

Institute for Christian Teaching
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**MENTAL, PHYSICAL, AND SPIRITUAL HARMONY
FROM A NEUROSCIENCE PERSPECTIVE**

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Introduction

Brain science became a compelling focus for me when our youngest son Tad was diagnosed with a degenerative brain disease—Niemann Pick. At the time of diagnosis, little was known about this untreatable terminal condition. In desperation I began to study brain anatomy and physiology in an attempt to understand and better relate to Tad's condition.

Tad died six years after his diagnosis, just before his 17th birthday. Though this tragic loss left a permanent void in our hearts, the venture into brain science became a catalyst for new insights on the brain/body relationship. By reading books and articles, attending brain conferences, participating in focus groups, and studying and dissecting the human brain in neuroanatomy lab, my role in teacher education at La Sierra University in Riverside, California grew to include the neurobiology of learning. Now I use this knowledge to help teachers-in-training and graduate students understand educational implications in the science of mind, body, and spirit.

This quest to learn about the brain also yielded a doctoral dissertation—a comparative analysis of two large bodies of education-relevant data: current educational brain research and Ellen G. White's 100-year-old counsels to educators¹. Though this study compared data from two seemingly dissonant philosophical perspectives—naturalism and theism, the comparison revealed new views on the integral linkage between brain and body. Out of this study, a postulate conclusion emerged: that an active, fractal-like construct² is operant and can be identified in the relationship between brain and body. This construct appears to be foundational in life processes represented within the human organ and possibly beyond.

For those not acquainted with fractal theory, the fern and the Sierpinski Triangle pictured in figure 1 below will help clarify this concept of repeated patterns. Further definition also is provided in the footnote at the bottom of the previous page.

¹ Ellen G. White was a pioneer in establishing the Seventh-day Adventist church. Though educated through the fifth grade only, she was an avid student of Scripture. Inspiration she gained in close affiliation with Divine thought strongly influenced her writings of 49 books and more than 5,000 periodical articles. Having read some of her books previously, when I began studying brain science, I was intrigued with the similarities between White's counsels to educators and education-related brain science.

² Fractal theory was introduced in the 1970s by Benoit Mandelbrot, a mathematician. A fractal is an entity that is made up of a repeated pattern at all levels of form and/or function. This repetitious pattern of smaller and smaller iterations exemplifies the pattern of the whole unit. Whether the design is viewed microscopically or macroscopically the pattern structure is seen. The example of a fern is often used to describe a fractal in simple terms. Each of the smaller segments of the fern replicates the shape and pattern of the whole. The pattern not only is the whole, it also is seen as the constituent parts of the whole. Fractal iterations in nature are common. The Sierpinski Triangle also exemplifies a fractal. Notice the fractal shapes within other fractal shapes.

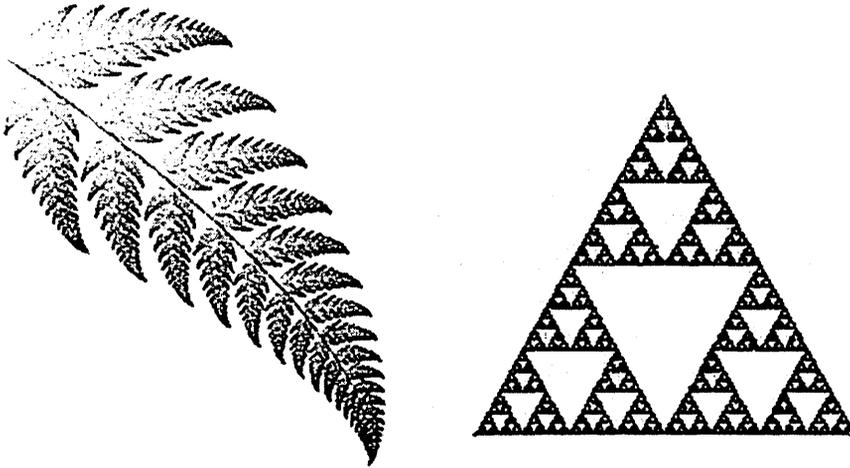


Figure 1. Graphic representations of fractal formations. The fern exemplifies a natural fractal; whereas, the Sierpinski Triangle (7th level) is a fractal of geometric design. In both of these examples, the overall shape is represented both in the whole and in the parts of each entity.

Websites for fractal tutorials also will be helpful for those just becoming acquainted with fractal theory. Samples of the many websites available include these:
 For older students: <<http://www.fractalarts.com/ASF/galleries.html>>
 For younger minds: <<http://www.parkenet.org/jp/ufjumpstart.html>>
<http://www.fractalus.com/gumbycat/GreatestStory.html>

Philosophical Context

Before proceeding to discuss the fractal-like construct in brain/body structures and functions, it is important to explain the philosophical basis on which this paper is presented. The following paragraphs provide this contextualization.

As science continues to probe for deeper understanding of the brain and its functions, it becomes increasingly clear that the boundaries between biology, chemistry, physics, neurology, psychology, philosophy, etc. are not easily defined. Even though these various disciplines have their own identity, they also represent a shared relativity (Rosenzweig, Breedlove, Watson, 2005). Reductionist thought is by nature limited in regard to explaining gross realities. Though Newtonian/Cartesian philosophy allows for scrutiny in limited focus, it is not as appropriate for understanding relatedness, symbiotic, and wholistic functions of the brain and the brain/body integration.

