The Scientist in the Casa: The Child as Scientist in the Making

by Ginni Sackett

If a parent were to ask what science and technology are offered in a Montessori preschool, Ginni Sackett provides a comprehensive reply. By precisely defining the words science and technology with an expansion of those definitions from renowned biologist E. O. Wilson, alongside the "experiences we offer every day to the children in our Casas," we can honestly present the Casa as rich in science and technology. The hands, the senses, and the mind cultivate both interaction with the concrete world but also cultivate the imagination and clear judgment. In this way "every material and activity…is preparing each child to follow the scientific process."

When we look at the publicity and program for this conference, we see a number of words that we often don't think of in terms of the first-plane child, or, more accurately, words that we tend to look at through a very particular lens when serving that age child. This afternoon I'm excited to explore with you some practical meanings of some of these terms and how they relate to our work with children who are still in formation, the children who are still creating for themselves the reason and imagination we usually associate with such words.

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In particular, I would like to explore with you the word *science* and the word *technology.* I want to explore the practical meanings contained in those words, and I want to explore the experiences we offer to first-plane children in light of those practical meanings.

I think we can all agree that the experiences we offer to children are very carefully designed, and the experiences related to science and technology are no less carefully designed. We can identify and analyze those experiences to see how their careful design helps children create for themselves the foundations for true, reliable, scientific understanding of their world and its technology. More importantly, I hope that we will all be able to affirm that the children in our environments are not just preparing themselves for scientific understanding and practice; they are actually doing science. By having these experiences of *doing science*, they are becoming individuals who can take a confident, secure, and knowledgeable place in relation to the technologies of their future. We will see that the child we serve in the Montessori *Casa* is both the scientist in the making and the scientist in the *Casa*.

What do we mean when we use these terms *science* and *technology*, and what makes them relevant in the *Casa*? Let's look at a practical definition of science. It's quite simple actually (no matter what any of us might have thought in a high school science class). A dictionary definition of science includes knowledge, especially any knowledge gained through experience.

What kind of experience? A second dictionary definition answers that question in detail: the knowledge known as *science* emerges through experiences that involve the observation, identification, description, experimental investigation, and theoretical explanation of natural phenomena.

And what does a dictionary tell us about technology? It tells us that technology is the application of scientific knowledge for practical purposes.

Another helpful focal point for our exploration comes from renowned biologist and Pulitzer Prize winning writer E. O. Wilson as he answers the question "What does science do?" Wilson answers

that "Science builds and tests competitive hypotheses from partial evidence and imagination in order to generate knowledge about the real world" (44).

Now let's consider how the experiences we offer to children in the *Casa dei Bambini* might support them in becoming practitioners of science as Wilson describes it here. Let's consider how these experiences support the children in becoming individuals who "build and test competitive hypotheses from partial evidence and imagination…" and how they become individuals who can use this ability to generate reliable knowledge about the real world to create the foundations for true scientific understanding of the world they inhabit regardless of the work they choose to do as adults. And let's consider how these experiences bring them to a positive and productive relationship with the technology of both their present and their future time and place: the technology that results from the application of scientific knowledge for the practical purposes of their lives.

A scientific mindset should seek and value reliable knowledge about the real world and allow us to evaluate technology through the lens of that reliable knowledge about the real world. We can explore the experiences we offer every day to the children in our *Casas* from the perspective of this desirable outcome.

I want to acknowledge a bias of my own here, but one that I hope you might share: It is good for all humans to approach the world they inhabit with a scientific mindset. A scientific mindset should seek and value reliable knowledge about the real world and allow us to evaluate technology through the lens of that reliable knowledge about the real world.

We can explore the experiences we offer every day to the children in our *Casa*s from the perspective of this desirable outcome. We can also explore these experiences to identify the common elements they possess. What these experiences all have in common is that they all simultaneously incorporate the hands, the senses, and the mind. They incorporate the hands by cultivating interaction with the concrete (real) world. They incorporate the senses by cultivating the

imagination. They incorporate the mind by cultivating clear judgment. When we look at Wilson's description of what science does, we can see that every material and activity in a Montessori *Casa* is preparing each child to follow the scientific process he describes.

