Spatial Imagery Development & Harmonic Thinking

The importance of imagery and visualization has been described in numerous books and articles. Brain research also addresses this issue. Robert Sommer in his book, *The Minds Eye*, discusses **abstractification**, a process in which an academic subject such as mathematics that was originally imagery-rich, becomes fixated in the use of codes or symbols. According to Sommer: "To empty numbers of their sensory content is to deny children the feeling for the beauty and play of sequence, series, and powers." He continues: "Without images behind the figures the person doing the calculation forgets what the term signifies ... Emptying ideas of their sensuality does not produce meaningful learning or discovery as some of its proponents maintained, but mechanical and arbitrary learning. What must be criticized is not abstraction itself, which is too much a part of the human mind to be discarded, but abstraction at the expense of the senses rather than in conjunction with them."

It is our belief that regardless of (or maybe because of) the amount of mathematics we took in school, many of us are indeed blind to mathematics. We often were not afforded the opportunities to develop rich visual imagery with the mathematics we were taught. For example, those of us who were taught to divide one third by one half will recall the invert and multiply rule that we were taught in school. But there are very few of us that can illustrate with objects or pictures why the result of this operation will give us two thirds. Most of us that were taught mathematics in a rote manner began to believe that the symbols were the concepts! Furthermore we thought abstractification was the essence of mathematics. Those of us who received heavy doses of rote instruction in mathematics rarely are capable of assocating visual, auditory, and tactile experiences with symbolic statements of ideas and relationships. We, the authors of MEBA™, were fortunate to have had a few teachers in elementary school and high school that provided some insight into the images related to the mathematics we were taught. However, it was not until our graduate level work that we explored intensive experiences with physical and pictorial models that represented the abstract mathematics we were taught! We have continued to grow in this area by our own instructional and clinical research.

History affords many examples of famous people such as Leonardo de Vinci and Albert Einstein who possessed cognitive flexibility. Behind each symbolic relationship that these people understood were rich images that related actual experiences with physical models, sketches and diagrams. Leonardo revered the visual and a well-known quote of Einstein expresses a similar belief: "The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The physical entities which seem to serve as elements in thought are signs

 Mary Gilfeather & John del Regato

and more or less clear images which can be voluntarily reproduced and combined ... The above mentioned elements are, in my case, of visual and some muscular type. Conventional words or other signs have to be sought laboriously only in a secondary state, when the mentioned associative play is sufficiently established and can be reproduced at will." Today we refer to visual and muscular (tactile-kinesthetic) elements of thought as **nonverbal** aspects of learning and "words or other signs" as **verbal**. Connecting these two aspects fosters cognitive flexibility or what we refer to as **harmonic thinking**. The history of mankind is steeped in the importance of thinking harmonically and connecting the verbal and nonverbal. Many important inventions and discoveries have been made due to this type of thinking.

By linking both nonverbal and verbal thought processes, MEBA™ puts students back in touch with a harmonic, imagery-rich way of understanding and communicating mathematics. For example, concrete and pictorial models are arranged in particular patterns so that learners can visualize the pictorial representation in their mind's eye. Multilinking cubes are arranged in standard configuration. Later, base ten materials are organized in a similar manner. After an activity, students are encouraged to close their eyes and visualize the structural patterns they have just experienced. Such consistent structural arrangements of objects and pictures are stressed to evoke the imagery of very large numbers and operations in the minds of learners. Since such learners can image mathematical relationships, the real power of mathematical thinking can be realized. In effect, learners are no longer dependent on remembering isolated facts and formulas, but can regenerate mathematical principles through imagery based on prior active learning exeriences.