This is not to suggest that measurement is inappropriate in brain science. Measurement and quantification are valuable means for advancing neuroscientific knowledge. However, “big picture” perspective and wholistic function provide understanding not attainable through narrow vision. Quality and quantity together allow greater advantage than either of these two provides singularly. Though this paper leans

heavily on data collected in quantitative research, it aims to provide a metaview that honors both macro and micro functions of the brain from a philosophical perspective.

Recently, after having presented on the topic of this paper at Fuller Theological Seminary, the chief rheumatologist at a prestigious medical school spoke to me following the presentation. His comments relate to the importance of meteperspective. “The metaview you are providing from a philosophical perspective is much needed” he commented. “What you present [fractal emphasis] applies not only to the brain, the heart, and the brain/body, it also applies to the immune system and, in fact, to DNA as well.”

Before explaining the dynamic fractal construct to which this gentleman referred, I would like to reference the source of this insight. Before dissertation study each day, it was my practice to spend at least one hour in private devotional time studying scripture and related commentary, journaling, singing, and praying. Without question, it was during this time that inspiration and metacognition were most significant. I treasure the thoughts that follow as a gift from God. May they bless you as they have me.

A Dynamic, Fractal-like Triad

The pervasive theme that emerged from this comparative dissertation study is the idea that a dynamic relationship exists among three major brain function components—cortex, limbic system, and brain stem/cerebellum. Further, this relationship is aligned respectively with mental, spiritual, and physical harmony that is critical at all levels of brain/body function. The anatomy and physiology of the tiny neuron, the brain itself, and the brain/body organ in form and function all are organized in fractal-like fashion.

One hundred years ago Ellen White referred to these three functions of “physical, mental, and spiritual powers” (1903, p. 13) as she defined *true education*. For centuries others also have referenced this dynamic reality, including ancient philosophers such as Socrates, Aristotle, and Plato. What is new about this ages-old triad construct, is the scientific data substantiating and/or negating what merely has been speculated philosophically for ages. Intuitively we have known that wholeness involves the mind, body, and spirit. Now, with expanded knowledge about the brain and its relationship to the body, wholeness is seen from an even more objective perspective.

With the aid of newly developed brain-imaging technology we now can view brain as it functions—not just speculate about brain activity based on external behavior. Though this new technology allows for greater understanding, it is important to know that even advanced technology is insufficient to reveal the full dynamics of brain function. Those most proficient in brain science readily admit that what is known about the brain is minute compared to what is yet to be learned about this most complex organ in the universe. Still, however, neuroscience moves forward and makes gains daily.

Data gained from new imaging techniques is further enhanced by increased knowledge about neurochemistry—a factor that unites mind and body. Candace Pert’s 1972 discovery of the opiate receptor opened the way for greater understanding of how

body/brain chemicals form a dynamic information network, linking mind and body (Pert, 1997). Pert equates neurochemistry with emotion—the phenomenon that occurs as neuron communicates with neuron and produces attitudes, spirit and action. Emotion influences relatively all thought potential before it is processed in “higher-order” cortical areas as conscious thought.

How do new perceptions about the body/brain integration relate to fractal theory? As an introduction to this explanation, perhaps a bit of personal narrative will help to humanize the mathematical and geometrical term of *fractal*.

As a child I spent hours with my father in small aircraft. From high above the world, patterns in the undeveloped terrain below fascinated me. Years later, patterns similar to those seen from the airplane appeared again in quarter-inch slabs of cut rock on which I wrote verses in calligraphy as a hobby. Later still, similar patterns seemed evident under the microscope in science lab and through the telescope while viewing galaxies and nebula far beyond earth’s atmosphere. These fractal-like or repetitious patterns seen over the years in micro- and macrocosms became even more meaningful after reading Margaret Wheatley’s *Leadership and the New Science* and becoming acquainted with fractal theory. Were these patterns in nature evidence of a grand plan of organization? I began wondering if they were clues and vestiges of Intelligent Design.

At this same time, I had begun research on the brain in my doctoral study program. My focus was to determine how similar or dissimilar educational brain science today is to a progressive educational authority’s counsels during the late 1800s and early 1900s—the writings of E. G. White.

As I researched, a mental construct surfaced again and again in the words of numerous specialists on the brain and learning. They described function at three levels: in the microscopic neuron, within the brain itself as a functioning organ, and wholistically in the relationship between the brain and the body, yet they did not acknowledge this repetitious representation. Previous childhood experience with repeated patterns and exposure to fractal theory began to transfer to my thoughts regarding brain anatomy and physiology. Was there evidence of fractal representation in the brain and body relationship?

Clearly, there was agreement that three major functions contribute to a balanced human reality—intellect (or higher-order thinking), physical activity resulting from physical functions within body and brain and from the physical world, and emotional/social states resulting from sensory-stimulated neurochemical levels. I began seeing these three major emphases as aligned with the age-old construct of mind/body/spirit. Each day as data accumulated the idea of fractal-like organization seemed more evident.

Had others aligned brain study with fractal theory? A review of the literature confirmed that this was true—at least to some extent. Mercier (2002), Bieberich (2002), Fernandez (2001, 1999), Hebb (1949), Marr (1982), and others also discuss fractal

function in a neuroscientific context. Their discussions, however, are more reductionist than the concepts that emerged from my study.

