# INTEGRATION OF ICT IN MONTESSORI SCHOOLS: HOW IT WORKS

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**Abstract**
*The integration of technologies into the Montessori education system has been one of the most popular issues amongst Montessori practitioners since the turn of the 20th Century. The bone of contention has remained the fact that in the time the method was developed, there were no learning technologies. Thus, many stakeholders fear that the introduction of ICT into the Montessori methodology can imminently diminish the method. Attempts to introduce ICT tools into the Montessori classroom has often met with huge resistance because most of such use lack the Montessori pedagogical undertone needed for effective integration of ICT into the method. This paper therefore examines current trends and practices in the integration of ICT into the Montessori system of education with a view to determining best practices for integrating ICT into Montessori schools. To do this, the paper takes a historical look at the Montessori method, its underlying principles, and analyzes available debates in journal articles and internet. Finally, the paper recommends that the integration of ICT like any other innovation in the Montessori classroom should be based on the principles and practices of the Montessori method so that the benefits of the method are optimized rather than diminished.*

**Introduction**

This work seeks to explore possible ways for integrating Information and Communications Technology (ICT), in the Montessori school as well as specific ICT tools that can enhance cognitive development. The method is named after Dr. Maria Montessori, based on her theories of learning which gave insight into the true nature of the learning process and laid emphasis on the training of the senses (Montessori, 1965). According to Montessori (1996), "a new education from birth onward must be built up. Education must be reconstructed and based on the laws of nature and not on the preconceived notions and prejudices of adult society." She, like Nevison recognized the impact of "Organic development" in children, as a result, the Montessori method aims to provide learners with the enabling environment for learning such that their learning develops 'organically'. Montessori learners are systematically introduced to a broad spectrum of guided activities from which they have the liberty to choose. In this method, it is believed that children will learn effectively at their own pace and according to their choice of activity, hence the need for a rich ecology of learning resources (technological and otherwise). Learners in the Montessori method are not segregated by age rather by activity and the consequence of this is that you could have Montessori learners who are 2months old or even in high school.

Although Montessori, formulated theories upon which Montessori schools are based, it is important to note that many schools which claim to be 'Montessori', practice methods that are far from the principles advocated by Dr. Montessori. However, the focus of a typical Montessori school is to accommodate a "thoroughly planned, stimulating environment, which will help the child form a solid foundation for creative learning" (Ahmadi, 2003)

**A brief history of the Montessori method**

The Montessori Method is somewhat similar to the Constructivist theory. The method was developed by Dr Maria Montessori. Born in 1870, she became the first woman in Italy to be awarded a medical degree. She majored in psychiatry, anthropology and education. Dr. Montessori believed that children are born with innate potentials which need to be manifested and disagreed with the idea that children are born in a blank state. Based on this belief, she emphasized the structuring of the child's natural environment to allow the natural manifestation of these innate tendencies while the teacher plays the role of an observer as the child freely explores his environment (Ahmadi, 2003).

At the age of thirteen, Dr. Montessori began to attend a boys' technical school against the wishes of her father but with the support of her mother. She spent seven years studying engineering after which she began pre-med and in 1896, she became a Doctor. While at the University of Rome psychiatric clinic, Dr. Montessori specialized in the treatment of children with special needs. By the time she was 28 years of age, Dr. Montessori became directress of a school for retarded children. She developed learning materials (Didactic materials) and methods that saw the children excelling relatively well at school tasks, particularly works that were regarded as beyond their abilities. At this point, Dr. Montessori saw a need to study "normal" children, considering that if the defective children could be brought to the same academic levels as the normal children, then something was wrong with the method of educating the normal children (Kilpatrick, 1914).

From here, she began educating and taking care of poor children from the slums of San Lorenzo, a remote area on the outskirts of Rome in her first Casa dei Bambini (meaning House of Children). The success of her methods according to Simon (1988) "convinced her sponsors that her methods were right and she attracted a wide following." During the 1915 Panama-Pacific Exposition in San Francisco, Dr. Montessori was invited to set up a classroom which comprised of twenty-one children, who were all new to the Montessori method, the class was set behind a glass wall for four months and visitors at the exposition came by to watch the class activities. At the end of the exposition, her class was honored with the only two gold medals awarded for education.