Let's go back to technology. I think we can all acknowledge that Montessorians, especially those of us who work with first-plane children, are liable to be considered as anti-technology, possibly even scornful of technology, both in our classrooms and in the everyday lives of the children we serve. We often speak and act in ways that would reinforce that impression about us.

But I would like to suggest what I think could be an important distinction for us in terms of the theme of this conference: Our *Casas* are not technology-free zones. Our classrooms are, in fact, packed with technology, with the technology that conforms to our definition. We can think of all of the amazing materials and activities of the Montessori *Casa* as technology, because they are all "the application of scientific knowledge for practical purposes."

Let's explore this for a moment before we come back to the hands, the senses, and the mind. We humans are never satisfied to just know stuff; we never seem content to leave our growing scientific knowledge as just something to know. We seem compelled to do something with what we learn and know. We do this in two ways: Sometimes we seek new scientific knowledge because we have identified some need or practical purpose we want to fill, and other times we discover some new level of scientific knowledge and then we determine how we can use it and apply this new knowledge for practical purposes.

The result of both of these progressions is the human-built environment. We can all agree this environment has very practical purposes indeed. The human-built environment (for better or worse) is the characteristic achievement of humans on this planet. Montessori called it the *supra-nature*.

In our classrooms, our children constantly engage with human technology. They are working with the elements of the human-built environment that have resulted from the application of scientific

Courtesy of Northwoods Montessori, Atlanta, Georgia

knowledge for the very practical purpose of supporting optimal development in young children. In our classrooms, we prepare and provide a manifestation of human technology that has been scientifically proven to match the characteristics of those children. This human technology constantly and simultaneously engages their hands, their senses, and their minds for the very practical purpose of optimal development according to the mandates of the first plane of development. The practical purpose is that these children will securely, confidently, and competently take their rightful place in the application of scientific knowledge in the built environment of their future.

We offer very special experiences based in human science every day to our children. If we can come to a greater understanding of this, this science happening every day in the *Casa*, we will become better guides of the children in our care. And we will become teachers who can knowledgeably, confidently, and securely talk to others about our work and its place in the human continuum.

Let's return to E. O. Wilson's quote and explore what it means to be scientific, to build and test competitive hypotheses from partial

evidence and imagination in order to generate knowledge about the real world. What is Wilson telling us about the practice of science? What capacities do we want to prepare our children for? How are they engaging in this scientific practice as they interact with the technology of our classrooms?

I love what Wilson is acknowledging in this quotation. I love that the process he describes begins with curiosity about something that is unknown–not unknowable, just still unknown. It all begins with a human decision to explore some unknown reality because it is unknown. The human mathematical mind is not content to accept this reality as unknown and unexplained; the human mind irresistibly wants to explain it.

So how can we know the unknown? Well, starting with what is already known, the scientist builds a hypothesis, a theory that might explain it. And Wilson is asserting here that the best science builds competing hypotheses–more than one plausible, possible explanation of what is being explored–and then tests these competing hypotheses to determine the most valid explanation possible for what is being explored. Finally, and this is a very important element of Wilson's thought here, the goal is *truth*: knowledge about the real world. This implies that the scientist has no psychological or ideological investment in the outcome; the scientist has no bias favoring one hypothesis over another; and the scientist is prepared to embrace truth even when it contradicts a belief or idea previously held.

> Every human is born with a scientific potential, with the potential to follow this progression towards knowledge of the real world. We know that the crucial factor in realizing any human potential lies in the experiences an individual has in the environment and depends upon whether those experiences cultivate that potential or not.

