Learning: Towards Health and the Human Condition

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Introduction

The purpose of this article is to assert the concept that education and learning are physiological events worthy of classification within the "health and wellness" movement of healthcare. The concept is driven from the context of the educational system in the United States, and therefore, may lack some generalizability. However, there is clearly generalizability in the broad ideas regarding the impact of learning on the well-being of the human system, the enhancement of the human condition, and the need to foster new paradigms of education.

The Meaning and Purpose of Education

Education is a term used so often, and in so many different contexts, that its meaning has become clouded. This article shall use the term *education* to mean the social system and universal vehicle for learning. The process of being educated shall rely on the term *learning*. Admittedly, this delineation serves this article well, but more formalized discussion is needed to parcel our language for purposes of common understanding.

Education, at least in its current form in the United States, serves several primary purposes. First, education represents the most common method for children to advance intellectually and to graduate into a workforce with a particular skill. A child will proceed, in most cases, through at least 12 years of school, earn a diploma, and enter the workforce. Some choose to proceed further into vocational-technical schools, colleges, and postgraduate levels, and to develop more advanced skills that typically translate into a broader array of opportunities in the same workforce. Second, education represents an opportunity for formalized social interaction between children as they mature and develop. Third, education is an indirect method to combat social problems such as crime and poverty. It is thought that with more knowledge and skill acquisition, a child may be rewarded with opportunities that promote social contribution and economic success. Fourth, education can be considered altruistically from the perspective that one can better oneself by knowing more. This latter point is not necessarily concerned with grades, diplomas, or graduation into the workforce. It simply underscores the value of knowing more.

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Education in Transition

The educational system in the United States maintains a methodology that appears to have evolved from the industrial age, when products were developed in mass quantity and in a linear, step-by-step sequence. This type of production worked well for the industrial age, as the population was increasing in size and the ability to transport products was improving, but still limited. Families were still considered nuclear and this often translated into little outward mobility. The home and work were at times synonymous. Today, the same methodology propels education. Large schools with large classrooms teach children in a sequential style reminiscent of the traditional production line.

The use and efficacy of this methodology today, however, is problematic and perhaps antiquated. Outcomes are not well measured, standardization of teaching and of teacher qualification is lacking, and children are often passed to the next step in the educational process without sufficient mastery of content. The United States boasts more financial prosperity and more overall resources than most countries, yet, there is an alarming percentage of individuals who cannot read and write, who drop out of school, who utilize drugs, who commit crime, and who do not take advantage of the opportunities available with higher levels of education. A multifaceted problem requires a multifaceted response and strategy. Nonetheless, education, whose purpose is to ameliorate or prevent these social ills, deserves close scrutiny in terms of its access, design, and implementation.

The new millennium brings a new society, an information age where knowledge has an unprecedented value worldwide. Information is now considered the fuel of the social machine, and those who have access to the information will benefit most. Those who create or innovate will lead the information age. The amount of information, speed of information transmission, and distribution network capacity are significantly increased as compared with even a decade

ago. These will continue to increase as we progress further into the 21st century. Our tools for learning and teaching are different. The electronic industry has revolutionized our methods of communication. Information is no longer processed sequentially, but runs in parallel forms consistent with brain function. Pace, volume, and depth of knowledge have taken center stage as necessary ingredients to succeed in the information age. Interestingly, the Internet has fostered a return to our homes being synonymous with our work.

Education and the Need for a New Paradigm

With such a radical shift in society's basic infrastructure for living, there clearly is a need to re-think education and therefore learning. The information age provides a unique opportunity to capitalize on the import and value of learning. Learning must be considered the outcome of education, must be without limit, and bound only by imagination. This article proposes one new way to conceptualize education for the information age:

> *Education is a vehicle for dynamic lifelong learning which seeks to maximize the neuronal capacity of the individual, thereby contributing to the individual's increased knowledge and knowledge potential, social opportunity, and health across the lifespan.*

On a more global scale, such an educational system will enhance the human condition overall, combatting the social ills noted earlier. This is a natural outcome of advanced knowledge acquisition as more opportunities avail themselves, each with promise for economic security, quality of life, and potential for social contribution.

