The Nature of Learning: Implications for School Curriculum

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Abstract

Learning is one of the natural phenomenons of the universe. In light of the new technological developments, especially in the field of imaging like FMRI, many of our theories, definitions, methods and ideas about thenature of learning and human brain are being challenged. There are a number of parameters that influence learning process. In this paper, the effects of physical exercise and diet and nutiritionon on learning have been examined. Scientific data suggest that extra physical activities incorporated into school curriculum could increase academic achievement even if curricular time for so-called academic subjects is curtailed. As per the impact of diet and nutrition on learning, research findings have indicated that saturated fats and simple sugars cause cognitive impairment. Therefore, it would be highly recommended that fast and fried foods, chemically processed menu must be banned at schools. In light of the research findings as per the the effects of physical exercise and diet and nutiritionon on learning, a number of suggestions have been made for teachers, curriculum developers and education leaders.

Key words: Learning, Physical Exercise and Learning, Diet-Nutriton and Learning.

1. Introduction

Learning is a complex phenomenon and a process. There many parameters that have direct or indirect influence on this phenomenon. In this paper, the effect of physical exercise and diet on learning is explored. In order to understand the effects of those parameters on learning, we need to explore the following questions:

- What is our basic knowledge about the human brain?
- What is the phenomenon that is called learning? Is it sufficient to learn something by living for permanent learning?
- What is the significance of stimulus for brain cells?
- Is there a relationship between premature aging and learning?

In light of the scientific findings on the above-given questions, some suggestions have been made for schools and teachers with a view to maximizing learning.

1.1 What Do We Know About Human Brain and Learning?

As a result of painstaking research conducted in the field, scientists learn more about how the human brain evolves and develops. In light of the new findings, many of our theories, definitions, methods and ideas about the brain are being challenged. Below are only few selected examples of myths and reality comparing what we used to believe and what we know now about human brain development:

Myth- At birth the brain is fully developed, just like other organs like heart or stomach.

Reality- It is true that most of the neurons are formed before birth, but majority of the connections among cells are made during infancy and early childhood.

Myth- The brain's development depends almost entirely on the genes we inherit from our parents.

Reality – Especially early childhood experience and interaction with the environment can be very critical and influential in a child's brain development.

The process of human brain development is a complex phenomenon that can not be explained by one single parameter. There are many factors which influence this complex process at various degrees. Some of the important factors include genetics, nutrition, the way the parents interact with the child during the critical developmental stages, daily experiences, physical activity, love and caring the child receives (Brotherson, 2005). Some scientists used to claim that the development of human brain was shaped and determined genetically and other factors like nutrition, learning environment with which the child interacts, physical activity and love play minor roles. However, it is scientifically proven that early childhood experiences have great impacts on the development of human brain and influence the neural networking and architectural design of the brain.

Recent developments in imaging technologies allow us to observe the process of brain development before and after birth. Neurons have branches or dendrites emerging from the cell body. These dendrites pick up chemical signals across a synapse and the impulse travels via axons. The electrical impulses cause the release of the neurotransmitters, which in turn, stimulates or inhibits other dendrites. As a result of this electro-chemical signalling connections, neuro-networking occurs. A single brain cell has the potential to connect with as many as 10,000 other cells. This incredibly complex networking process is often referred as the brain's "circuitry" or "wiring." Experience and stimulus that the brain is exposed to have a great deal of influence on the way this neuro-networking takes shape. A remarkable increase in synapses occurs during the first year of life. The brain develops a functional architecture through the development of these synapses or connections.

For example, when family members repeatedly call a child a certain names, then connections are being made that would allow the child to recognize that name belongs to him or her. From birth, the brain rapidly is creating these connections that form our perceptions, habits, ideas, thoughts, consciousness, memories and overall the mind. It is observed that by the time a child is 3 years old, a baby's brain has formed about 1,000 trillion connections (almost about twice as many as adults have). As of age 11, a child's brain prunes unused connections.