Where do these competing hypotheses leading to truth come from? Wilson answers that they come from a combination of partial evidence and imagination. I love that he uses the phrase "partial evidence"–our hypotheses start with something that is known,

something that has already been proven through interaction with the real world. So the hypotheses are suggested first by what is already known, this partial evidence. This is a very important point: the competing hypotheses must begin with something else that is observable and verifiable in the "real world." But then–and this is Wilson's true stroke of wisdom–the human imagination comes into play; the human imagination is equally important for generating the competing hypotheses. We are not limited to the evidence that already exists; we can also imagine possible explanations. An imaginative leap is necessary. Before knowing the answer, we must first imagine several possible answers.

But when science imagines the answer, that imaginative leap must stay grounded in the available evidence; the partial evidence we do have will serve us to appropriately limit the ways we might imagine the explanation. Finally, imagining several or competing possible answers also keeps the scientist intellectually honest; in other words, keeps the imagination (which as we know is limitless) in check and uninvested in the answer. This creates objectivity and keeps the scientist alive to the truth rather than satisfied with mere speculation, however appealing that speculation might be, to cherished ideas and beliefs already held. I think that by combining these two concepts–the objectivity of partial evidence with the subjectivity of the human imagination–Wilson is urging us to continue to question, to never be satisfied that we know all there is about the real world.

Where does the partial evidence exist and how do we perceive it? The evidence exists outside the human imagination in the real world, and we perceive it through our senses. In fact, to study, to know, and to use this partial evidence we must perceive it and we must interact with it. Only then can the human imagination come into play, to project–to imagine–the parts that are still unknown, the possible evidence that is not apparent, or at least not yet apparent, to our senses.

Finally, we test these competing hypotheses to determine the truth, to fill in the gaps in the evidence, and to determine which imaginative leap is most likely to be correct. We test the competing hypotheses using the same processes of interaction and perception.

Then we must employ our minds to judge the worth and validity of each hypothesis. We use our minds to determine, to judge, which hypothesis provides the best explanation possible, to give us some new insight into a truth of the real world.

The history of the human-built environment is a history of this balance and the technology that characterizes our built environment is a product of this kind of science. This pursuit of knowledge of the real world through the creation and testing of competing hypotheses is grounded in partial evidence and the imagination. Speculation is not enough, wishful thinking is not enough: This scientific process itself is a necessary source of the technology that shapes and organizes the practical purposes of the human world.

That's a lot to think about. Here is something else to think about, another bias if you will. Every human is born with the potential to be this kind of scientist. Every human is born with a scientific potential, with the potential to follow this progression towards knowledge of the real world. We know that the crucial factor in realizing any human potential lies in the experiences an individual has in the environment and depends upon whether those experiences cultivate that potential or not.

Our work is to offer experiences through which a child's many potentials can all be cultivated, and then we leave it to each individual to decide how and how much to incorporate these potentials into her life. But there is never a message as to who does or who does not have a particular potential. We take this same approach to cultivate the scientific potential in each child: We offer experiences through which the child cultivates that potential and then we leave it to the child to decide how and how much she will incorporate this scientific potential into her life's work.

Let's consider a similarity here with cultivating the artistic potential. It is the same approach. We even have specific activities for art and a section of the *Casa* dedicated to these art activities. Some Montessorians propose, then, that we should also have specific science activities available to the first-plane children of the *Casa*. I believe this is a choice for each Montessori guide to make for him/herself. I am on the side of not having specific science activities and

Courtesy of Lynn Jessen

that was my choice as a teacher in the *Casa* (even though science activities were included in my AMI training). But what I can say with certainty is that even if you never have a single targeted science activity in your *Casa*, the scientific potential of your children will be cultivated every day through the experiences they have throughout the environment.

Returning to our dictionary definitions of science, the children in the *Casa* will be in a constant process of observation, identification, description, experimental investigation of the real world, and they will follow this process using every piece of technology in all

of the areas of the *Casa*. From this concrete experience they will be irresistibly forming competing hypotheses from partial evidence and their growing imaginations leading to valid, reliable, and truthful theoretical explanations of what they have observed, identified, described, and experimentally investigated. In fact, we could say that all of these activities of science are simultaneously the necessary structures of any exploration, that they are the necessary components of exploration, and that they organize the necessary characteristics of the child as explorer.

