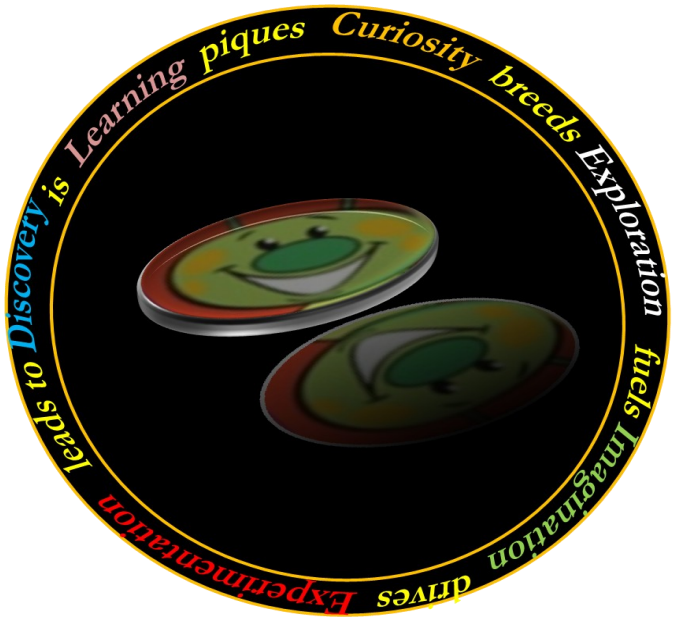
Sensory Math : Continuing Childhood's Learning

I have no special talents. I am only passionately curious.
Albert Einstein

The world is but a canvas to the imagination.
Henry David Thoreau



The difference between the impossible and the possible lies in a person's determination.
Tommy Lasorda

Math has Evolved out of Need

Some believe that math is some well established body of knowledge waiting to be discovered by clever minds when, looking back on its evolution, it becomes evident that it is a creation of the human mind. From a shepherd's need to account for the number of his flock in ancient times to an engineer determining the minimal length of a runway for a supersonic jet in modern times, math has been 'discovered' out of need. It is in these utilizations and in other mundane routines, such as determining the number of minutes you have before leaving the house in the morning or the number of cupcakes you need to bake for your son's birthday party, that math becomes organic. In the process, it sheds its abstract mystical nature and becomes concrete, making it possible to determine the answers to the questions faced in everyday living.

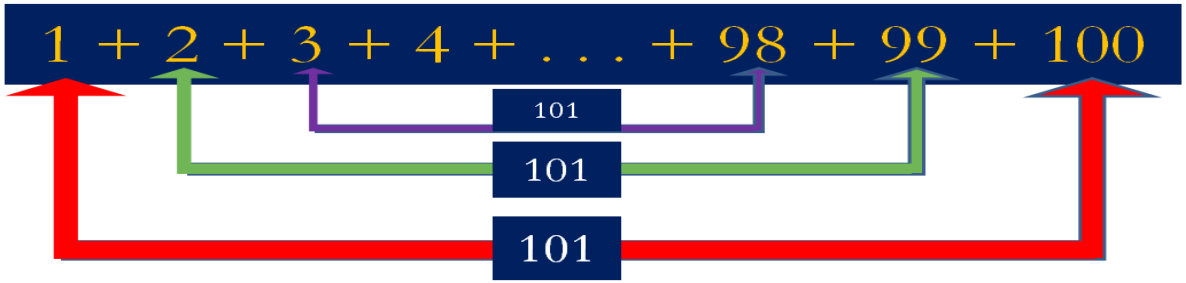
When this view is combined with the belief, *"Non notationes, sed notiones" (Not notations, but notions")*, held by the great mathematician, Karl F. Gauss, a curriculum can be formulated to 'discover' math concepts through applications. By concentrating, not on symbols, but on the ideas behind them, understanding that leads to effective internalization of these concepts is also facilitated.

Math begins with the concept of NUMBER. If students understand the number 4 as it applies to a collection of objects, rather than just a symbol, then they internalize its idea and see it with the mind's eye. If they learn to sight amounts and count them by groups, then they rely on thinking rather than counting one by one or finger counting to determine the number of objects in a large collection.

This workshop is about teaching and learning how to see a number with the mind's eye because it is an essential skill to be able to do mental arithmetic. You will do this by getting in touch with the childlike ways that you came to know your 'world'. You will use the same method of learning you used as a child, when everything was a game and fun. The tools you will use are the senses.

The Discovery Method of Learning

There is an anecdote about the great mathematician, Karl F. Gauss, exhibiting creative thinking early on in elementary school. The teacher had asked the class to determine the sum of all the whole numbers from 1 to 100, thinking that the task would keep the students occupied for some time. No sooner than he had asked the question when young Gauss brought his writing slate up to the desk with the correct answer. The star pupil determined the sum, not by applying a procedure that he had been taught, but by discovering a pattern when adding the 1st number and the last one, the 2nd number and second to last, the 3rd number and third to last, and so on. Gauss noticed that when he added each pair of numbers, the sum was the same, 101. He concluded that, since there were 50 pairs, the answer had to be **50 x 101** or **5050**.