As the synapses in a child's brain are strengthened through repeated experiences, neuro-networking is formed. In other words, the connections which emerged as a result of environmental stimulus establish the foundation for further learning and the perception of the outside world for the learner. If any of those connections are not used then they are eliminated/pruned based on the "use it or lose it." Principle. The more the connections are used repeatedly, especially during the early years, the more they become permanent. The prime example for this phenomenon would be picking up one's native language.

The human brain has approximately 100 billion neurons at birth. Each neuron has the potential to connect to the other 10,000 neurons and this means about 1 billion potential connections. New connections between brain cells and new neuron networks established is called learning. The human brain weighs on average 1.36 kg and comprises only 2% of the human body. However, it consumes more than 20% of the oxygen and nutrients that the body intakes.

For the brain, stimulus is a sine qua non! The timing when the brain is exposed to stimulus is extremely critical. In other words, the effect of the stimulus which the brain exposed during the first periods after birth is not the same as the effect of the stimulus that are exposed during adulthood for the development of human brain.

Learning happens continuously throughout life. However, there are critical stages or prime times when the brain is ready to absorb new information and develop new skills more easily than at other times. While this is true especially in the first three years of life, it continues throughout early childhood and adolescence. This is especially applicable to learning languages, numerical skills and developing certain kinds of skills like playing an musical instrument. Learning can occur at later times but, it usually is slower and more difficult. Therefore, providing children with the best learning opportunities during these critical times is crucial. For example, the "prime time" for visual and auditory development is from birth to up to 6 years old. The development of these sensory capacities via being exposed to various stimuli is very important for allowing children, especially babies, to perceive and interact with the world around them. During the first few months, especially, babies need to hear a language and see shapes, colours and objects. Those stimuli are so vital that they determine the way the brain takes shapes and neuro-networking occurs. Therefore, it can be safely stated that "first years last forever."

1.2 Is Learning by Doing Enough?

Is learning by doing enough to ensure permanacy? Zull (2002) claims that learning by experience is not sufficient on its own for real learning and a conscious effort should be exerted to understand the essence of the thing we learn. He also points out that the learner must be given the opportunity to reflect on what has been learned.
Imagine a fisherman showed you how to tie a complex sailor's knot years ago and even if you learned to tie it without receiving any help, can you guarantee that you can tie the same knot perfectly years later, for example 10 years later? Even though you are the one who experienced to tie a complex sailor's knot, you should do more besides learning by living for the learning to become 'a part of you' for the permanency of it. What do the new educational approaches say in this regard?

First of all, the learner must be convinced that what he or she is going to learn is meaningfull to him or her. In order to ensure that the learner should find answers to the below questions:

-What does this experience that I have gained mean to me?
- Does it matter to me?
- Is it meaningful to me?
- In what way the thing that I have learnt is going to change my life?
- Can I transfer this new knowledge / skill that I have acquired into other areas of my life?

For the learned thing 'to pass thorough us and to be a part of us (personal reflection)'these questions and their answers are of great importance. The second step we need to take during this process is to question the learning process and to make inferences about the process. For example if we turn back: Why do I twice pass the long end of the rope through the ring that I have made with the short end that I am holding? What would change if I passed it through three times or just once? Here what we are trying to do is to question the experience process and make individual inferences. It is important to come up with new hypotheses and abstractions at this stage.

Another stage is to test personal hypotheses/abstractions/inferences and to record them carefully and systematically. To perform the above-mentioned stages of learning learner gives the opportunity to take control of his own learning process. Modern educators believe that these processes should be taken in an order for the learned thing to become a part of the learner. In fact, each learning is a prize for the human brain. The human brain rewards itself by releasing happiness hormone as a result of learning and releases endorphins. Providing and planning a training environment based on 'learning' rather than rote learning should be the first objective for us, educators.

According to Zull (2002) there are four pillars of human learning:

I. Getting information (sensory cortex,) – Gathering
II. Making meaning of information (back integrative cortex,) - Analyzing
III. Creating new ideas from these meanings,(front integrative cortex) – Creating
IV. Acting on those ideas (motor cortex.) – Acting

Those four pillars seem to match with the structure of the brain.
Each learning means to create new 'networks' established between the brain cells. Actually, creating new networks of neurons (learning) is the basic food for our brains. Brain cells undergo a great destruction especially after the age of 30. One of the most important ways to avoid this is always learning something new such as learning to play a musical instrument, learning a foreign language, using the new technology that has never been used previously, knitting carpet, sculpting, dealing with a sports branch that we have not experienced before and so on. "Use it or lose it" seems a very appropriate motto for the brain.