Maria Montessori was very aware of this process as the heart and soul of the child's activity in the *Casa.* It is why we give the presentation of any activity or material and then get out of the way, why we show only the minimum necessary in that presentation and no more. We organize those presentations so carefully so that what we show is the right minimum necessary, a minimum that steers the child in the direction of productive, scientific exploration that leads to true knowledge of the real world. We present no more than what is minimally necessary for the child to become engaged in the presented activity.

Maria Montessori and her colleagues created the technology of the *Casa dei Bambini* for the child's scientific exploration of the real world and designed and refined that technology for the purpose of that scientific exploration. She described this beautifully in the book *Psychogeometry* in a section where she is specifically talking about the geometry cabinet, but I propose that we could substitute any activity in the *Casa* and the description would still be as apt and as accurate.

In *Psychogeometry*, Montessori writes that when the child uses this particular material, she is conducting "active experiments involving movement, research, and trial and error." Montessori further states that these active experiments are very complex activities and that the movement, research, and trial and error that characterize these very complex activities occur through "the hand that moves … the eye that recognizes … the mind that judges" (11).

Although Montessori was writing particularly about the geometry cabinet, any activity from any area in the *Casa* can be evaluated

according to these interactive, process-oriented criteria. Confirming how each material in the context of all the activities relates to science, supporting active and scientific experiments by the child who uses it, and demonstrating the reality of the child who uses this complex technology of the *Casa* prepares for science by doing science.

This would be an interesting exercise and could be the basis of a dynamic parent night–focusing on one material from each area to discover how the child experiences a progressive level of engagement including:

- Interaction with the concrete world: the hand/body that moves;
- Senses engaged: the sense that recognizes/perceives;
- The unknown that is being explored;
- The partial evidence becoming apparent to the child's perception;
- The possible imaginative leaps;
- The possible competitive hypotheses; and
- The mind that judges the truth of the experience.

I would like to offer three final thoughts.

The first is another quote from E. O. Wilson, "The most successful scientist thinks like a poet–wide-ranging, sometimes fantastical–and works like a bookkeeper" (41). Here, with another evocative image, Wilson again combines the imaginative with the practical and reminds us that both sets of potentials must be cultivated into a creative balance for optimal scientific development. Our application of this point of view to the technology available to the children in our environments again confirms the brilliance of their design.

To conclude, two more thoughts from Maria Montessori–thoughts which I think become much more meaningful and helpful

Courtesy of Colegio Montessori de Chihuahua, Mexico

for us when we explore the activities of the *Casa* from this perspective of the child as "the scientist in the *Casa*." The first comes from excerpts from *Psychogeometry/Psychoarithmetica* found in a 1982 issue of *AMI Communications*:

> But what was really wonderful was to see the great spiritual happiness of the children, their amazing enthusiasm, their persistence with self-imposed, difficult problems, and their great joy whenever they arrived at the solution, that was often reached through channels unheard of by the teacher herself. (10-15)

Here Montessori assures us that it is this joy, this spontaneous enthusiasm, and this great happiness that are the greatest proofs of educational success. Such outcomes cannot be forced or artificially contrived. Although these outcomes can be observed with certainty, they cannot be tested or measured existing as they do within the subjectivity of an active learner.

And finally, this quote emphasizes the vital importance of cultivating the mind that judges equally with the hand that moves and the senses whose perceptions form the foundation of imagination:

> If we go on with this education, which gives the child gradual independence, his personality will acquire the capacity for clear judgment. In society this is most important. When we are able to judge for ourselves independently, we cannot fall victim to the enthusiastic words or fanatical reasoning of another person. (*Creative Development in the Child* 201)

In our current times, this is a thought well worth considering as it affirms the positive impact and ultimate value of the work we do in support.

Thank you so much for spending the afternoon thinking about the experience of science and technology we offer to children in our environments, and thinking about the valuable layers of scientific knowledge available to each child–to each scientist in the making–carrying out active experiments in the real world of the *Casa dei Bambini*.

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