Learning about Learning

Teaching for Effective Learning:

The learning brain

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The learning brain

What we know

The adult human brain weighs about 3 pounds (1300 grams) and is made up of water (78 percent), fat (10 percent) and protein (8 percent).

Most of what we know about how the brain works has emerged relatively recently and is due to the more frequent use of brain imaging in medical research and neuroscience. Scientists, however, still regard this knowledge as being only the tip of the iceberg. There is still a huge amount that we don't know about how the brain functions and greater understanding is required before neuroscience can impact meaningfully upon educational thinking and practice. However, despite this limited understanding, research during the latter part of the twentieth century has begun to influence the work of schools and the learning experiences of children.

A model for understanding the brain in terms of its evolutionary history is the Triune Brain Theory developed by Paul MacLean. According to his theory, the following three distinct but interconnected brains emerged over the course of evolution:

The reptilian brain - the oldest and lowest part of the brain, comprising of the brain stem and cerebellum, controls the body's vital functions such as heart rate, breathing, body temperature, balance and what is known as the 'flight or fight' response to perceived danger.

The limbic system - sometimes referred to as the mid-brain, manages our emotions and is responsible for some aspects of memory. It is believed to be the seat of our value judgments, which are often made unconsciously and which exert such a strong influence on our behaviour.

The cerebral cortex - sometimes referred to as 'the thinking brain', is the largest part of the brain. It consists of two hemispheres, commonly known as right brain and left brain. Communication between the hemispheres is needed for even simple tasks to be undertaken and is performed by the corpus callosum - a column of neurons that electrically connects the two sides of the cortex. These hemispheres have been responsible for the development of human language, abstract thought, imagination and consciousness.

Four specialist regions have been identified within the cortex:

- *Frontal lobe* - its function is generally thought to be associated with planning, problem solving and some movements
- *Parietal lobe* - its function is to support speech, touch, sensitivity and perception
- *Temporal lobe* - associated with hearing, speech, smell and aspects of memory
- *Occipital lobe* - containing the primary visual area.

The cerebral cortex is flexible and has almost infinite learning abilities. It has been fundamental in enabling human cultures to develop.

The working units or nerve cells of the cortex are called neurons. Neurons are made up of a central system, (cell body), a stem (axon) and tree-like structures (dendrites) that connect with other neurons across tiny gaps called synapses. Brain activity involves the collection of electrical messages by the dendrites.

In his publication *The Brain's Behind It*, Alistair Smith describes this process:

The basic unit is the brain cell, components formed by genes and chemicals. Each brain cell has a synapse, which is the mechanism for connecting with other cells. Brain cells combine through electrical and chemical bonds to form circuits and these organise themselves into neural networks, which in turn form large scale neural assemblies. These assemblies support four specialist brain regions that carry out specialised functions.

The brain is a vastly complex and adaptive system with almost countless neurons or brain cells that generate the many neural nets from which our daily experiences are constructed.

Although the composition of the brain is the same in all humans, there are individual differences in the way that each person receives, stores and processes information and in how the brain grows and develops. Each person's brain is, therefore, unique.

Some myths about the brain

Over the years a number of popular misconceptions have developed in relation to the brain. These include:

- **We only use 10% of our brains.** This misunderstanding developed from early research stating that only 10% of the brain was known about.
- **We lose brain cells every day and eventually they just run out.** In fact, new neurons are grown throughout our lives (even in old age) by a process is known as neurogenesis.
- **Mental abilities are separated into left and right.** A common misconception is that the left brain is all about reasoning and logic, whilst the right brain deals with everything creative. Research shows, however, that when we are thinking and learning, all parts of the brain are functioning.
- **You can't change your brain.** Many people believe that a person's intelligence is fixed and it's not possible to become smarter. In fact, our brains are constantly changing in response to our experiences and this plasticity means that everyone is capable of becoming more intelligent.