2. Physical Exercise and Learning

Phyiscal exercise is believed to be one of the most important variants that affect the learning phenomenon. One of the first developed parts of the human brain is the part called cerebellum. It is determined that commands related to motor activities are given and controlled from this section. For this reason, the creation of action-oriented learning environments is especially important during childhood. How much opportunity do we givechildren to move in a large area? We, educators, must dwell on this question especially.

Jensen (1997) reported that in 1960s children spent approximately 100 hours sitting in a car and the duration has increased to 500 hours on average in 1995. Those passive hours should be spent in wide areas where children move freely and planning should be done accordingly. For one thing, moving in large areas from infancy onwards is now known to have a positive effect on learning. A recent survey revealed that subjects that spare more time for physical education ,regardless of their socio-economic status, exhibit a superior performance on academic subjects such as math and reading (Hillman & Erickson, 2008).

New research has demonstrated that the effect of exercise first occurs in the muscles (muscle contraction and relaxation) then in the brain with the protein called as IGF (Insulinlike Growth Factor) which is generated as a result of this. The IGF produced in muscles reaches the brain through blood and triggers the formation of neurotransmitters. BDNF (Brain Derived Neurotrophic Factor) is one of these essential eurotransmitters in providing the communication between the two brain cells.(BDNF level increases in people who do regular exercise and as a result of these dendrites occur in brain neurons.) This situation sets up a substructure for the probability of neuro-network occurrence that is to new learning. In summary, the IGF produced in muscles triggers the formation of BDNF and BDNF forms the learning substructure and eases communication between the two brain cells (Ozdinler & Macklis, 2006). Approximately 20 years ago, scientists used to believe that the brain cells that especially die rapidly from the age of 30 are not renewed. However, in recent years, especially experiments conducted on animals have shown that new nerve tissue can be produced in brain with exercise. Unfortunately, doing sports at certain times is not enough. To maintain the positive effects of exercise on our brain we should exercise regularly When we do not use our brain to learn new things 'premature aging' takes place. In other words, it is in our hands to age our brain earlier or to keep it young. A philosopher says; "If one is never confused, it means he is never using his brain. Between two rivers, only the obstructed one will make noise." If this article confused your mind about the learning phenomenon, then it reached its objective.

It has been scientifically proven that physical activities have positive influences on concentration, memory and classroom behaviour. Research finding proves the correlation that phyiscal activities are closely related to intellectual performance. Therefore, physiacl activities can be added as extra curricular activities to the school curriculum by taking time from other subjects without risk of hindering student academic achievement. On the other hand, adding time to "academic" or "curricular" subjects by taking time from physical education programmes does not enhance grades in these subjects and may be detrimental to health (Trudeau, 2008).

A research study was conducted which involved a population of 287 British Columbian primary school children at the 4th and 5th years. Physical activity was coordinated by classroom teachers, amounting to 47 minutes more per week in interventional than in control schools. Despite a decrease in academic time and increase for physical activity, the academic performance of the experimental group, as measured by the Canadian Achievement Test, remained unchanged. In fact, data analysis revealed a trend towards an enhanced academic performance in the intervention schools with the average score rising from 1,595 to 1,672 units (Ahamed and et al, 2007). Another interventional study was conducted involving 6^{th} grade, 11 year-old, students covered a single school term. 55 minutes per day of physical education activities were included in the curriculum, vs. the same allocation of time for arts or computer sciences. The two groups performed equally well in mathematics, sciences and English (Raviv and et al.,1994). Another intervention study involved 92 preschool and 266 first grade children. The experimental manipulation here was a school-based movement education programme, and children in the experimental group showed greater reading skills and arithmetic scores than controls (Coe and et al., 2006).