In comparing the two large bodies of data (E. G. White's writings on education and educational brain science), evidence is apparent that wholistic interplay exists between brain, body, and emotion/spirit—microscopically at the cellular level, anatomically in the organization of the brain itself, and overtly in the relationship between the brain and the body. These three integrated aspects are represented at all three levels within the brain and body! There is fractal-like organization, yet no one—to my knowledge—aligns this organization with the importance of wholistic care and nurture of the brain and its development—specifically in educational practice. The overview nature of this comparative study had yielded a metaview on neuroscience and learning.

Closer examination of these three levels of form and function may help the reader to better understand this alignment and its implications for parenting, education, and mental health. Let's look first at the anatomical structure of the brain itself as an organ in mental/physical/spiritual relationship.

The Brain as a Fractal-like Organ

In the 1970s, when Paul MacLean proposed the *triune brain theory*, he described three levels of the brain—the cortex, the limbic center, and the brain stem/cerebellum. At that time MacLean believed each of these areas functioned as a brain within the brain. Since then, however, MacLean has joined with others in a different emphasis. Current thought suggests that each of these three areas functions as part of a dynamic whole. One area is dependent on the other two as simultaneous and symbiotic processing takes place.

Though MacLean's original concept has changed, the three major areas he identified are still considered as basic areas of the anatomical brain. Each area is multifunctional and is integrated functionally with the other two parts and their processes. Yet, these three areas continue to be identified with major functions that take place in each area.³

Viewing the brain as a whole, the cortical area is commonly identified with higher order thinking and conscious thought; the limbic center is associated with emotion, sensory input produced by the environment, and memory; and the brain stem/cerebellum coordinate physical movement and conduct incoming and outgoing information to and from the brain and entities within the physical body. In a sense, the cortex can be thought

³ Though MacLean's early intuitive position has been rejected in regard to each of the three major parts of the brain serving as a brain within the brain, from the perspective of fractal theory, as I have postulated, MacLean may have been more accurate than his colleagues perceived. It is true that the three main areas of the brain act as one. However, it may be equally accurate to say that each of these three main areas of the brain functions in a fractal-like pattern that iterates mental/physical/spiritual (emotional/social) wholistic function.

of as the mental component; the limbic area as the emotional/social/spiritual component; and the brain stem/cerebellum as the physical component.

Having said this, it is important to note that—typical of fractal function—each of the three areas of the brain also can be described in terms of mental/physical/spiritual (emotional/social) function. For example, even though the cortex can be classified as the *mental* component of the brain, it also functions as a fractal representation on its own. It is known that memory (mental) also is stored in the cortex, that emotional/social/spiritual function is significant in the cortex as a result of sensory stimulation and neurochemical states, and that a prominent function of the cortex is motor (physical) function. Limbic area function and brain stem/cerebellum function also can be described as representative of the whole as well as in part in fractal function. The pattern of form and function is replicated at diminished and expanded levels throughout the brain. Like systems within systems, a grand repetitive organization is evident.

The Microscopic Neuron as a Fractal-like Organ

On a much smaller scale, the mental/physical/spiritual *fractal* again appears. The tiny neuron cell responds to neurochemical signals (emotional function)—much like the limbic area in the larger brain—as dendrites receive incoming sensory data. This data is then passed on to the soma—the cell body. In the soma “higher order processing (mental function) occurs. Similar to cortical function in the larger representation of the brain, the soma determines whether or not action potential will be passed on to the axon. Axonal activity (physical function) through inhibition or transfer of the action potential is similar to the brain stem/cerebellum function in the larger entity. Not only does the neuron function in these three capacities—mental, physical, and spiritual, it pervasively influences and is influenced by the same elements taking place at different levels and within varying systems of the brain at micro and macro levels. Neurons make up the structure of the cortex, limbic system, and the brain stem/cerebellum. Cortex, limbic area, and brain stem/cerebellum constantly affect the neuron and are affected by the function of the neuron.

Body/Brain/Spirit as a Fractal Organ

From the macro perspective, the body/brain also exhibits this same fractal-like organization. The brain (mental) controls cognition; the body (physical) serves to stimulate and maintain brain/body function; and neurochemistry (emotional/social/spiritual), created by sensory stimulation from the environment and from internal systems within the human unit, integrates the body/brain and establishes spiritual states beneficial or detrimental to life processes. This dynamic interaction of body, brain, and neurochemistry profoundly influences its constituent parts—affectively and effectively.

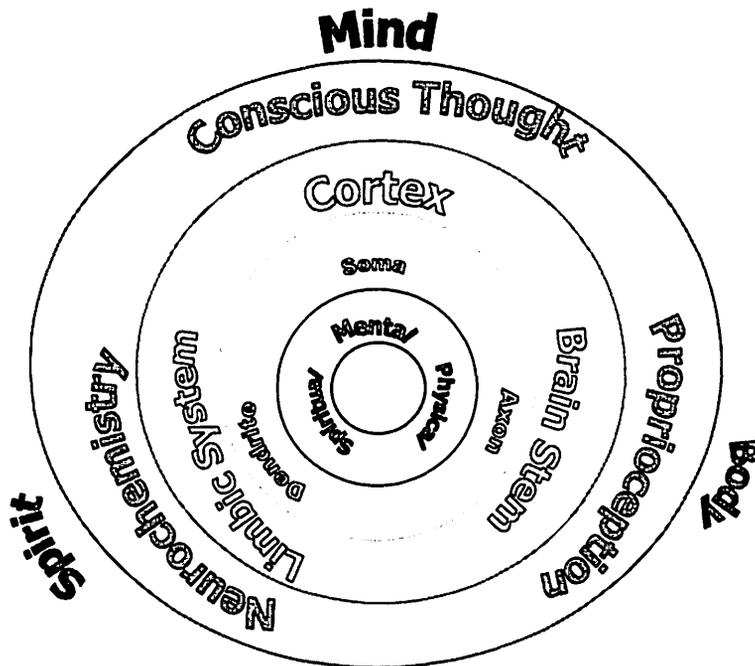


Figure 2. Alignment of fractal-like representations at neural, brain, and brain/body levels.