Physiology and learning

Whilst scientists might disagree amongst themselves about the extent to which human physiology affects the functionality and development of the brain, it is generally recognised that certain physiological factors can inhibit or enhance a person's capacity to learn.

'The greatest unexplored territory in the world is the space between our ears.'

William O'Brien, former President of Hanover Insurance

'The brain is a living network of understanding, rather than a dormant warehouse of facts.'

John McCrone, New Scientist, May 2003

Dehydration, ie lack of water, can reduce a person's ability to concentrate and learn effectively. The brain requires water for neurotransmission, forging neural pathways and generating neural nets. Dehydration can also create stress due to decreasing the amount of water in the blood, leading to a rise in salt and increased blood pressure.

The brain also requires a balance of proteins, unsaturated fats, vegetables, complex carbohydrates and sugars as well as key trace elements. Maintaining a balanced and healthy diet is, therefore, important for effective learning. By contrast, children with diets high in sugar and food additives can find it difficult to concentrate well and, in some cases, this can also affect behaviour.

Other physiological and environmental factors can also impair the brain's ability to work efficiently. When children are, for example, tired or hungry, too hot or too cold, they are unlikely to be able to concentrate effectively on their learning.

Stress and anxiety can also play a significant role in learning. The brain is programmed to give threatening stimulus an immediate priority. The amygdala, the emotional centre of the brain, responds to all threats and fears by focusing attention and triggering the release of the chemicals adrenaline, vasopressin and cortisol. These rapidly alter the way we think, feel and behave. In a state of anxiety or high levels of stress, therefore, children are not predisposed to learning. The importance of emotions in learning is discussed in the Emotions and feelings section of this resource.

'Two rules come from the field of brain research and enrichment. One is to eliminate threat and the other is to enrich like crazy.'

Eric Jensen, Teaching with the Brain in Mind

Many observers believe that a state of relaxed alertness is best for learning. In this zone our brain is activated and neural connections are more easily made. Learners are more amenable to working outwith their comfort zones and responding positively to new challenges.

Frequent new learning experiences and challenges are vital to enriching brain growth. Recent research has shown how enrichment changes the structure of brain cells, encouraging many more dendrite branches to grow and connections to be made. New and stimulating challenges framed within a safe and friendly learning environment, maximise brain growth in a child.

The learning brain

Bill Lucas identifies five key principles underlying the operating systems of the mind.

- The brain loves to explore and make sense of the world
- The brain likes to make connections
- The brain thrives on patterns
- The brain loves to imitate
- The brain does not perform well under stress

These predispositions enable the brain to engage fully with the learning activity - a state the psychologist Mihaly Csikszentmihalyi refers to as flow. He believes that when the challenges facing learners are greater than their skills, children enter a state of anxiety. By contrast, when the challenge does not extend to the skills of the learner, the result will be boredom. Csikszentmihalyi asserts that flow – the perfect learning state - is achieved when the challenge is equal to the level of skills and the learner receives continual feedback on his or her performance.

In schools, teachers have made increased use of approaches designed to optimise brain learning. Some schools use physical techniques such as brain gym to stimulate children before they undertake learning activities. Physical movement that increases the oxygen in the blood stream helps the neurons to fire and aids concentration.

Children are not good at sitting for long periods of time and so brain breaks have become an increasing feature of classroom practice. These are simple exercises designed to equip the teacher with tools to manage the physiology and attention of the class. Brain breaks can be used to energise or relax the class, to enhance fine and large motor movement, improve co-ordination and link to learning.

Whilst physical activity can underpin more effective learning, it is important for staff to provide a good balance of visual, auditory and kinaesthetic activities to engage the brain and cater for different learners.

Remembering

Memory is our ability to recall to our minds what we know, our experiences, those things we are able to do and how to do them. We rely on our memories not just to recall events in the past, but also to help us perform everyday tasks and cope with the future. Memory is a large part of who we are and is a foundation stone of learning. Learning and memory are inseparable; the memory of a learning experience provides the only evidence.

