How to Teach Oral Ecology Using Complexity Approach?

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Oral ecology is a recently emerged branch of inquiry that studies the oral world - the 'world of human mouth'. When applying the approach of complexity in teaching oral ecology, we seek to explore the 'oral world' in relationships with the world of the whole organism existing in unbreakable unity with the social and natural environment in which we live. This is our rational for suggesting an oral ecology based approach in dental education.

Complexity and ecology

The word "complexity" has roots in two Latin words: *complexus* which means "totality" and *completere* which means "embrace". The science of complexity seeks to embrace totality of the studied phenomena and processes. And as far as the totality of reality is sustained by dynamics – energies and forces which never cease to manifest, complexity focuses on them; it is their interactions and interrelationships, their emergent phenomena and self-organization, their evolution and transformation that complexity tries to understand, describe and explain (Bak, 1996, Dimitrov, 2003, Eriksen and Dimitrov, 2003a, Gleick, 1987, Mandelbrot, 1982, Solé and Goodwin, 2000, Waldrop, 1992)

Ecology, on the other hand, originates in the Greek word *oekos* meaning "house"; the house is a place where its inhabitants closely relate to one another and interact dynamically. When 'the house' of the humans expands so as to encompass the planet, the universe and the all-embracing totality of existence responsible for the emergence, unfoldment and transformation of human lives, then ecology and complexity converge into one indivisible field of inquiry; to which we refer as a study of self-organization (Dimitrov, 2003). The impetus towards self-organization is inherent in the dynamics of nature; every living form embodies this impetus. More than a century ago, the pioneer of social ecology, the French researcher Elisée Reclus defined the human beings as "nature achieving self-consciousness" (Reclus, 1905); it is the self-organizing impetus of nature that makes it seek to achieve self-consciousness through us.

Oral ecology

The mouth is 'the house' of the oral dynamics and the oral ecology focuses on these dynamics. Complexity theory explains that the oral dynamics cannot be understood only by keeping them locked in the mouth. Through the prism of complexity, dynamical processes in human mouth are seen as nested in dynamical processes of the individual's body, nested in social dynamics, which are nested in the dynamics of nature and the planetary and universal dynamics (Bak, 1996; Gleick, 1987). Therefore, the first thing that needs to be underlined when we teach

oral ecology using the approach of complexity science is its inseparable connectedness with human ecology – a study of the ever-changing, evolving and transforming interrelationships and interactions operating at different level of human nature - physical, emotional, mental, spiritual, social, environmental, universal. Human ecology is organically imbedded in the ecology of society (social ecology) (Dimitrov, 2003) and the ecology of nature and planet (environmental ecology) (Sole and Goodwin, 2000; Bak, 1996). This implies that the understanding of oral ecology is impossible without developing understanding of the essentials of human, social and environmental ecologies. This is a direct consequence of applying the complexity approach. One can never grasp the nature of a complex dynamic entity when studying it in isolation from the entities which it relates to - depends on, exercise influence to, and co-evolves with.

If we focus on the micro-world of the human mouth, we can observe more than 400 distinct species of micro-organisms, mainly bacteria. In addition, recent investigations have documented that a number of non-cultivable species might be added, interfering in the balance between oral health and disease (Aas, 2006). Billions of interacting bacteria live on the surface of each tooth, in the crevices of the tongue, on the inner sides of the cheeks, on the gums and the palate. In this humid environment, saliva participates both in positive and negative feedback loops in relation to the whirling bacterial dynamics. The proteins which the saliva contains have positive impact on the growth of the bacteria, as they provide them with nutrients, while the antibacterials agents in the saliva (lysozyme, immunoglobulins, antifungal and antiviral components) have negative impact impeding their growth. Saliva also contains acid-buffering substances. Bicarbonate ions in the saliva neutralize the tooth-decaying acids produced by a variety of acidogenic bacteria and the phosphatic and calcium ions in the saliva act both as buffering and re-mineralizing agents repairing microscopic initial de-mineralized area.

Inseparability of oral and human ecologies

According to the principles of complexity, changes in human ecology – the ecology of the human organism as a whole – bring forth changes in oral ecology. When we are under severe stress or intensive emotional, mental, or spiritual involvement, we lose control over the quality and quantity of the food and drinks which we consume and which directly may affect our oral health.

