes introduce numbers to 9 by using separated objects. Two boxes with compartments numbered zero through 4 and 5 through 9 respectively allow the child to count a quantity of spindles into the appropriately numbered compartment. The fixed sequence of the numbers on the boxes serves as a guide for this first experience in impressing the notion that separate objects make a given number. The objects may be bundled with yarn or ribbon to illustrate a set. For the first time, the concept of zero is introduced, and the fact that there are no digits other than one to ten.

Cards and Counters

Cards and counters are individual number cards or cutout numerals for the child to arrange to arrange in order and individual disks to count. Here the level of abstraction requires the child to demonstrate that he recognizes the numbers one through ten, knows the order of one through ten, understands one to one correspondence, and can relate the proper quantity to the numbers.

Once the child has developed a secure knowledge of numbers to ten, the exciting world of the golden bead materials opens up to her.

Introduction to the Decimal System (Golden Beads)

Small round beads, gold in color represent categories. One bead, referred to as a unit, represents the quantity one. Ten golden beads, threaded together on a wire are referred to as one ten. Ten tens wired together into a square are named one hundred. And then the one hundreds wired together into a cube are named one thousand. During an initial lesson a variety of games familiarizes the child with the names of these four categories and the matching bead quantity.

The golden beads allow the child to see and feel the quantities from one to a thousand and to understand for the first time on a basic level, the concept of squaring and cubing of numbers.

Number Card Symbols for the Decimal System

A similar activity introduces the numbers for one through nine in the units, tens and hundreds of simple and thousands. All number sets are color coded by category to emphasize place value. Four sets of these number cards, one large set and three small sets, are used for problems in the golden bead lesson. The child learns that the number of zeros determines the category.

Children perform the golden bead activities on a floor mat, because the activities occupy a large space, and require a lot of movement.

Formation of Complex Numbers with Beads and Cards

Combining both card and bead familiarizes the child with the formation of complex numbers and the matching quantity. These activities also form an impression of the hierarchy of numbers, place value and the role of the zero in determining place value.

The Changing Game of Nine with Golden Beads

With this material the child will change ten of one category into one of the next higher category. Hands on counting of the bead quantities illustrates that ten units equal one ten and ten tens equal one one hundred and so on. Now the child is ready for the four operations of addition, subtraction, multiplication and division.

Golden Beads Addition

Using skills acquired from all the previous golden bead exercises, this activity introduces the process of addition using four digit numbers. Small number cards and the matching quantities represent the numbers to be added. The larger cards are used for the sum or answer. Combinations that will require exchanging are gradually introduced.

Stamp Game

As the child becomes comfortable with his concrete understanding of numbers, the level of abstraction is increased. Wooden squares or stamps of identical size represent the different decimal categories with colors and numbers. The green unit stamps are marked one. The blue ten stamps marked 10. The red hundred stamps marked 100, and the green thousand stamps marked 1000. The thousand stamps and the unit stamp are both green because both are the basic unit of their decimal category. Lessons follow in the same format as the golden bead activities. The children use the stamps as they did the beads, working on a table now instead of a floor mat. The teacher writes out four digit problems to be solved using this material.

Teen Board,Ten Board and Hundred Board

Introduced after golden bead addition the teen board highlights the terminology, sequence and formation of numbers eleven through nineteen. The unit bars in combination with the ten bars in the golden bead material form the teen quantities. A series of lessons introduces the teen numbers.

The ten board, similar to the teen board, highlights the terminology, sequence, and formation of numbers ten through ninety-nine.

The 100 board has a 10-by-10 grid pattern with tiles numbered one through one hundred for linear counting practice and reinforcement of number recognition in the tens.

Linear Counting Introduction

Skill in counting is developed using the bead chains. A Chain of ten "ten bars", representing the

square of ten, is introduced first and counted to 100. The student counts the first bar, chooses the correctly numbered ticket, places the ticket next to the last unit on the counted bar, and continues to count and label each bar in sequence. All chains can be counted using this process. These exercises also provide a foundation for the squaring and cubing of numbers one through ten.

Skip Counting

Counting the same chains by the bead bar increments, instead of each unit increment, provides a foundation for the multiplication tables and multiples.

Memorization of Facts

Our number system is designed to have the numbers zero through nine. Every number we can conceive of is built of these and combinations of ten. If you can learn to manipulate those numbers you can do it on any magnitude. If you know that four and five make nine, it doesn't matter what hierarchy you are in, you can successfully solve the problem once these facts are understood.