Maria Montessori was forced into exile from Italy during the second world war as a result of her political views which were considered anti- fascist. She exiled to India and there, she developed her work; Education for Peace, and many of other ideas being taught in her training courses today. She was nominated twice for the award of the Nobel peace prize (Singh, 2005).

**A close look at the Montessori pedagogy**

The Montessori Method celebrates the uniqueness of each child and advocates the use of diverse task-related objects to stimulate learning activities. While the traditional school system operates in a way that is typical of a teacher-learner setting which involves children sitting in desks and drilled on learning materials, the Montessori school setting is prepared based on subject areas e.g. gardening, fine art, animal care, sanitation, library corner, food preparation, etc. Learners are at liberty to move about the classroom, learning from one another without pressure to complete a chosen task. Emphasis is then placed on careful observation of processes, and record-keeping under the watchful eyes of the teacher. Being learner-centered, the Montessori school is "designed to help children with their task of inner construction as they grow from childhood to maturity. It succeeds because it draws its principles from the natural development of the child… children's innate passion for learning is encouraged by giving them opportunities to engage in spontaneous, purposeful activities with the guidance of a trained adult"(Renu, 2005).

In a typical Montessori school, various corners or sections are designed for specific subjects to enable learners at each level, take charge of their learning as self-reliant and collaborative beings. Ideally, Montessori classrooms are "designed for a three-year age mix (three to six, six to12, 12 to 15), which allows for both individual and social development" (Renu, 2005). They are so structured to enable younger learners learn from the older ones while the older ones learn by teaching or helping the younger ones. The Montessori school teaches order and discipline from the foundation and learners are trained to maintain this order while exercising their liberty. According to Montessori (1965), the Montessori classroom is controlled by "didactic materials" supplied to the school and remains the only objects of interest to which the learners have access. Through these materials, sensorial training is given to help Montessori learners categorize and give order or meaning to the world around them, based on the Montessori principle of "first the education of the senses, then the education of the intellect" (Kramer, 1976).

In the Montessori school, the adult's role is to continuously restructure the learning environment such that the child is able to make meaningful connections to it. With a systematic exposure to books, projects, and lessons, teachers are able to arouse the learners' curiosity thus, stimulating creativity and the development of skills that enable them search for answers for themselves. Through appropriate use of technology therefore, children in Montessori schools can gain access to a wide range of information that

can provide answers to their questions shifting their dependence on the teacher to self. They can also simulate real-life roles without the danger of failure, or getting hurt. Montessori schools encourage learning by stimulating the learners' environment with relevant and interesting ecologies of media. The Montessori Method has roots in the constructivist theories of John Dewey, which advocates that the process of education "begins unconsciously almost at birth, and is continually shaping the individual's power" (Dewey, 1897).

**Critique of the Montessori Method**

In a critical view of the Montessori Method, Barron (1992) asserted that Piaget admired Montessori's early work and thus "praised her understanding of the use of concrete materials as an element in fostering children's intellectual development." However, not many people agree that the Montessori Method is a child-centered approach as noted by Dewey. The major arguments that have come up are the use of didactic apparatus which they claim limits or restricts the learner's imagination. One of the major critics of the Montessori Method is William Kilpatrick who was a devout disciple of John Dewey. In 1914, he published the book; "the Montessori system examined". Smith and Dennis (2005) reported that Kilpatrick's examination of the Montessori method was based on three things; the book 'The Montessori method', his observation of Montessori classrooms in Rome, and a private interview with Dr. Montessori which according to him, convinced him that Montessori was ignorant of other on-going works in the field of education besides her own Smith. Kilpatrick's major critique of the Montessori method is that it emphasizes the child's individuality to the detriment of group work. Further highlights of his critique of the method include that:

- it did not allow enough time for social cooperation and interactive play
- there was an unnecessary emphasis on the training of the senses
- the work was too much a preparation for further ends
- it bore no direct relationship to the real world
- it was simply derivative of Rousseau, Pestalozzi, and Froebel
- it relied too much on mechanical manipulation of materials with little time for free play
- it was just too individualistic with its emphasis on auto-education and self-correcting materials (Smith and Dennis, 2005).