Despite all the research on the human brain, we still don't really know exactly how memory works. We do know that memories are *physically* encoded in some way in our brains, but just how we carry out this encoding, where we do it and how we use it for recall is still not fully understood.

Neurologists also believe that memory exists in different forms and various attempts have been made to name and classify them. The kinds that are thought to be particularly relevant in learning are *procedural* and *semantic* memory.

Procedural memory is our memory of how to do things and is formed through the repeated practice of actions or skills. These are the most durable of our memories. The opportunity for a learner to rehearse repeatedly their learning facilitates a deeper level of understanding which aids transfer to other learning experiences.

Semantic memory relates to our knowledge and concepts about the world we live in, and involves the ability to store and recall information in the form of numbers, words, facts and rules. Semantic memories are not formed automatically - they require motivation and are they are easy to lose.

While semantic learning can be thought of as storing knowledge of '*what*', procedural learning can be thought of as storing knowledge about '*how*'. The demands for semantic memory in the school setting are, however, unceasing and many children who struggle in school have relative weaknesses with their long-term semantic memory system.

'I am sceptical about the claim that memory operates in a way that is blind to content. Normally when we say a person has a good memory we mean that he or she is good at using memory for certain things.'

Howard Gardner

Short and long-term memory

Memory is generally defined as the processes of encoding, storing and retrieving information in our brains. It is thought to begin with the encoding or converting of information into a form that can be stored by the brain and this system is usually referred to as *short-term memory.*

Some of this information is processed further and stored within our long-term memory system in order that it can be retrieved at some point in the future. Long-term memory is a series of networks in our brains, helping us to create connections between what we already know and what we are trying to learn.

School places many demands on short-term memory systems. Learners must remember instructions given to them by their teachers, together with the facts and information they are required to assimilate during class time. Learners receive a wealth of information that enters the short-term memory and must then be stored in long-term memory if it is to be retrieved at some point in the child's future learning.

During a typical school day, however, learners are presented with considerable amounts of new information to be assimilated and transferred from short to long-term memory. This situation makes it difficult for learners to process and store new information within long-term memory, and it creates fertile ground for 'forgetting'.

One of the challenges for schools is to establish learning environments that help learners to transfer information from short to long-term memory more effectively.

Implications for learning

It is important for education professionals to keep up to date with emerging research about the brain and to reflect on how it might impact on teaching and learning. Although it is widely accepted that we know relatively little about the workings of the brain when it comes to learning, ongoing developments in neuroscience continue to provide insights that help schools to adapt teaching methodologies in order to create better learning for young people.

'You can read the same material again and again without it entering your long-term memory. Memorising material needs to be more active. You need to seek out the meaning, think it through and structure it in the way you feel is most relevant.'

Nick Mirsky, The Unforgettable Memory Book, 1994

In general terms, a balanced and nutritious diet, adequate exercise, good rest and being properly hydrated will help to provide the right *physiological* conditions for learning. A learning environment characterised by warm and supportive relationships and where children feel relaxed, will create the right *emotional* conditions for learning. It is important, however, to ensure that young people experience a sufficiently high level of stimulation and challenge in their day-to-day learning since this creates the optimum *cognitive* conditions for learning.

Specifically, schools can create enriched learning environments by:

- creating non-threatening classrooms where learners are free from anxiety
- providing visual, auditory and kinaesthetic ways of learning
- ensuring adequate levels of challenge and providing ongoing feedback
- engaging children actively in their learning
- breaking the learning into chunks to aid concentration
- previewing and reviewing to create memory hooks and associations
- making use of memory techniques, mnemonics and mind maps
- using regular brain breaks to help maintain focus
- using self and peer assessment to foster metacognition
- ensuring a sufficiently high level of challenge to promote flow
- communicating the importance of a balanced and nutritious diet
- encouraging regular exercise and adequate rest
- ensuring that learners remain properly hydrated.

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