Some may argue that the average 8 or 9 year old is not capable of such a feat. I disagree! Children are natural learners. They are curious, inquisitive, imaginative, and creative. They learn about themselves and the world around them by testing and observing effects: sometimes purposefully and at other times using trial and error. From placing objects in their mouths to study texture, to recognizing familiar voices, to learning how to communicate through actions and words, children are accomplished learners before they start formal schooling. Like Gauss, they accomplish all this by utilizing the senses. With these tools, they gather the information which they then, analyze, evaluate and act upon.

By immersing students in activities that require exploration, investigation, and analysis, teachers can instill thinking skills. By imbedding concepts in the activities, teachers enable students to acquire mathematical concepts and algorithms. When students find the activities relevant, applicable and interesting, the learning becomes a playful game of discovery, instead of a dreaded chore of memorization.

It is in this setting that students become independent learners and acquire the tools to learn how to learn. In time, they discover, first hand, the essence and joy of learning.

- Sensory Math

Sensory Math reflects and builds upon the natural way that children learn. Using visual, tactile and kinesthetic modes, children discover math the same way they learned about their 'world' from infancy. Whether it is placing an object in their mouths to explore its texture or pushing an object to observe the resulting effect, children gain knowledge experientially. Key to the interactions is the use of the senses. Sensory Math is framed around these three principles:

1. Math content is imbedded in child oriented activities that keep students engaged and continue the discovery method of learning to which they have grown accustomed from infancy.
3. Activities are constructed around concepts. Computational skills are acquired as result of the problem solving nature of the activities.
3. The experiential nature of the activities facilitate students' understanding making internalization of the concepts more effective.

Sensory Math is built upon the premise that if math concepts were imbedded in activities that pique children's curiosity, then their natural inquisitiveness would lead them to explore, imagine, experiment and analyze the stimuli provided for them. The discovery learning method is effective because it is a continuation of a familiar natural approach.

The central tenet of Sensory Math is that every child has the potential and ability to learn given the proper experiential stimuli or activities.

- The Activities: What, Why, and How

The process begins by identifying What are the seminal ideas that span mathematics. Once the determination is made as to how these ideas or strands are connected, they are then sequenced. Next, the topics are developed and the ensuing concepts are streamlined for efficacy and efficiency. It is at this time that the experiential situations or activities are created.

Each activity is designed as a problem solving exercise that students undertake to discover a math

concept. The motivation or Why for learning math is to address a question or need imbedded in the activity. By making the activities relevant to the needs of students, math becomes applicable to their 'world'.

The methods used to deliver and communicate the content of the activities is the How. To address different learning modalities, students are engaged in activities that call upon multi-sensory skills and tools. Students discover the intended concept of an activity in a relevant and meaningful setting that accentuates their ability to think, rather then their ability to memorize. The result is that students gain knowledge through personal engagement enabling them to internalize discovered ideas.

The discovery learning approach turns the classroom into an 'explorative playground' in which learning is not a chore but an enjoyable and playful experience.

- With Sensory Math Students Develop Learning Tools

The Sensory Math Program begins with children learning how to determine the amount in a collection of objects by sighting it, rather than counting each object one by one which makes them dependent on finger counting. Sight counting accelerates children's computational skills because they become adept at seeing smaller amounts imbedded in larger ones, discovering that a number can be formed by combining smaller parts of it, and, thus, learning the different combinations of a given number. Put together, these skills make students proficient in mental addition and subtraction. By the end of first grade or early second grade, they possess the tools necessary to master the times table. After all, multiplication is nothing more than an efficient way to add large collections of objects by utilizing equal grouping.

Mastering skills early on gives teachers greater flexibility in the presentation of the overall math curriculum in terms of structure, depth and enrichment. For instances mastery of multiplication makes it to possible to introduce Integers and the concept of ratio by third grade which, in turn, paves the way to algebra by fourth grade.

Sensory Math immerses children in activities through which they acquire problem solving skills while developing individual attributes and learning mathematical concepts. Place value, for instance, is taught and learned while taking a walk. By playing games children learn concepts hands-on enabling them to make connections rather than acquire knowledge by memorizing facts. In essence, math is utilized as a vehicle for child development and to acquire mathematical knowledge.

Sensory Math is effective because it uses the activity that children enjoy the most: GAMES. Children are inquisitive by nature and by providing them with a learning model with which they have grown accustomed to from birth, they discover math as result of a playful activity as opposed to learning it by heart.

- Validation of Sensory Math

The philosophy and methodology exemplified in Sensory Math is the result of thirty-two years of classroom experiences, curricula research, development and successful implementation. The program demonstrates how students can discover math by engaging in practical activities that make sense and that are relevant to them.