Memorization Materials

These boards and charts are used to help the child work through in an ordered and then a random way the combinations for addition, subtraction, muliplication and division. Various mathematical laws such as the cummative property of addition are introduced.

Different techniques, with or without booklets, provide variety to encourage repetition for the memorization of all tables.

Small Bead Frame

The small bead frame offers more abstract procedure for the addition and subtraction processes. The number categories of one, ten, one hundred and one thousand, line up on a wooden frame, top-to-bottom, in the style of an abacus. A grasp of the addition tables and an understanding of the carrying process support this work. Following the small bead frame, the large bead frame introduces multiplication at this level of abstraction. Including the additional categories of ten thousand, one hundred thousand and one million, the large bead frame allows work with seven digit numbers in addition, subtraction, and multiplication in the same manner as the small bead frame.

Checkerboard

The checkerboard was designed to help children become aware of multiplication in different categories. For example, units times units makes units, units times tens makes tens, tens times tens makes hundreds, and so on. It also allows children to do very large multiplication problems without the necessity of having memorized all the multiplication facts. The checkerboard has many items that are already familiar to the child such as the hierarchical colors and the bead bars. The checkerboard is divided into colored squares, green, blue, and red, representing the category colors. This arrangement results in a diagonal display of the colors.

Racks and Tubes Division

Small test tubes, standing in racks of ten, contain ten color coded beads, each representing the categories through one million. Color coding on the racks represent the number families. Millions in black, thousands in gray and simple in white. A green bead from the white rack represents one

unit. A green bead from the grey rack represents one thousand. A green bead from the black rack represents one million. A blue bead from the white rack represents one ten. A blue bead from the grey rack represents one ten thousand and so on. Skittles, three boards and color coded cups to hold the dividend complete this material for short and long division, using up to a seven digit dividend and a three digit divisor.

Small Metal Inset Fractions

Segments of ten metal circles and ten metal squares represent halves through tenths. Used for designing and comparing, these small metal insets establish a foundation for understanding the concept of fractions. Using the same small metal inset material, several sequenced lessons lead the child to experiment with equivalencies, laying the groundwork for the concept of lowest common denominator. Initial lesson introduce the vocabulary, integer, denominator and numerator.

Advanced Fraction Work

These additional fraction materials show ways to break one into parts. Children use them to add, subtract, multiply and divide fractions, and to understand them in relation to decimal fractions and percentages. Rather than beginning with a rule, the student does much manipulative work and arrives at rules for working fractions abstractly.

Decimal Fractions

This material acquaints the child with patterns in our number system. With each tenth number, we can increase a hierarchy and we can also decrease in hierarchies with each ten beyond the whole number. This material gives practice in composing amounts and performing the four operations.

Study of Decimal Fractions

The decimal checkerboard material includes the checkerboard, loose squares, the bead bars and symbols for the multiplicand and the multiplier. This material allows the child to experience geometric representation of decimal fraction multiplication, with an emphasis on place value.

Square Root

A peg-board, colored pegs and a squaring guide are designed to lead a student from sensorial work in the process of squaring to abstraction. The terminology, written form and analysis of pattern and square root are researched.

Cubing

Cubing is a series of sensorial exercises, which show the process of building a new cube by adding to the sides and height of the original cube. The components of the cube are named while building it, leading to a formula for finding the mathematical value of the cube.

Cube Root

The cube root work begins with the sensorial building of the cube and gradually leads the learner to the process of deriving the cube root of a given number. As the cube is built, and the process is recorded the working of researching and proof is differentiated. In the final process of abstraction, the relationship of the number and its cube root is understood and the cube root can be found using an abbreviated formula.

Signed Numbers

A series of bead materials are used to introduce the student to an awareness of negative numbers. The four operations are performed using signed numbers, with the student arriving at rules for operations with signed numbers.

Powers of Numbers

This cube material for the powers of numbers is designed to bring an awareness of powers beyond squares and cubes for decimal numbers. The language of power, base and exponent are introduced. This is an indirect preparation for non-decimal basis and is a preparation for algebraic manipulation.

Algebra

The algebra materials consists of skittles and dice on a fulcrum which are manipulated to solve linear equations. As with most of the Montessori math curriculum, children develop a concrete understanding of algebra using a hands on approach. Elementary aged children develop this basic understanding of algebra prior to entering middle school.

The Montessori math curriculum provides children with an extraordinary understanding of the meaning of numbers. Anyone who has learned mathematics in a Montessori classroom can easily conceive of the difference between one hundred and one thousand, or the difference between a squared number and a cubed number. The carefully designed movement from concrete to the abstract allows the child to deeply understand complex mathematical principles.