Going beyond the boundaries of the physical body, is it also true that body/mind/spirit is affected by an even broader representation of this postulated *fractal*? Without stretching the imagination, abundant evidence suggests that this *fractal* construct is functional in the environment that bathes the individual. Mental, physical, and spiritual influences not only surround us, they contribute to the quality of our intellectual capacity, physical health, and emotional/social/spiritual condition and development. Next, we will consider this fractal-like construct in context of environmental influences on the human unit—philosophically, physiologically and socially.

Mental Stimuli in the Environment

Research on brain plasticity suggests that abundant influences feed our intellectual capacity. However, the truth of this statement has long been contested. For centuries the nature versus nurture debate has raged, and traditionally nature seems to have commanded the lead. A major question has been: Which determines intelligence—genetics (nature) or environmental influence (nurture)? New knowledge about how the brain develops, about enrichment and the brain's ability to change and grow, now indicates that nature and nurture are about equal in determining cognitive ability. Experience and environmental influences have much to do with turning on genetic functions that may remain latent otherwise (Diamond, 1998).

Reigning philosophical influences also play a significant role in an individual's mindset. The belief system of parents, teachers and peers powerfully forms the attitudes, habits, and relationships of a child. Even before the child has explicit memory of

biographical happenings, caregivers implicitly shape his/her mental orientation in ways that are difficult if not impossible to change. Schools further develop the beliefs and orientations of individuals in society. Considerable research focuses on how teacher expectations transfer to the learner and how that transference impacts learner self-confidence and performance (Weinstein, 2002; Abrami, et al, 2004; Yeung, et al, 2000; Eden, Dov, Ravid, Gad, 1982). These mental impressions mold our lives and greatly determine life functions.

What we think others think about us also has significant impact upon self-concept and resilience. Current research on stereotype threat (Croizet, et al, 2004; Ambady, et al, 2004; Schimel, et al, 2004; Cullen, et al, 2004) suggests that consciously and unconsciously others' perceptions of us determine our attitudes and performance levels. Resilience and self-efficacy are strongly determined by what we believe. This phenomenon relates closely to the next consideration.

Emotional, Social, Spiritual Stimuli in the Environment

Emotional intelligence, a term popularized by Daniel Goleman and others in the 1990s, is now a well-rooted concept in educational theory, thanks to new knowledge about the brain and neurochemistry. Each thought we think has not only been influenced by emotion-related memory storage, each thought transaction directly results from interaction between neurochemistry and electricity. Neurochemistry itself is emotion in a chemically material state. The role of emotion in cognition is undeniably profound.

Emotion plays a star role in other disciplines, as well. The entertainment world, for example, thrives and realizes huge profits through adept emotional appeal to audiences in most cultures. Some research now is aimed at studying addictions that develop not from chemical intake, but from other sensorial stimulation. New fields of study—neurocardiology, neuroeconomics, neuropsychology, to name a few—have developed and now recognize the relevance and seminal influence of emotion and neural function in ways not previously emphasized.

You may wonder how neuroscience relates to economics and emotion. Paul Zak of Claremont Graduate University explains that pleasure and choice drive the stock market, and trust has much to do with pleasure and choice—and consequently with economics. New research on trust suggests that when two people trust each other, oxytocin levels rise in each individual. Oxytocin is a hormone—neurochemical—that produces relaxation. Receptor sites throughout the brain respond favorably to appropriate levels of this neurotransmitter that also promotes bonding. What stockbroker wouldn't want professional bonds with desirable clients?

Research on pheromones, heart-rate-variability signal transfer, and other emotional/social/spiritual influences also continue to inform from a scientific perspective regarding the powerful role of neurochemistry in our environment. Not only does our own neurochemistry affect our surroundings, the environment impresses upon us in similar ways as well—consciously and subconsciously. Advantageous levels of emotion

in the brain/body increase beneficial function of the immune system, the heart, respiration and digestion.

At a U. C. Berkeley brain conference I attended several years ago, new knowledge about the heart and its connections with the brain was a central focus. More recently, I was privileged to spend time with Earl Bakken, developer of the first wearable heart pacemaker. Bakken indicates that the heart is now described as a sensory organ with capacity for memory and a type of “mind of its own.” He speaks of greater numbers of connectors extending from the heart to the brain than from the brain to the heart. This new research suggests that the heart plays a much greater role in cognitive function than previously believed. It is intriguing to consider this new data in alignment with the postulated fractal described previously in this paper.

After learning more about the heart’s role in cognition, I began a study of Holy Scripture to search out texts that refer to the heart. Consequently “As a man thinketh in his heart, so is he” has taken on new dimensions in my mind. New developments in this area are likely. In affiliation with Earl Bakken, the Cleveland Clinic is now establishing a center for heart/brain research.