The above research findings suggest that the enriched physical activity programmes demanded a substantial reduction in the time allocated for academic subjects. However, the children achieved at least equally despite the reduced teaching time, the evidence seems strong that the efficiency of learning was enhanced (Shephard, 1997).
Dwyer et al. made a cross-sectional survey of 9000 Australian schoolchildren between the ages of 7 and 15 years 10 girls and 10 boys per school. Linear regression analysis was used with good control of confounding variables showing a significant association between academic achievement and physical activity. In all subjects aged 9–12 years, school performance was positively associated with ratings of physical activity during the preceding week. In girls 10–15 years old and boys 8–15 years old, academic achievement was also positively associated with the estimates of lunchtime physical activity. The correlation coefficients between physical activity and academic achievement, although low ($r = 0.08$ to 0.19) were statistically significant, suggesting that physical activity was contributing to academic chievement in both boys and girls.

Research findings from the longitudinal Maryland Adolescent Development in Context Study included 67% African-Americans and 33% European-Americans showed that participation in extracurricular physical activities was a significant predictor of better academic results and of higher academic expectations (Hawkins and Mulkey, 2005). Moreover, sports participation by 8th grade African-American males resulted in aspirations to continue their studies toward college, with less likelihood of acting inappropriately in school. More research findings can be found in the literature proving a positive association between school sports participation and academic achievement.

In children with reading disabilities, a school-based programme of balance and coordination training, throwing, catching, and stretching produced significant improvements in both reading and semantics. Positive changes were maintained for at least 18 months following the programme (Reynolds and et al, 2003).

Hippocampal section of the brain is believed to be the most credible physiological explanation for learning and memory in mammals, including humans. Long-term potentiation (called LTP, which is a long-lasting enhancement in signal transmission between two neurons) leads to an increase of synaptic efficacy following an increase of synaptic traffic. It was scientifically proven that that physical activity encourages hippocampal LTP (Cooke and et al, 2006). It was also shown that regular exercise creates a favourable environment for LTP by increasing the hippocampal concentrations of neuroprotective factors like brain-derived neurotrophic factor (BDNF) and of other growth factors such as insulin-like growth factor (IGF-1), nerve growth factor, and fibroblast growth factor 2 FGF-2 (Cotman and et al, 2002).

3. Impact of Diet and Nutrition on Learning

Needless to say that daily intake of food is vital for proper performance. However, many of the readily available and unfotunatelly popular food at many schools today are actually hindering children's abilities to learn. Most of them contain excessive sugar, caffeine, chemicals, additives which make children tired, unfocused, jittery and causing sickness in the long term. This unacceptable habit of eating has also adverse influence on students' grades, performance, behavior and moods.

It is well known that glucose comes from carbohydrates and while glucose is vital for energy, foods which are too high in glucose, as a matter of fact, can cause a body's energy levels to drop. It is also known that as glucose is ingested, the body releases insulin so as to process the foods eaten. Normally, after a healthy meal, glucose levels should rise slightly, and a body should feel energized after taken the nutrition. However, humans with high-glucose diets experience disturbance because the glucose taken is so high that the body begins to shut down as it processes all of the food. Popular foods which are accessible and available in school cafeterias usually include white and refined breads, fried foods and sweets. All of those can cause decreased in energy and lack of focus. It is common knowledge that too much glucose can damage kidneys, eyes, blood vessels, and nerves. In U.S. it is estimated that one out of three kids is overweight. Experts point out that both overweight and underweight children are considered as malnourished. This is because a lack of proper food intake is deined as malnutrition. In other words, taking in a great deal of calories does not necessarily mean nourishment and does not guaranty taking in any essential vitamins, nutrients, and minerals. This lack in vitamins and minerals can cause to detrimental side-effects. Kids with insufficient diets are reported to have more health related problems and also have diifculties in academic learning. They are also reported to have behavioural problems. It is also well known that malnutrition, in the long run, can damage brain cells.