Learning and Health

It is well known that advanced education relates to better, higher-paying jobs, better socioeconomic status, better health care access, and healthier living environments (Moceri, Kukull, Emanuel, Van Belle, & Larson, 2000; Stern, Alexander, Prohovnik, Stricks, Link, Lennon, & Mayeux, 1995; Snowdon, 1997). Each of these factors correlates to quality of life and overall health, yet most Americans probably attend more to the financial outcome of advanced education rather than the health outcome. However, *there is emerging evidence that suggests education and learning across the lifespan make an important contribution to brain health and may serve to slow down and even prevent or vaccinate against neurodegenerative disorders in late life* (Albert, 1995; Mortimer, 1997; Schmand, Smit, Geerlings, & Lindeboom, 1997; Stern, Alexander, Prohovnik, & Mayeux, 1992; Stern, Alexander, Prohovnik, Stricks, Link, Lennon, & Mayeux, 1995; Stern, Gurland, Tatemichi, Tang, Wilder, & Mayeux, 1994; Stern, Tang, Denaro, & Mayeux, 1995).

Interestingly, science has demonstrated that rodents placed in a healthy environment not only have larger brains relative to rodents in isolation, but spawn new neurons (brain cells), *particularly in the learning and memory region* of the brain known as the hippocampus (Greenough, Cohen, & Juraska, 1999; Kempermann, Kuhn, & Gage, 1997; Gould, Beylin, Tanapat, Reeves, & Shors, 1999; Van Praag, Kempermann, & Gage, 1999).

While neurogenesis in the animal model (Gould, Beylin, Tanapat, Reeves, & Shors, 1999) provides hope for generalization to the human brain, research historically had not demonstrated evidence for neurogenesis in humans. However, a revolutionary study (Eriksson, Perfillieva, Eriksson, Alborn, Nordborg, Peterson, & Gage, 1998) using special chemical staining techniques on hippocampal cells in human beings revealed neurogenesis, a finding which, if replicated, could change our entire understanding of the human brain. The impact of the environment and of learning on the human brain appears to be similar to that found in the animal model of brain development (Kotulak, 1997). Further supporting this idea is a recent study (Moceri, Kukull, Emanuel, Van Belle, & Larson, 2000) that found a relationship between early life poverty and increased risk of dementia later in life.

Advent of Neural Plasticity

Neural plasticity is a term used to describe the human brain as a highly dynamic, constantly reorganizing, and malleable system. This understanding of our central nervous system challenges entrenched notions that the human brain is a rigid, limited, and fixed system that progressively deteriorates without correction. Neural plasticity enables environmental input to modify and perhaps grow the human brain. Indeed, we may conceive the potential to develop our brains across the lifespan such that we can defend against disease invasion such as Alzheimer's.

Researchers interested in neurodegenerative disorders such as Alzheimer's disease (AD), which affects four million Americans, and costs the country 100 billion dollars annually in direct care and 30 billion dollars in indirect care related to caregiver illness, have underscored the importance of education as one environmental preventative factor. Multiple correlational studies have demonstrated a reduced risk of AD for those with advanced education (Schmand, Smit, Geerlings, & Lindeboom, 1997; Stern, Alexander, Prohovnik, Stricks, Link, Lennon, & Mayeux, 1995; Stern, Gurland, Tatemichi, Tang, Wilder, & Mayeux, 1994; Stern, Tang, Denaro, & Mayeux, 1995). The neurobiological explanation of this has been labeled *Reserve Theory* (Mortimer, 1997).