Furthermore, other critics have claimed that, a weakness in the Montessori Method is its interwoven nature with Dr. Montessori herself. In Maria Montessori: a Biography, Rita Kramer (1976) explains that a New York Times writer, in an interview with Dr. Montessori in 1913 stated:

> *"...the method is Montessori and Montessori is the method and one may well have grave doubts about how it will go with 'auto-education' when Maria Montessori's personality is removed."*

Although, Kilpatrick opposed the Montessori ideas, he extolled the virtues of the "practical life" work that the method emphasized. Comparing the works of Montessori and Dewey, Kilpatrick (1914) states thus:

> *"….the two have many things in common. Both have organized experimental schools; both have emphasized the freedom, self-activity, and self-education of the child; both have made large uses of "practical life" activities. In a word, the two are cooperative tendencies in opposing entrenched traditionalism…."*

**Current use of technologies in the Montessori school**

Geoff et al (2003) reported that, "the computer has become a recognized tool in the education of young children, particularly where it is used to promote problem solving skills and social interaction amongst children." The proliferation of technological devices in today's world calls for some qualitative evaluation in choosing those that will serve educational purposes. "Early on, the use of such technology (as the computer) in these settings (classroom) prompted fears that the abstract nature of the computer would prove damaging to young children's cognitive and social development" (Brady and Hill, 1981), "later, the application of constructivist approaches of teaching and learning using computers displaced many of these fears" (Haugland and Wright, 1997; Henninger, 1994). The computer is one of the most significant developments in Montessori schools over the years and in more recent times, varying software packages specially designed for learners.

This leaves one to begin to wonder about how Dr. Montessori would have reacted to the use technology in the modern day Montessori classroom considering that even in her time, her innovative ideas were eccentric. Considering her use of didactic materials, one will no doubt agree that she would have welcomed the computer technology in the Montessori class while carefully guiding learners as they explore the opportunities of the world around them through the affordances of the computer technology. As Love and Sikorski (2000) rightly pointed out; the educator is tasked with the responsibility of preparing children for the world they would someday inherit. To effectively do this, "computer technology is indeed a necessary experience that needs to be modeled in the classroom". To further buttress this point, Love and Sikorski (2000) cite Postman (1993) as saying that:

> *"…technological change is neither additive nor subtractive, it is ecological. I mean "ecological" in the same sense as the word how it is used by environmental scientists. One significant change generates total change. If you remove caterpillars from a given habitat, you are not left with the same environment minus caterpillars: you have a new environment, and you have reconstituted the conditions for survival; the same is true if you add caterpillars to an environment that has had none. This is how the ecology of media works well. A new technology does not add or subtract something, it changes everything."*

No doubt therefore, the introduction of computers in the Montessori school has brought about significant changes in the way in which the Montessori principles are applied; some of these changes are unique to the Montessori philosophy while the others are general. According to Love and Sikorski (2002), "computer technology has the potential to enrich the learning experience in the Montessori classroom." In a study by Armstrong (1999) on how computers are currently being used in the Montessori classrooms, she explains that computers are used for "practical life, drills, phonetics, research, games, word processing, Logo/MicroWorlds, simulation of Montessori materials and educational research."

Various computer softwares have been designed to make rote learning and drill practice more fun; this appears to have an element of the Montessori principle since making the learning process fun, will ultimately encourage learning. Furthermore Armstrong (1995) noted that "children whose fine motor and writing skills lag behind their creativity have utilized word processing programs with great success. Logo/MicroWorlds were designed specifically with a Montessori-like constructivist philosophy in mind. The purpose of MicroWorlds is precisely to allow the child to explore worlds to which he has no other access, for example a world where Newtonian physics makes intuitive sense. The child can then build on this intuitive understanding, making more and more complex MicroWorlds. This closely mirrors the ordered, sequential learning of the Montessori Method" In view of this, I have course to agree with Montminy (1999) when he opined that "it no longer makes sense to ask if our children should be exposed to computers but rather when, where, and how should we introduce our children to what kind of computer experience."