The effect of negative emotion on body/mind has been the focus of much research. Martin E. P. Seligman, former president of the American Psychological Association, describes how negative emotion can lead to clinical depression. In his search for ways to correct this tendency toward emotional imbalance, Seligman, began collaborating with Mihaly Csikszentmihalyi (pronounced *chick-sent-ma-hi*), author of *Flow*, a book about the value of peak motivational experience. Together they advanced a focus on positive emotion.

University of Michigan’s Barbara Fredrickson now specializes in psychophysiology and the effect of positive emotions on the mind and the brain. In an *American Scientist* article (2003), Fredrickson cites research that suggests positive emotion promotes longevity, individual and collective functioning, psychological well-being and physical health. She researches to find out “how and why ‘goodness’ matters” (Fredrickson, 2003, p. 330).

Whereas negative emotions—anger, fear, sadness, etc.—are “distinctly different experiences” that signal specific autonomic responses that are evidenced in facial expressions; positive emotions—joy, amusement, serenity, etc.—are “relatively undifferentiated” and “have no distinguishable autonomic responses.” Negative emotion tends to move us toward survival action of some kind, while positive emotion helps us “solve problems concerning personal growth and development” (Fredrickson, 2003, p. 332).

Positive emotions promote physical, intellectual, and psychological/social health that endures “long after the positive emotion has vanished,” Fredrickson suggests. This positive effect promotes resilience and optimism that may help to undo the harmful effects of negative emotion on mind and body.

“People who regularly feel positive emotions are in some respects lifted on an ‘upward spiral’ of continued growth and thriving.” They “become more helpful to others,” and can “transform communities into more cohesive, moral and harmonious social organizations.” (Fredrickson, 2003, p. 335)

More than one hundred years ago, Ellen White offered related advice. She counseled that when the human mind connects with the mind of God, the Holy Spirit takes residence in the heart. When this occurs, she explains, the effect of love has a powerful, beneficial influence on the mind and the body. Subsequently, an atmosphere forms around us that is beneficial to all who come near. Negative emotion, on the other hand, is detrimental to self and to those near us. (White, 1898b; 1886a; 1955; 1977a, p. 802; 1985c, p. 262; 1979a, p. 65) In the teaching profession, this truth is critically important to understand. The spirit harbored in a teacher’s heart is profoundly influential on those under their care—especially the younger ones.

In his book, *The Developing Mind*, Daniel Siegel provides abundant data to substantiate the powerful influence adults, especially parents and teachers have on young minds. He addresses issues of attachment and self-regulation from the context of emotional influence during the earliest years.

Emotion not only serves to transmit neurological data among neurons, within the brain, and between the brain and body, it also actively distributes to and influences the community around us. Research on positive emotion provides new meaning for the value of spiritual functions in maintaining mind/body health. Communal worship, trust in divine power, pausing for table grace before eating, shifting focus from self to the needs of others, etc., may be more beneficial than previously realized. Perhaps choices of this kind are innate tendencies toward seeking wholeness.

Physical Stimuli in the Environment

Physically, through sound, touch, taste, smell, and vision, the environment stimulates us to action as we attempt to survive and to thrive. Disequilibrium is a significant part of these processes in that it requires motion through exchange. An example may help to explain this concept.

Dr. George Javor, a biochemist at Loma Linda University in California, suggests that living matter constantly tries to move toward balance. However, if it arrives at balance and remains there, life dissipates.

Disequilibrium is a natural law in life as we know it on Earth. As we walk, we repetitiously move from balance to imbalance and back again. With this movement our muscles contract or extend and proprioception is created in the joints. Proprioception is a type of neurotransmission or sensory signaling that wards off rigidity—and rigor mortis, in fact! It sends signals to the vestibular area and reticular formation. The Reticular

Activating System (RAS) is vital in maintaining consciousness. If the RAS is not communicating with at least one cortical area in the brain, a comatose state ensues.

Case Western Reserve University's James Zull suggests that "movement is cognition expressed." Circuitry within the cortical lobes naturally moves cognitive signals repetitively from sensory integration to executive processing and ultimately toward action in the motor cortex. The brain wants to act on data that is being internalized. This action, when appropriately related, helps to promote long-term memory storage. Societal opportunities to work and to serve not only benefit the community, they are advantageous in promoting brain and body health for the participant, as well.

Sports programs in schools may be more vitally important than some school administrators consider. They provide opportunity for students to exercise freely, but they also honor brain health and function, which contribute to intellectual success. Physical activity in the curriculum is not time wasted in play. In fact, some research reports on school systems that have purposefully designed curriculum so that at least one-third of the school day is devoted to physical activity. These schools and districts report that academic scores have gone up rather than down, as some might expect when time is taken away from textbook study and activity traditionally classified as more intellectually rigorous. These new studies seem to promote the idea that intellect is promoted—not diminished—through physical exercise and the arts.

From another perspective, over emphasis on sports in the academic program can be detrimental to wholistic development. When athletic programming creates competitiveness, social stratification, and interference with balanced function, the value of physical development becomes skewed. Overemphasis on intellect, sports, the arts, or even humanitarian endeavors can be problematic. Harmonious development is best accomplished when each part of who we are honors the validity and importance of each of our other constituent parts.

Overlapping Nature of Environmental Stimuli

Perhaps it has occurred to you that these three environmental influences—intellectual, emotional/social/spiritual/ and physical—are somewhat overlapping in nature. True to fractal theory, this study has suggested that each component does contain each of the elements of the other two components.

