

Why should we use Concrete Materials?

In this piece, we will be discussing the importance of the Montessori mathematics materials and how they function as a bridge towards abstraction. We will also discuss how modern research into the cognitive functionality of a child can affect the way the materials impact a child's development in mathematics, particularly in children with additional needs.

The Montessori classroom is a place of beauty, a place of calm tranquillity where children can learn at a pace that suits them, surrounded by materials that support that learning. Mathematics is a crucial component of the national curriculum and has proven over the years to be one of the most difficult subjects to teach. The subject has an innumerable variation of possibilities and strategies to reach the correct outcome, thus directors have an overwhelming task when delivering presentations.

The ultimate goal for any teacher is to navigate children towards abstraction in a particular strand of the subject. The children are able to use one's strategical awareness to solve complex problems in one's head. Mainstream schools tend to issue numerous worksheets and pencil and paper methodology, which only meets the needs of those children who have grasped the concept during the presentation delivered by the teacher. This is where the materials in a Montessori classroom differ.

Montessori's hands-on approach to learning allows children to physically feel and touch the numbers they are computing in a way that not only stimulates their mind but stimulates their senses too. Take for example the *Cabinet of Powers*. When a child is asked to go and collect a ten bar of beads compared with a cube amounting to a thousand beads, not only can they physically count the amount of beads but they can see it, feel it and most importantly weigh it. The difference between the two amounts has suddenly changed from just a number, to **an** real tangible amount that can not only be seen but touched.

The importance of the hand and brain working together is perfectly explained by Lillard & Lillard; *"In the child, it is the actions of the hand guided by the intellect that create a feedback loop of information, the hand reports to the brain, the brain guides the hand by this new information by carrying out a new direction."* (Lillard & Lillard, 2003: 48). It is this link between the brain and hand that allows the concrete to develop into the abstract ways of thinking. The continuous feeding of information via the senses back into the brain allows for a deeper understanding of mathematical concepts.

This multi-sensory approach to mathematics allows children to learn from all angles. Stimulating a variety of senses, the children have a much higher chance of grasping the concept than just introducing it through pencil and paper methodology. Although we must not forget that the standard methodology would still be taught, but with the materials alongside to allow students to understand the true meaning of number values.

Division and multiplication require a huge amount of knowledge of the number system as a whole. Crossing the tens barrier, carrying numbers and exchanging ten units for one ten, are all too commonly overlooked by mainstream teachers by instructing children to simply 'carry the one', or 'add the magic zero'. These commonly used phrases only act as a temporary Band-Aid to misconceptions in mathematics, which can often hinder children as they move into more complex forms of mathematics.

Materials such as the racks and tubes or the multiplication checkboard allow children, especially those with additional needs, to use the sense of colour, size and the physical movement of amounts to understand why ten units is equal to one ten, or why two blue beads and three red beads equals twenty-three. These attributes of the Montessori mathematics materials allow children with special needs to utilise their other sensorial attributes to tackle the problem from another angle. The measured progression of the presentations based on the materials allows children to have a concrete understanding of the concept before they move on to the next phase.

“Through the exercises of the senses children learn to compare and contrast, to perceive fine distinctions and to construct abstract ideas from concrete experiences.” (Feez, 2010: 128).

The golden beads material is a perfect example of a resource that allows all children, even those with additional needs, to walk the mathematical path towards abstraction. The fact that the algorithm is written down during an addition calculation, followed by the placement of the numbers in question being laid out in golden beads, allows the child to physically see, feel and weigh the amount he or she is trying to compute. The child can physically see that a number three in the thousands column is actually a very big number. It is three large thousand cubes, which must be picked up, touched and weighed by the student. This physical touch allows the child to quantify that number three and understand that because of its place value, it is more than just three. Being able to visualise numbers is a wonderful skill that must be emphasised if we are to lead children towards abstraction and this is something that the Montessori materials do very well. They allow children of all abilities to truly understand what a number is worth.

It is important that teachers and directors understand the progression a child is making whilst carefully monitoring progress and documenting observations. The beauty of the Montessori classroom is that presentations are given to small groups and tasks can be differentiated accordingly. Steady progress and a concrete understanding are crucial in mathematics if we are to lay the solid foundations that will scaffold the way to success in more complex problems later down the line. Careful annotations must be made as children use the materials and understand new concepts. These annotations and observations will allow directors to differentiate tasks accordingly, group children for future presentations and refine their own pedagogy to meet the individual needs of those children who may be excelling or struggling with a particular concept.

It is important to note that Montessori materials are not only used to assist those students who may find it difficult to grasp a concept but they also act as an indicator for those children who may be able to excel in the subject. The hierarchical colours and patterns that emerge when using the materials such as the pegboard or the binomial cube allow children to take mathematics in their own direction. They allow for exploration and abstract thought. Concepts and strategies can be tested, tried and physically pulled apart to be re-invented by the child, thus creating a deeper sense of mathematical exploration. This opportunity to explore the materials and concepts independently is explained perfectly by Eissler; *“The emphasis on self-directed concentration is that children learn to take ownership of their own education. This gives children power, the power they crave as they mature.”* (Eissler, 2009: 140).

The opportunity to explore the materials independently allows children to use trial and error and ultimately make mistakes. Psychologist Jason Moser studied the neural mechanisms that operate in people’s brains when they make mistakes (Moser et al., 2011). Moser and his group found something fascinating. When we make a mistake, synapses fire. Synapses fire when the brain is learning. Montessori’s concrete materials allow for mistakes to be made, and this can only enhance the learning process.

Similarly, this self-exploration of the materials nurtures the ability of the child to concentrate and engage with the problem at hand. Feez speaks of the particular benefits of self-paced, uninterrupted learning when working with children with attention deficit disorder. *“The more time children spend working in this way, the more abundant is the attention under their control.”* (Feez, 2010: 52)

Continuous observations by the teacher of strategy selections and the interaction with the materials made by the child must be documented by directors in order to understand where we go from here. Teachers must continuously ask themselves, what has this student understood and how does this help scaffold my next lesson? The observations and assessments made by directors not only allows them to understand what a child has conceptualised, but they also act as an assessment of the teaching or delivery strategies used by the director. Could the presentation be introduced in a different way? Was there something in the presentation that may need to be changed for the following lesson? These questions need to be asked if teachers are to refine their practice and pedagogy to enhance the learning of their students in mathematics as we strive for abstraction.

To summarise, it is important to understand that the Montessori mathematics materials are designed in a way that allows careful progression for students. They allow conceptual development to be made whilst stimulating the various senses. Alongside this, the mathematical materials allow teachers not only to assess the attainment of the child in question but also allow for periods of self-reflection upon their own delivery of a subject. With this, directors are able to differentiate presentations to suit the needs of all ability groups whilst allowing the children to understand the concept at their own pace, in their own space and independently.

References

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