Essentially, information which is learned must be processed by our brains, itself a physiological event. Such learning promotes development of new neurons and neural pathways. The theory advances that with increased cell density and cell volume, a progressive disease such as AD will not impact the brain or will impact the brain at a later age because the disease will have to destroy a greater number of cells to manifest clinically. The increased volume of cells in the brain provides a reserve to fight off invading diseases such as AD. Interestingly, the Reserve Theory has been advanced for other etiologies of dementia besides AD (Albert, 1995).

Language Development and Prevention of Dementia

Two major studies provide additional evidence for framing education or learning early in life as preventative health or a vaccine against neurodegeneration in late life. The first involves a well-known longitudinal investigation of nuns, with the major finding being that nuns suffer AD significantly less than the general population (Snowdon, 1997). The author of this research points out that nuns remain involved in cognitively complex activities across the lifespan and do not withdraw mentally with age. Such maintained cognitive exercise is consistent with the Reserve Theory and offers a strong explanation for reduced AD.

Related to the nun research findings above is an interesting study (Snowdon, Kemper, Mortimer, Greiner, Wekstein, & Markesbery, 1996), in which the diaries of nuns, written around the age of 22 (prior to taking their vows), were analyzed and rated for grammatical complexity and idea density (number of ideas in each sentence). Nuns who had diaries rated with higher idea density suffered AD significantly less than nuns with low idea-density ratings. Idea-density correlated significantly with classic markers of AD at autopsy (number of plaques and tangles in the brain) suggesting that language development early in life may be a predictor or risk factor for development of AD.

A second study (Plassman, Welsh, Helms, Brandt, Page, & Breitner, 1995) provides additional evidence for potential of early predictors of later developing neurodegenerative disorders. This study analyzed, retrospectively, the intelligence test scores of older military veterans prior to their enlistment when they were young men. Those veterans who developed AD had significantly lower intelligence scores when they were young men than did veterans without AD. This finding, together with the nun research, suggests overall early intelligence and language development may be useful predictors of risk for late life neurodegenerative disorders such as AD.

These studies further indicate the potential import for language development and learning early in life to prevent or limit vulnerability to AD later in life. Acredolo (1999), a psychology professor at the University of California, Davis, tracked 40 hearing babies who learned simple signs starting at age 11 months. Her follow-up of these babies two years later found their verbal ability to be four months ahead of non-signing babies. Further, after second grade, the children who learned sign language had an average IQ of 114, higher than the IQ of 102 for non-signing children. This interesting research underscores the capacity of hearing children, too young to speak orally, to develop their language system through the use of sign language. Direct development of the neural network underlying language early in life appears to have promise for increasing later IQ, and hence potentially reducing the risk of dementia in late life.

Education and Wellness for the 21st Century

These interesting findings are of more than academic import. With proper application, they position education and learning early in life within a health and wellness framework adequate for our time. I offer the following points to advance education and lifelong learning for primary wellness, to prevent illness, and as an early life vaccine against neurodegeneration in late life.

1. Begin to think of education and learning as an active promoter of health, no different than exercise or nutrition. Learning and operating on information (mental exercise) is the conduit to brain wellness as physical exercise is for cardiac health. Schools and libraries are to brain health as the gymnasium and exercise rooms are to cardiac health. Longitudinal studies can be conducted to measure the effects of early learning interventions on neural development.
2. Our educational system should accentuate curriculum that enhances language and verbal skills. Language is highly correlated with overall intelligence, and increasing one's IQ early in life has promise in prevention of late-life neurodegeneration. Language itself may have a prominent role in health and wellness. The neural system for language can be developed prior to oral language, and correlates with IQ. This suggests strongly that all children should be exposed to American Sign Language prior to development of oral language as a health issue. Cross-cultural studies that measure the effects of learning multiple languages on brain development and dementia risk are needed.
3. Learning must be considered a continuous process and not a fixed stage. Continuous learning throughout life must be reinforced socially and must be promoted through

appropriate financial incentives from embryonic development to the latter stages of life.