Vital Role of Service

One hundred years ago, Ellen White promoted the idea that learning is a result of the "harmonious development of the physical, mental, and spiritual powers" (White, 1903b, p. 13). Further, she states that this harmonious development "prepares the student for the joy of service in this world and the higher joy of wider service in the world to come." Service as an empowering fourth component in cultivating human development is critical in wholistic education. As a disequilibrating, service maintains healthful status. In

contrast, sustained focus on self development introduces the likelihood of truncated potential and entropic frustration.

Acquiring benefits educationally, relationally, and physically is vital; however, constantly taking in and not giving back again may diffuse human potential. Like the Dead Sea, if we receive but do not altruistically redistribute to the community around us, stagnation and loss of vitality may result. When the human unit—mind/body/spirit—is activated in benevolence toward the community of which it is a *fractal* part, the integrity of life substance is honored and human potential tends to thrive.

Plumping the Pyramid and Potentiating People

Wholistic function is most likely realized when we honor balance between mind, body, and spirit, and when that wholeness aims at service to others. The first of the triangular illustrations in figure 3 illustrates how one part of the *triad fractal* can diminish or swallow up the other two. Extreme extension of one or even two of these fractal parts leads toward flat lining—an undesirable state in physical science and education as well. The second example represents wholeness, harmony, and balance among integral parts.

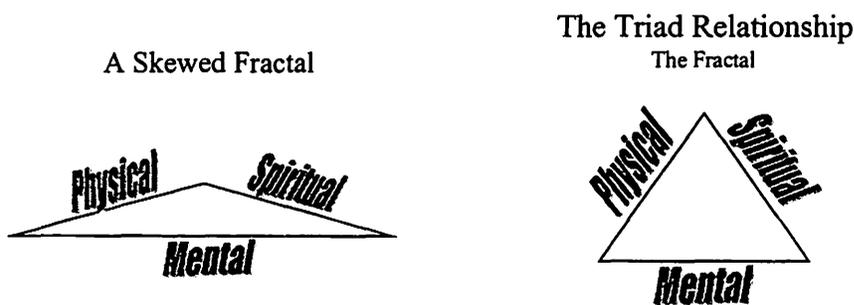


Figure 3. The *fractal triad* is represented here first in skewed form and then as an equally balanced entity. Harmonious balance would likely allow for flexible change rather than rigid stasis. However, rigidity in skewed form is less than ideal.

A “squashed” or skewed fractal may truncate optimal development and perhaps produce an imbalanced serve to others. Over emphasis on one aspect, or even two dimensions of the construct, diminishes the natural law of order and fluid balance that appears to be integral at every level of brain/body structure and function.

In regard to life on Planet Earth, the potential of the human unit is realized not as a closed independent entity but as a beneficial contributor as well as a reciprocal receiver of the benefits of others. In the spiritual realm, this give-and-take relationship with the ultimate Source of Light (mental), Life (physical), and Love (spiritual) provides ultimate empowerment. Only Creator God can fully release potential in those created in His own image. The following metaphor reiterates this concept.

Albert Einstein proposed the theory of relativity, and in its abbreviated form it is stated as $E = mc^2$. In my classes at La Sierra University, I use this formula as a metaphor or mnemonic device to help students conceptualize the idea of *potentiation dependency*. Students are reminded often that the metaphoric correlate I use is not a mathematical correlation. It is merely a qualitative comparison. Let me explain further.

Einstein said that energy is equal to mass times the speed of light squared. It seems reasonable to me—based on the conclusions drawn from the fractal-like iterations recognized in my dissertation study—that the components of Einstein’s formula might be substituted in the following parallel way—again, metaphorically and not as a quantitative correlation:

E (energy)	=	m (mass)	times	c^2 (speed of light squared)
E_1 (educational potential)	=	(mind + body + spirit)	times	(light + love + life) ^(Light + Love + Life)

Students in my classes hear me use the term *God Fractal* in reference to the ultimate source of Light and Love and Life and the ultimate Potentiator. Graphics in figures 4 and 5 help to illustrate how I perceive God’s impress upon human creation.

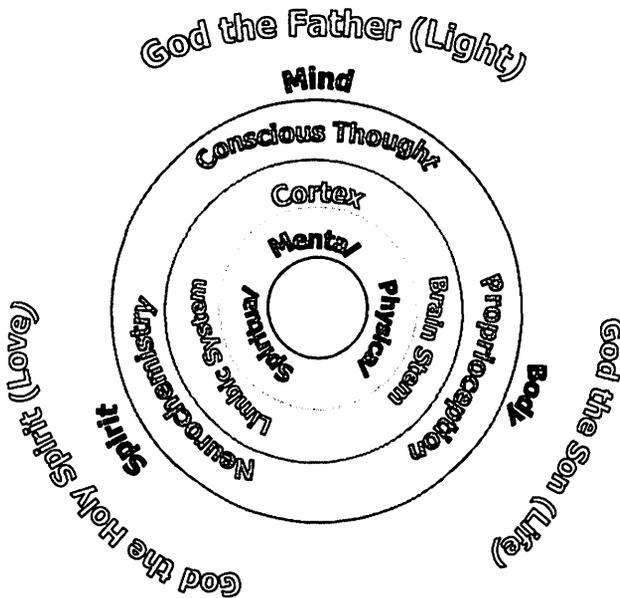


Figure 4. Fractalary implications in this graphic include the three entities of the Godhead. An important note in this regard may help to eliminate concern that the Godhead cannot be separated into three entities. Christian theology recognizes the Divine Godhead as three in one—mysteriously distinct as three individuals but intimately and integrally functioning as one entity. Similarly, the three areas of the brain cannot be separated without destroying the integrity of the brain as a whole. The cortex cannot function without vital input from the limbic structures and the brain stem/cerebellum. This same inter- and intra-dependence is true for each of the areas of the brain, the neuron, and the brain/body/spirit.

