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How Montessori Methods in Mathematics Education Meet the Needs of Students with Learning Challenges

AMS Research Committee White Paper

Ginger Kelley McKenzie, Ed.D., Associate Professor Childhood Education and Literacy, Xavier University and
Victoria S. Zascavage, Ph.D. Assistant Professor Secondary and Special Education, Xavier University
Angela K. Murray, PhD, AMS Research Coordinator, Editor

One of the goals of AMS is to disseminate research relevant to Montessori education. The AMS Research Committee is publishing this white paper to illustrate how Montessori mathematics education uniquely meets the needs of students with a variety of special needs.

Maria Montessori is considered a pioneer in the education of children with special needs. Noticing that children with special needs were not receiving an appropriate education, in 1898 at the University of Rome's Psychiatric Clinic Maria Montessori developed the necessary materials and space to educate those children labeled "uneducable" (Montessori, 1967). As she worked with children who have learning challenges, Montessori tested and perfected her program, a program designed to teach academic, real-life experiences, and social skills (Montessori, 1967). The schools that bear her name use an educational method dependent on self-directed, self-paced, and self- correcting activities (Christle, 2010). In the United States, Montessori schools became popular in the 1950's and 1960's, an era where many educators "adopted her developmental and child-centered approach to early child education as well as her belief that all children could learn regardless of economic status or disabilities" (Christle, 572). The academic success of Montessori education is founded on time-tested methods that teach skills from the concrete to the abstract, an element of effective differentiated instruction essential to the included student with many different learning styles and challenges (Mastropieri & Scruggs, 2010). Cossentino (2010) concurs that "Montessori practices…manipulative materials, individual instruction, and academic self- regulation are considered effective educational methodology for both the typical student and the student with developmental/learning disabilities" (p. 39).

Effective Mathematics Instruction in an Inclusive Early Childhood Setting

Mastropieri & Scruggs (2010), nationally recognized as strong voices for educational inclusion, have incorporated research-based methodologies for effective mathematics instruction in their current textbook, *The Inclusive Classroom: Strategies for Effective Differentiated Instruction.* Included as best practice for students with special needs in mathematics are five major components developed by Carnine (1998).

1. 'Big Ideas' teach conceptual generalization. In Montessori math, the *Bird's Eye View of the Decimal System* enables students to grasp the 'Big Idea' of numeric place value. *The Bird's Eye View* is a hands-on manipulative layout using beads that represent single units, bars that

represent units of ten, squares that represent units of a hundred, and cubes that represent units of a thousand.

***Case 1*: Lisa Gets the Big Idea**

Lisa, a 4-year-old with ADD (Attention Deficit Disorder) in a Montessori early childhood classroom, enjoys laying out 10 single-unit beads on the right side of a large floor mat. Just to the left of each unit-bead, Lisa places a ten-bar. To the left of each ten-bar Lisa places a hundred-square which is made of 10 ten-bars attached to each other. And finally, to the left of each hundred-square, the child places a thousand-cube. Each thousand-cube is made of 10 hundred-squares stacked on top of each other. Together, this creates a beautiful layout called the Bird's Eye View of the Decimal System. In order to support her attention challenges this Montessori classroom has a small, compact, light weight three shelf moveable unit on wheels so the child has all the materials she needs next to the floor mat where she is working. This allows her to attend to the work with limited movement.

Because the materials are easy to access to create this layout representing the decimal system, Lisa is able to focus on learning the concept. She is very proud when she completes this project.

2. Conspicuous Strategies are used to reinforce successive concepts. Mastropieri and Scruggs (2004) state that: "Overall, it is important to consider that curriculum materials (for special education students & others) do not (should not) determine instructional objectives, but, appropriately employed, should support and enhance the learning of instructional objectives" (p.157). Because Montessori classrooms are set up to offer multisensory materials and activities, students with learning difference are able to embrace curriculum materials with high-priority characteristics that reinforce the scope and sequence "within each grade level necessary to build conceptual understanding" (Mastropieri & Scruggs, 2010, p.127).

Pickering (2003 b) states that if an appropriate early childhood program (such as Montessori math and geometry curriculum) is offered to a child with a math related disability such as dyscalculia the learning difference does not become a learning disability. For example, the red and blue rods are an example of a Montessori hands-on tool that can be used to teach multiple concepts depending on the child's needs, learning style, and readiness. The red and blue rods consist of ten different rods. The one-rod is one decimeter long and is painted red. The two-rod is two decimeters long; one of the segments is red and the other is blue. Each subsequent rod adds one decimeter in length, and the color of each segment alternates between red and blue. Thus, the ten-rod is one-meter long.