It is an obvious fact that today's children get exposed to computers as early in their lives as just after birth. It is therefore, not uncommon to see kids as young as eight or nine months using computers. Various computer programs like Reader Rabbit, Arthurs reading game, big thinker's kindergarten etc, help children to start off the learning process early in their life. Most of these learning programs are designed such that they are easy to use and stimulate learning in kids while at the same time appealing to their senses. The Montessori teacher will therefore play a vital role in the full exploration of these technologies. To effectively do this, the teacher needs to be competent in handling these technologies so that they can provide learners with the ideal Montessori experience. The Internet will also prove useful for research activities in the Montessori class. It would suffice at this point to ask; how can all of these technologies affect the overall cognitive development of the child?

Zuckerman, Saeed and Mitchel (2005), in their work, *Digital Montessori-inspired Manipulatives (DMiMs)*, sought to provide a sort of framework for classifying manipulatives which according to them, "are physical objects specifically designed to foster learning." They also acknowledged that abstract concepts are hard to learn, hence the need for tangible interfaces (physical objects) which both Dr. Montessori and Froebel based their practice on. They noted that "until now, the physical objects designed by Froebel and Montessori have been collectively called Manipulatives" (Zuckerman et al, 2005) and

therefore offered new classifications: Montessori-inspired Manipulatives (MiMs) and Froebel-inspired Manipulatives (FiMs). They opined that FiMs were learning materials that modeled real-world structures, while MiMs are flow blocks whose primary concern is to model more abstract and conceptual structures. Acknowledging that, there are computationally enhanced versions of manipulatives, they offered a further classification: Digital Montessori-inspired Manipulatives (DMiMs), (Zuckerman et al, 2005). They went further to define Digital MiMs as "computationally enhanced building blocks systems that support learning of abstract concepts."

The study described two typical forms of DMiMs, namely; SystemBlocks and FlowBlocks. For Zuckerman et al (2005), SystemBlocks can help learners to identify similar generic structures in simulated systems models. For example, by analogizing the flow of water through a bathtub, children can see the same generic structure in viral spread through a population, $CO_2$ pollution growth from emissions, and a bank account savings growth from interest and so on. Similarly, FlowBlocks can be used to simulate mathematical as well as computer-science concepts. They are therefore of the opinion that "Digital MiMs maintain coincident and synchronous input/output behavior, meaning that manipulation and simulation occurs at the same space (on the building blocks themselves) and in real-time. Digital MiMs construct abstract structures, but nevertheless are playful tools, facilitating a physical, multi-sensory, interactive experience."

In an evaluation of 25 children between the ages of 4 to11 years (for an aggregate of 40 hrs) and how they interact with 'FlowBlocks' and 'SystemBlocks', Zuckerman et al (2005) observed that the "digital MiMs are engaging for children and was successful at introducing specific concepts such as rate, accumulation, feedback and probability to the different age groups." It was also observed that the "characteristics of the digital MiMs encouraged children to make analogies between the simulated abstract behavior and real life examples that are meaningful to the children" (Zuckerman et al, 2005). Consequently, they classified the benefits of using tangible interfaces in teaching into three, namely;

1) Sensory engagement: here, they explain that the use of physical objects is a natural way by which children learn and that it constructively engages multiple senses (including touch, vision and auditory).
2) Accessibility: that there is a dramatic improvement in accessibility to younger children, people with disabilities and novices.
3) Group learning: does not give total control to one person, thus, fostering natural group interaction and discussion.

They concluded that "an iterative process of hands-on modeling and simulation provides children with an opportunity to confront their misconceptions about dynamic behavior." (Zuckerman et al, 2005). From their work we can say that learning with technological devices especially; manipulative ones will enable learner's link abstract concepts to reality in varying degrees thereby encouraging higher order cognitive skills.

**Benefits of using ICT in the Montessori school**

- ICT, in the right hands can be used to effectively construct new understandings and communicate effectively in the Montessori School. This will involve the use of technology in accessing and managing information for educational purposes. ICT certainly plays a vital function in developing the teaching and learning processes at all stages and improving the quality of education (Lamanauskas, 2008).
- The Montessori method is a learning-based activity and communication is a key factor in its success. The use of ICT in this method will help to develop knowledge by scrutinizing and studying as well as relaying information through the use of application software.
- The use of multimedia resources helps to enrich the Montessori classroom with a mixture of audio, visual and text materials that can help train individual senses. The use of video conferencing can stimulate interests, as our dynamically involved and "knowledge-based society offers new opportunities to effectively satisfy students' need for teaching/learning" using multimedia aids (Lamanauskas, 2008).