It is not only the substances, which we put in the mouth, that may affect its dynamics. Any experience classified by the human ecologists as negative life events (fear, anxiety, anger, jealousy, grief, animosity, envy, hatred, anguish, suicidal urges, etc.) have the potential to interfere with the balance of the oral dynamics (Breivik *et al*, 1996). Everyone is familiar with a sudden emergence of dryness or bitterness or an emission of bad breath, when some stressful personal or social conditions trigger a rupture of negative experience. The Hindu sages used to say that our words can pollute the mouth much more than the substances we put in it. Harsh, cruel and offensive words directed to another person 'pollute' the mouth of those who use it. They are heavily impregnated with negative thoughts and emotions – indirect triggers of serious disturbance to the dynamical processes in human mouth.

Complexity approach to oral dynamics

When teaching topics related to oral health and disease by applying the principles of complexity, the whole complex of factors behind oral ecology is emphasized instead of the search for a fragmented scientific description of the oral phenomena studied (a reductionist approach). The search for answers of this and similar kind of questions starts with recognition that the functioning of the mouth cannot be isolated from the functioning of the organism, and the organism cannot be isolated from its environment. In "The Tree of Knowledge", Maturana and Varela wrote: "When we speak of living beings, we presuppose something in common between them... Our proposition is that living beings are continually self-producing. We indicate this process when we call the organization that defines them an autopoietic system... The most striking feature of an autopoietic system is that it pulls itself up by its own bootstraps and becomes distinct from its environment through its own dynamics, in such a way that both things are inseparable" (Maturana and Varela, 1978). Although distinct from our environment, we are inseparable from it.

An important concept in the study of human complexity is the concept of multiple attractors: human dynamics are drawn towards many attractors. Often these attractors are unwholesome - habits like smoking, excessive consumption of alcohol or (mis)use of drugs. It is clear that the oral dynamic are severely disturbed by these kinds of habits not only directly, but also indirectly as a result of the destructive effects which the unhealthy habits have on the ability to control one's own behavior, to be responsible for one's own actions, to take care for one's own health. If individuals lack this ability, the ecology of their entire lives is destroyed: they may become helpless victims of the unwholesome habits.

Complexity approach to dental education

When applied to the teaching of oral ecology, complexity makes us clear that the oral health cannot be sustained by caring for the mouth only (Eriksen and Dimitrov, 2003a ; Eriksen and Dimitrov, 2003b). The whole complex of the three vital constituents of human nature – body, mind and soul – must be healthy. Wholesome life ecology that is based on complexity theory aims at exploring the secrets of the wholesome - healthy and fulfilling - human life (Dimitrov and Naess, 2005).

What connects and centers the body-mind-soul dynamics is the human spirit. When life is lived in a wholesome way, it seems that the human spirit takes care for its unfolding, and the power of spirit is irresistible; any attempt to suppress it undergoes fiasco. It does not matter that the science cannot understand the power of spirit. In analogy with the chaos theory, where the mathematical proof of a chaotic attractor is in the emergence of the effects which the attractor manifests in the phase space of the chaotic dynamics, the proof of the power of human spirit is in the emergence of the effects this power manifests in the experiential space of the human dynamics. To live wholesomely is *conditio sine qua non* for keeping the oral health at its highest possible level. And to study oral health ecology through the lens of complexity means to learn how to live in a wholesome way.

There is another key reason for applying complexity thinking in dental education. It is not only the organism and its environment that affect oral dynamics. Changes in oral dynamics may affect the whole organism and its environment in various ways (Bergdahl 2002). For example, smoking pollutes not only the mouths of the smokers and thus affects directly their oral ecology, but has also serious negative effects on the functioning of their entire organisms. One whole issue of the journal *Oral Health and Preventive Dentistry* was devoted to that topic (Watt *et al.* 2006). Such holistic negative effects often strike back on the health of the mouths of the smokers and thus again affect (this time indirectly) their oral ecologies. Ancient thinkers considered the mouth as "a sacred gate to the temple of the body" – a gate that permanently needs attention, vigilance, and care. Any worsening of the oral ecology implies worsening of the functioning of the body, that negatively affects human health and the perception of quality of life (Inglehart and Bagramian, 2002). Health has strongly manifested social dimensions. The increase in the number of sick people in society has a serious impact on its social dynamics.

During the last years, efforts have been made towards a more comprehensive, "holistic" dental education (Shanley, 2004; Plasschaert *et al*, 2005) emphasizing an evidence-based approach (Haynes and Haines, 1998). So far this has mainly been a pragmatic approach. What has been missing in dental and oral education is an underlying conceptual theory supporting and framing this way of thinking. In previous publications, we have tried to emphasize this way of thinking (Eriksen and Dimitrov, 2003a; Dimitrov, 2003; Eriksen *et al*, 2006; Loesche 1997, Dimitrov, 2001). The present paper is an attempt to propose a "complexity" approach in dental curriculua and to promote this view from a "complicity" perspective.

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