4. Early verbal and nonverbal communication between mother/father and the developing child in the womb is important, as it may lay the foundation for human interaction and foster a stimulating environment.
5. Environments for our children must be stimulating, challenging, and nurturing. This is the case for the home and for day care centers across the country. Brain development in childhood is tremendous, and there is relatively little a child's brain cannot ascertain. These early experiences help to prepare the brain for new learning on more complex levels with advancing age. Our preparation to maximize intelligence and brain capacity is a health care issue. Likewise, negative and impoverished environments contribute to brain retardation and perhaps increase the risk for dementia later in life (Moceri, Kukull, Emanuel, Van Belle, & Larson, 2000).
6. Our educational system must be seen as a place to maximize lifelong health, not simply a time-limited place for obtaining a diploma. The 12-year (9-month a year) school experience might not be appropriate if we view the school as a wellness center. Adults and older adults must remain connected to the educational system of our country. New learning and development of new skills translate into brain development and brain health. The educational system can be the primary vehicle to capitalize on the reserve theory discussed above.
7. Our health insurance companies need to re-think how money is spent for maintaining health. I would argue that education and measurable learning across the lifespan should be given financial incentives in the same way as an exercise routine. Imagine your health insurance provider paying for your education/learning with the purpose of preventing a progressive disorder late in life that may cost three times as much. It is significant to note that more older Americans are returning to college than ever before!
8. Curriculum on aging across the lifespan should be incorporated into all school systems. As aging is an international issue, we must begin teaching our children how to age successfully. Topics such as financial planning, nutrition, education, and occupation can be presented as important factors to a long and healthy life. Teachers may even be recruited from older persons who are now aging successfully, as research indicates that children like to have older adults in the classroom (Newman, Faux, & Larimer, 1997).
9. Our school systems must begin to think beyond education and redefine their missions as health facilitators. A school building can literally become the wellness center for the 21st century with a focus on learning, mental stimulation, and brain health. It likely has as much to offer in maintaining health and preventing illness across the lifespan as any primary care physician's office. Schools might have positron emission tomography (PET) scans to measure the outcomes of their curriculum on brain development or eradication of learning disabilities. Teams of teachers, neuroscientists, language experts, and cognitive neuroscientists can jointly design curriculum to enhance early neuronal development.
10. New communities may be built around a school or learning center. Such centers can be linked with each home via computers. However, we must not permit our dependency on computers to reduce our social interaction, itself an important environmental factor for brain health (Bassuk, Glass, & Berkman, 1999; Fabrigoule, Letenneur, Dartigues, Zarrouk, Commenges, & Gateau, 1995; Katzman, 1995; Martin, 1996).
11. Consumers of health services must demand more than our current options for wellness. We must encourage health insurance payers to recognize the importance of education and learning, religion, role and purpose, housing, and transportation to our health. Payment for such social needs will demonstrate a commitment to real wellness. We can measure the impact of such an approach to health and wellness and determine the economic and quality of life outcomes compared to what we have now. □

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Special Section on Future of Educational Technology

A forthcoming special section of this magazine, Guest-Edited by Hoyet H. Hemphill of the North Central Regional Educational Laboratory (NCREL), features a series of papers adapted from presentations made at a recent national conference sponsored by this organization. The papers to be published are as follows:

- Emerging Technologies in Education. By Kathleen Fulton and Margaret Honey.
- Beyond Technology Integration: The Case for Technology Transformation. By Charles M. Reigeluth and Roberto Joseph.
- Effective Use of Instructional Technology Requires Educational Reform. By M. David Merrill.
- Since Computers Came to School. By David C. Dwyer.
- When Worlds Collide: Introducing Information Technology (IT) Culture to Public Education. By Tim Best.
- A Vision of Education in the Year 2010. By Sylvia R. Cadena Smith and Janine Onffroy Shelley.