***Case 2*: Using colored rods, José with an Auditory Processing Deficit grasps the concepts of length and relative size and advances his language skills in both Spanish and English.**

At age three with an Auditory Processing Deficit which manifested itself in both Spanish, his Native language, and English, José joined a Montessori classroom in Texas. His teacher used red and blue rods to help him learn numbers one to ten. She handed José the one-rod, said "this is one," and placed it on the project mat. José traced the one-rod with his small fingers, repeated the word "one," and put it back on the mat. The teacher continued this exercise, handing José rods two through 5 – or more, depending on his ability to learn this work.

Now that José is older and ready to learn the concepts of "greater than" and "less than," the teacher uses the same rods. Naming each item as she places them on the mat from left to right, the teacher first puts the one-rod on the mat, then a wooden image of the "less than" symbol (<), then the three-rod. Using the same process, she could teach the relationship of "greater than" with a five-rod, the (>)

symbol, and a one-rod. Because he has an Auditory Processing Deficit, the concrete materials and the teacher working only with Jose by himself, support his learning style.

Naming each item individually helped José be successful even though he had an Auditory Processing Deficit, and as he gets older using the same rods to learn successively more complex concepts supports José's efforts to build upon his math knowledge. This is a conspicuous Montessori strategy.

3. Time Efficiency is planned to allow flexibility to encourage self-motivation. The entire Montessori classroom is synchronized with math materials readily available, and allowance is made for active interest; children can stay at the task of choice until it is completed. Ryan and Deci (2000) described self-motivation as the result of self-control and self-determination. Montessori classrooms remove deadlines so that children can become self-motivators. Even though deadlines are flexible, what Mastropieri & Scruggs (2010, p. 127) call Scope (the breadth and depth of content presented in school) and Sequence (the order in which content is presented) are monitored as critical factors for setting the overall time allocations of instruction.

Case 3: Kari with cognitive delay is observed from a distance to allow self-motivation and time efficiency.

Kari, a four-year-old, with cognitive delay uses the Spindle Boxes to learn to count. Each Spindle Box is labeled with the number of spindles (zero through nine) that it should contain. This exercise is an example of clear communication because, with 45 spindles, if Kari makes a mistake putting the correct number of spindles in its appropriate box, she will have either too many or too few spindles left when she fills the last box. This teaching method, called "control of error," is an example of time efficiency. The Montessori adult is an excellent observer and watches Kari complete the task from a distance. If Kari does not complete the activity correctly, the teacher will present the activity again at another time. It may be necessary for her to see it again in order for her to master and understand the concept before she moves to the next skill. The teacher will use this time to support and access the student individually.

4. Clear Communication is assured by presentation of early childhood math exercises by one Montessori adult to one child in a manner that reduces the possibility of error or misunderstanding. Pickering (1992, 2003a), states that children who are at risk with Dyslexia (a brain-based type of learning disability) "benefit from this Montessori structure, the procedures, and the curriculum" (1992, p. 90).

Case 4: Lisa with ADD learns new concepts by handling geometry shapes and sticks.

Montessori 3-6 and 6-9 classrooms have a Geometry Cabinet with several drawers housing different geometric shapes: circles, triangles, rectangles, quadrilaterals, curvilinear shapes, and polygons with more than three sides. In her 3-6 classroom, Lisa, the girl discussed earlier with ADD, is introduced to one cabinet drawer at a time. In a puzzle-like activity, she places each shape on a control card that matches the shape, then she returns the shapes to the drawer she is working with. In her 6-9 classroom, Lisa builds on her familiarity with geometry shapes by using geometry sticks in a manipulative activity to learn the characteristics and names of all seven possible kinds of triangles. When Lisa is able to demonstrate her knowledge by identifying and naming all seven different triangles, she gains confidence in what she has learned by going back to the triangle drawer in the Geometry Cabinet and labeling all the triangles. In Montessori classrooms, this is an example of practice to review and retain, which is very appropriate for children with attention challenges who often need opportunities for repetition.

5. Practice to Review and Retain incorporates the re-use of familiar math materials from early childhood on to support new learning experiences. Math materials in the Montessori early childhood classrooms are concrete manipulatives for young children, and these same math materials are used again with older children to teach more complex math concepts (Chattin-McNichols, 1992; Lillard, 2005). Math activities such as the Golden Bead materials teach place value to younger students, and later the same materials are used to teach addition, subtraction, multiplication and division. Lillard (2005) expressed this by saying:

> *In traditional school curricula, it is very difficult, if not impossible, for teachers to do a really good job integrating new information with children's prior lessons…. Montessori education is distinguished by involving lessons and materials that were developed with the entire educational program from ages 3 to 12 in mind* (p. 235).

Montessori methods of instruction fit the recommendations of Carnine (1998) specific to special education and identified in Mastropieri & Scruggs (2010) as being effective for mathematics instruction for the included student with special needs. A Montessori classroom is individualized for the needs of each student using effective mathematics instruction that incorporates Big Ideas, Conspicuous Strategies, Time Efficiency, Clear Communication, and Practice to Review and Retain. Each of these components can be experienced in a Montessori inclusive environment where individual students receive individual attention and respect.

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