The great mathematician of antiquity, Archimedes, advocated a somewhat similar approach: *"I thought fit to write out for you and explain in detail . . . the peculiarity of a certain method, by which it will be possible for you to get a start to enable you to investigate some of the problems in mathematics by means of mechanics.. . . Certain things became clear to me by a mechanical method, although they had to be demonstrated by geometry afterwards."*
In other words, we acquire understanding and knowledge best when we, first, solve problems using practical methods. The underlying theory can be investigated after understanding the concept.

Activities, such as games, which are an integral part of Sensory Math reflect the Archimedean view. Students discover ideas playfully, hands-on, and by making connections. The approach is more effective than the lecture method that relies mainly on auditory and memory modes of learning. With the experiential approach, students acquire a better understanding of the material and, thus are able to internalize it.

Child psychologist David Elkind also considers the approach effective. In his book The Power of Play, he puts it this way: *"All too often, however, we mistakenly project our grown-up conception of play onto the play of children. Yet for children in general, and for young children in particular, self-initiated play is a basic mode of learning. Through such play, children create new learning experiences that they might not otherwise encounter."*

The games and the activities would have minimal impact on understanding math if, individually and collectively, they lack substance. The concepts imbedded in them require thorough knowledge and understanding of the overall mathematical landscape, and their delivery calls for extensive planning and creative arrangement. In the words of English educator, W. W. Sawyer, who puts it as follows in his

Vision in Elementary Mathematics: *"The difficulty of learning a subject depends enormously on the way the subject is presented."*

Ultimately, learning is a personal journey to develop an understanding about ourselves. As such, it is just as much about the child as it is about knowledge. Swiss pedagogue and reformer Johann Heinrich Pestalozzi's motto, *Learning by head, hand and heart,* reflects the same sentiment. Back in the 18th century, he formulated educational methods that were child-centered and based on individual differences, sense perception, and the student's self-activity. His philosophy and methodology are, still, being implemented successfully in the Montessori and the Waldorf. Schools.

I'll end my introductory remarks with a personal anecdote. I recall how as a teenager, having some difficulty in falling asleep one night, I began to play a mental game with numbers. After some analysis, I made what I thought a starling 'discovery'. The following day I excitedly shared my findings with Mr. Shaw, my math teacher. He patiently listened to my explanation and, then, proceeded to show me that my 'discovery' was a well known mathematical fact. At the time, I felt somewhat deflated, but reflecting on the incident years later, I came to view it as an achievement because I had come upon the 'discovery' on my own.

Sensory Math is based on the idea that children are born discoverers so why not have them learn through what they do best.

My Learning Experience

One of my fondest childhood memories is of my maternal grandfather teaching me how to tell time with his pocket watch. By making a game out of it, he made learning something new interesting and fun. I can still see the smile on his face when I would make a 'discovery'. I have similar recollections of my first grade teacher motivating the class to acquire computational skills, such as multiplication, as result of climbing a fictitious mountain. I used to look forward going to school because I associated learning with playing games and imagining adventures.

Unfortunately, as the years passed, there were fewer and fewer interesting activities and, eventually, they stopped. They were replaced with instruction that emphasized memory and less discovery, and success was based on how well you could recall 'facts' on exams. By the time I graduated from middle school, I had lost interest in school. Fortunately, an adventure awaited me when my family and I immigrated to America.

The language barrier, instead of being an obstacle, turned out to be motivating factor. The inability to communicate heighten all my senses as means of learning. Just as I did as a child, I observed, listened, and explored. I arrived at understanding through analyzing information, rather than just accept 'facts' at face value. I used trial and error, cause and effect to acquire understanding. The whole learning process was a game, with curiosity, imagination, persistence and hard work as part of my tools. I rediscovered how enjoyable learning was, even when I was not successful. When I was right, I felt inner pride and satisfaction because I had discovered something 'new'. It did not matter that it may have been a well known concept. What mattered was that I had come upon it on my own. It was my discovery! As time went on, I began to view and feel about learning as I once did as a child. The approach continued to influence me throughout my formal education and it has become the foundation of my teaching philosophy.

Since my retirement, after thirty-two years of teaching math to middle and high school students, I have been involved in creating a math system that builds upon the natural way that children learn: observe, experiment, analyze and discover. It is the well proven method by which they learn the language to communicate and by which they come to understand the world around them. I call it Sensory Math

About the author

Domenico Marcario taught math at the middle and high school levels for thirty-two years in the Locust Valley School District in New York State. While there, he researched curricula from around the world and co-authored and implemented a highly successful middle school math program. Since retirement, he has expanded his research to elementary school. He has written Carlito C. Caterpillar Math House Games, a program aimed at the K-2 level consisting of 20 steps, with each step engaging students in an activity or game to discover a fundamental math concepts, while acquiring skills at the same time.

For information, including workshops and teacher training contact:

Domenico Marcario
PO Box 233
Glen NH, 03838

386 338 2087 **email: d.marcario@yahoo.com**

Visit c3pla.com for more information about Sensory Math.