The Triad and Human Potential

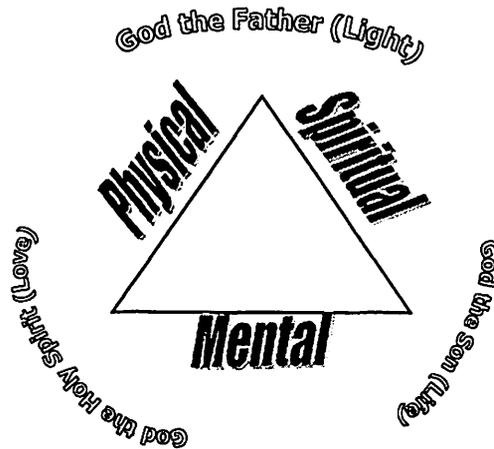


Figure 5. This graphic representation suggests that the mass of who we are (brain/body/spirit) realizes maximal potential only as it is enhanced intimately and integrally by the Godhead—three in one as Father, Son, and Holy Spirit.

This philosophical stance is not provable by quantitative measures, nor is it likely to be proven through argumentative logic. Admittedly it is biased as a worldview that holds the Creator God at its center in framing the thinking basic to these conclusions. However, the conclusions drawn here are honest observations from a mind educated in the humanities, informed by scientific data, and inspired through the study of Holy Scripture—all legitimate bases on which conclusions are formulated. In time, the value of these thoughts will be tried and hopefully refined and expanded. It will be gratifying enough to know that they have provided at least some disequilibrium.

Meanwhile, this information is useful in teacher education classes I conduct at a Christian university in Southern California. In these courses I superimpose the fractal postulate onto a model for teaching and learning that was originally developed by Bernice McCarthy. She founded her work on the learning theory of David Kolb, Karl Jung, Lev Vygotsky, and others. The graphic in figure 6 is a blend of McCarthy's teaching and learning model and the fractal postulate promoted in this paper.

A Fractal-friendly Teaching and Learning Model

In quadrant one of this model, emphasis is placed on connecting with prior knowledge and helping the learner to understand why the new concept is important and relevant to his/her own context. James Zull (2002) suggests that the brain wants to be in charge of its own learning. This is difficult when teachers are prone to saturate classroom activity with extrinsic motivation and didactic instruction. When learners connect with the challenge of learning something new, it is more likely that what Mihalyi Csikszentmihalyi calls *flow* will occur. When flow happens, learning is fun and students

often lose track of time, because they are so engrossed with the quest to know. Quadrant one addresses the emotional/social aspect of the triad fractal in that it connects with the human spirit. This quadrant addresses the question “Why do I need to know new information?”

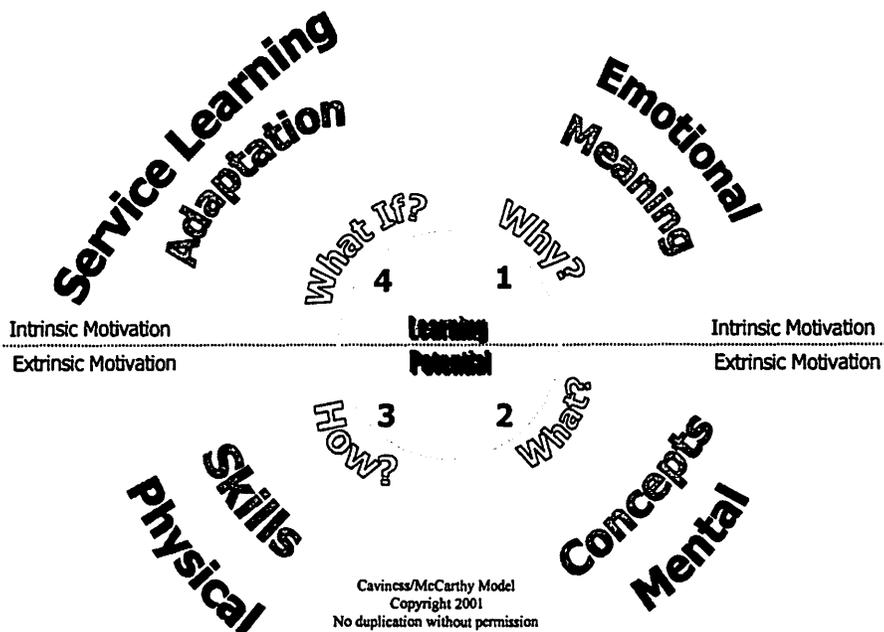


Figure 6. This plan for teaching and learning is based on Bernice McCarthy’s 4MAT model. It is designed to honor two major tensions: active and passive processing and concrete and abstract conceptualization.

Quadrant two promotes the functions of modeling and defining—activities the teacher provides in a more didactic mode of instruction. Students benefit from informed or expert knowledge. This quadrant honors the mental component in the triad fractal, and it addresses the question “What is it I need to learn?”