**Integration of ICT in Montessori Schools and how it works**

The introduction of new technologies into the classroom is often received with a lot of fanfare. However, it is important to note that the manipulative learning tools developed by Montessori did not have any technological undertone. Bearing this in mind therefore, any new introduction of technology into the Montessori classroom must be founded on sound Montessori pedagogy else it will ultimately defeat its purpose and inevitably diminish the method. Upon this understanding, one can easily agree with Montessori's opinion that "every item of culture that enters the syllabus must stimulate the child's intellect…draw his attention and demand his concentration" (1989c).

Furthermore, for ICT to be effectively integrated into the Montessori classroom, due consideration must be given to the question raised by Love and Sikorski (2000); "how would Maria Montessori respond to technology in the classroom if she were alive today?" To do justice to this question, there is need to understand that even in her time, Montessori favoured the exposure of learners to a wide range of 'age-appropriate' learning tools. Therefore there is no doubting the fact that she would have embraced 'developmentally-appropriate' technological learning tools in the modern day Montessori classroom placing particular emphasis on *when*, *where*, and *how* learners should be introduce to *what* kind of technologies (Montminy, 1999).

As a result of the rapid proliferation of technological devices in our world today, there is need for Montessori practioners to bridge the technological gap (which exists as a result of learners' exposure to varying forms of technology in their various homes even prior to formal education age) by modeling relevant emerging ICT tools in the Montessori classroom. An approach to any integration of ICT in the Montessori classroom that will work will be one that selectively introduces developmentally - appropriate technological learning tools. The teacher has a huge responsibility in the effective integration of ICT in the Montessori classroom. Therefore, Montessori teachers need to have a clear understanding of the Montessori methodology as well as the affordances of learning technologies if they are to leverage on the potentiality of enriching the Montessori learning experience through the use of ICT in the Montessori classroom.

Finally, the integration of ICT into the Montessori classroom should follow a thorough selection process which takes into cognizance, key characteristics of Montessori's unique didactic materials which have made her method so successful over the years. As a guide, Love and Sikorski (2000) propose that any ICT tool to be introduced into the Montessori classroom should possess the following attributes:

1. A discernible sequence or order which promotes logical thinking.
2. An aesthetically pleasing look that, easily attracts learners' attention, promotes peace and is devoid of all forms of violence.
3. Developmentally appropriate and relevant to the learners.
4. Error control features that promote independent or self-directed learning.
5. Multiple levels of difficulty in manipulating the technology.

**Conclusion**

Despite the various critique against the use of ICT in the Montessori Method, various research reports agree that the use of technology in the Montessori classroom, has the potential to enrich the overall Montessori learning experience (Papert, 1980, Roddy, 1997, Love and Sikorski, 2000). To harness the potential of ICT to enrich the Montessori learning experience however, every ICT tool to be introduced into the Montessori classroom must conform to the principles and practices of the Montessori methodology. Furthermore, teachers need to be empowered through training to become as comfortable with technology as today's child is if they are to record any success in integrating ICT into the Montessori classroom without diminishing the method. Finally, the integration of technology into the Montessori classroom will achieve optimum results if it does not attempt to replace the role of the teacher, but rather to supplement it.

**Recommendations**

Based on the outcomes of this review, the following recommendations are made for the effective integration of extant and emerging technologies in the Montessori classroom:

1. Since the teacher is responsible for the success or failure of any attempt to integrate ICT in the Montessori classroom, there is need to empower Montessori teachers through continuous trainings to be very comfortable with learning technologies. Once they feel comfortable with these technologies, the likelihood of harnessing their affordances for the benefit of the Montessori child would be significantly increased.
2. In choosing learning technologies to be used in the Montessori classroom, due caution should be exercised as not all learning technologies are relevant to the Montessori pedagogy.
3. The introduction of any new or extant technology must be systematic following the principles and practices of the Montessori pedagogy. If the integration of ICT in the Montessori classroom is not pedagogical, the outcome of such use cannot be any different from the use of such technologies in the traditional classroom setting.
4. All stakeholders in Montessori education need to encourage the development of Montessori-inspired ICT learning tools to reduce the chances of acquiring ICT tools that will be used in such a way that the original ideas of the Montessori methodology are hampered.

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