Unlike saturated fatty acids, Omega-3 fatty acids are considered to be protective against cognitive decline (Carrie and et al, 2009). Research findings have shown that intake of saturated fatty acids is correlated with impaired cognitive function. It is scientifically proven that consumption of a meal containing simple carbohydrates can impair memory function compared to intake of complex carbohydrates (Papanikolaou and et al, 2006). Kanoski and Davidson (2011) talk about the effect of excessive consumption of Western diets which contain mainly saturated fats and refined carbohydrates. It is claimed that the said diets can produce a number of neurophysiological changes that would directly or indirectly impact the hippocampus. These changes include impaired glucoregulation, reduced levels of neurotrophins, neuroinflammation, and alterations in the structural integrity of the blood-brain barrier. This is believed to be the cause of impairments in several types of hippocampal-dependent learning and memory operations. Intake of Western diets is also associated with impairments in other spatial memory function.

Hu et al, (2001), indicated that the intake of saturated fat and refined carbohydrates can contribute to the development of metabolic syndrome including insulin resistance and glucose intolerance as primary characteristics. Similar research findings can be found in the literature which talks about peripheral insulin resistance as an important contributor to the decline in cognitive function in individuals with metabolic syndrome. Insulin resistance is found in almost 80% of obese individuals. High dietary levels of simple carbohydrates and saturated fat are believed to be linked with the development of insulin resistance in humans (Gross et al, 2004).
It is consistently reported in the literature that cognitive deficits related to insulin resistance and poor glycemic control in humans are observed in memory tests which are also impaired in individuals with damage to the hippocampus, such as tests of delayed verbal memory (Greenwood et al, 2003).

It is highly recommened that children must be provided with smaller meals or snacks every three to four hours. This would boost their energy and improve their focus. Healthy and balanced diet should include natural fruits and vegetables, whole grains, and lean proteins. It is important to include foods rich in lecithin, such as peanuts, soy beans, and wheat germ. Potassium and vitamine C are also highly recommended which can be derived from oranges, bananas, apricots, avocados, melons, peaches, and nectarines. There is no doubt that we should avoid processed foods in order to ensure healthier body and brain power.

4. Discussion and Conclusion

Scientific data suggest that extra physical activities incorporated into school curriculum could increase academic achievement even if curricular time for so-called academic subjects is curtailed. Extra physical activities are likely to increase attachment to school and self-esteem which are indirect but important factors in academic achievement. Canadian study found that the time allocated to physical activity was positively correlated with the time that children spent in reading (Feldman and et al, 2003). It is common sense to suggest that parents concerned with the health and academic success of their children should be focusing on the prevalence of various metabolic pathologies in which sedentary behaviour plays a key etiologic role, such as obesity and diabetes, both of which appear at an ever younger age (Taras and Potts, 2005). Such pathologies have the potential in a great deal to influence school performance of children adversely.

Many questions and hypothesis remain to be researched vis-à-vis the relationship between academic performance and physical exercise. However, there is enough scientific evidence to believe that extra physical exercise to be incorporated into school curriculum would have positive effects on children. As per the impact of diet and nutrition on learning, research findings have indicated that saturated fats and simple sugars cause cognitive impairment. Therefore, it would be highly recommended that fast and fried foods, chemically processed menu must be banned at schools. Schools must be serving whole-grain breads, vegetables, fruits, salads, and lean proteins instead of fast food. Since natural and un-processed foods provide kids with a lower intake of glucose, children are expected to feel more energized, less lethargic, and more able to focus on their studies.

In light of the above given research findings, it is strogly believed that curriculum developers, teachers and school leaders need to make a number of changes in their approach to learning with a view to creating the ideal learning climate in their schools:

- Increasing the hours of physical exercise classes can contribute in a great deal in the academic and physical performance of the students.
- Training the trainers for physical education (for teachers with a different background other than physical education) can be incorporated into the in-service edution of the school staff.
- It is strongly advised that schools receive professional help in preparing and delivering food for its pupils and staff with a view to ensuring healthy and balanced diet and nutrition.
- Schools are suggested to provide training activities vis-à-vis physical education and healthy and balanced diet and nutrition for the parents as well. This could be regarded as a social responsibility and/or community support on behalf of the school.
- Teachers, school leaders and policy makers could be updated about the recent developments in the realm of human brain with the emphasis on the nature of learning and learning cycle models.

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