Unfortunately, and perhaps as a result of the still reigning paradigm of Newtonian/Cartesian philosophy that prevails in educational practice, as teachers we tend to favor—and even dominate the learning environment—with this quadrant’s focus. The fractal mental emphasis tends to be honored above the physical and spiritual elements—especially when school funding necessitates budget cuts. Physical education and the arts are first to be eliminated. With an awareness of this tendency, perhaps educators can become more proactive in self-monitoring their classroom instruction to prevent imbalance resulting from fiscal duress within school systems.

Quadrant three allows time for students to experiment under the guidance of the teacher. It is important for teachers to monitor student activity to prevent students from learning from incorrect procedures. As students develop proficiency, they can then move

toward extending what they have learned to contexts that represent real-life experience. This emphasis on promoting extended application allows students to begin using their own creativity and making learning their own—from an intrinsically motivated perspective that opens the door for transfer of knowledge to occur. This quadrant addresses the question “How does this concept work?” and it honors the physical component of the triad fractal.

Quadrant four emphasizes refinement of personal application and time to share with others what the learner has created. Quadrant four is especially important because it promotes opportunities for students to collaborate with each other regarding their extended applications developed in quadrant three. This collaboration provides refinement and feedback before the student shares with a larger group their integrated learning. An excellent way to truly learn something is to teach someone else. This quadrant promotes this activity and, at the same time, allows the teacher opportunity to do authentic assessment.

In quadrant-four focus the learner takes what s/he has learned and moves it forward, beyond self, with a service-learning spirit of sharing with others. This phase of the learning experience creates a medium for learning that honors disequilibrium—that phenomenon which promotes stretching and growing. In class, I describe this benefit by using the Dead Sea as a metaphor.

The Dead Sea constantly receives from its environment, but it does not redistribute through tributaries that benefit the surrounding environment. Consequently, the waters of the Dead Sea do not support life the way other give-and-take entities are capable of doing. Similarly, the potential of our triad-fractal balance is realized when we move focus away from intake for personal improvement to output for the benefit of others.

Another illustration further explains the need for disequilibrium. If we stand in perfect balance without moving for an extended period of time, our muscles begin to ache. Maintaining such a position indefinitely would eventually lead to rigor mortis. We need disequilibrium to keep us flexible and in tone. A friend of mine is a Royal Canadian Mounted Policeman. He heard my presentation on this topic a few years ago and shared from his own experience in support of this concept. Standing on guard duty, he explained, without the privilege of movement (only the batting of the eyes) becomes painful, causes him to perspire heavily, and always yields weight loss.

We were created to *live and move and have our being*. Disequilibrium is our friend as teachers in the classroom. Neither we nor our students should be deprived of the privilege of redistributing to others the benefits we have gained through mental, physical, and spiritual nurture. By providing opportunities for students to translate learning into service learning projects, we honor the Spirit of Christianity, the law of disequilibrium, and the release of body/brain-friendly fractal potentiation.

Quadrants two and three focus on extrinsic motivation, as mentioned previously. Extrinsic motivation is beneficial for promoting skills development; however, typically it does not promote creativity. Quadrants one and four emphasize intrinsic motivation, which allows the learner to be in charge of his/her own learning in creative and dynamic ways. Consistent elimination of one or more of these emphases can diminish our serve as we work with the sacred potential God has placed within each and every student under our care.

When practicing teachers return to our campus in the summertime to take continuing education coursework, I often ask the primary teachers to reflect on students' creativity between first and third grades? Consistently, they report that creativity levels drop significantly during that time span. Based on knowledge about brain plasticity and optimal periods for learning, it is my concern that when our students' minds are most impressionable—in the primary years of education, we may be inadvertently conditioning them and their brains toward robotic thinking by overdosing them on extrinsic motivation and deprivation of intrinsic stimulation.

In his dissertation study, Brewer (1992) reports on research findings that indicate a strong prevalence among teachers to teach using quadrant two and three activity to the neglect of quadrants one and four. Even when convinced that quadrants one and four are important, teachers are prone to continue in established or routinized practice. We tend to teach the way we were taught, and traditionally, extrinsic motivation has been the *modus operandi* for most teachers. Unintentionally, are we truncating the minds of children by depriving them of brain-friendly, learner-centered activity that allows them to take ownership in their own learning? Concerns such as these drive my passion to help teachers understand more fully the triad fractal and its implications for teaching and learning.

Summary

This article reports on research findings that support the postulate that fractal-like repetitive patterns are evident in the human brain and body at micro and macro levels of form and function. From the tiny neuron to the brain itself and then to the brain/body representation, this *fractal* can be identified. It manifests itself as a harmonious relationship among mental, physical, and emotional/social/spiritual functions that contributes to the integrity of higher order thinking, physical well being, and psychological balance. The possibility that the fractal-like nature of organization identified in brain/body structure and function is proffered as evidence of Intelligent Design—a reflection of the image of God in His creation.

The importance of service-learning is promoted as a means of releasing fractal potential and maximizing the learning experience. Through this means of healthful disequilibrium, the learner gains opportunity for creative expression, concept internalization, increased likelihood of long-term memory storage, and spiritual enhancement through others-centered focus.

This paper offers a brain-friendly model for teaching and learning, which also serves as a tool to aid teachers in self-evaluation of their instructional planning and delivery. This four-step plan supports efforts to maintain balance between extrinsic and intrinsic motivation, active and passive learning, and concrete and abstract conceptualization. The model offered is founded on the work of Bernice McCarthy and the theoretical positions of David Kolb, Carl Jung, and Lev Vygotsky.

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