# Thinking: Critical for Learning

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by

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## Introduction

For the past seventeen years I have been engaged in research, thinking, teaching and collaborating that has one end in mind - the enhancement of learning and the encouragement and improvement of thinking. Depending on the particular group with which I'm conversing, the language and focus of dialogue shifts, representing different ways of knowing about thinking and learning. The philosophers argue about the meaning and consistency of the use of terms. The researchers argue about the validity of qualitative versus quantitative research methods. Other academics demand 'rigorous analysis' and 'critical thinking'. Meanwhile the teachers request a pragmatic approach: *"Forget all this theorising and just tell me what works in the classroom."* They have rejected the more formal approaches because these have not connected with their way of knowing and consequently have not informed their practice. An unsatisfactory situation has emerged in education. Pragmatic approaches reduce to ad hoc decisions. Research which is carried out in a setting which does not represent the reality of a classroom becomes irrelevant. Academic analysis is labelled 'ivory tower' and ignored by practitioners because its language and approach tends to exclude. Ultimately, it seems to me, we need a synthesis of our many ways of knowing about learning and thinking.

This paper presents a way of knowing about learning and the critical role of thinking processes in learning which is developing from my own experiences as a teacher interacting with learners from pre-school age to adulthood in both formal and informal settings. It has been refined, extended and elaborated on through my interactions with other teachers. It has been shaped and made more explicit by drawing on psychological and neurobiological research. It will be tested through 'sounding it out' against the experiences of teachers and learners. It will be further refined and modified as I continue to draw on more recent psychological and neurobiological research and as I, and others, subject it to philosophical analysis. At this point in its development it has passed the test of being both informative and formative for teachers - an acid test for me in my continuing quest to bridge the gap between theory and practice in education.

### Snapshots of learning experiences

#### *Classroom 1*

In a Year 8 Maths class students are working from a textbook completing an exercise which requires that they calculate the circumferences of circles with different diameters. How have they come to learn how to do this? What is the nature of the thinking which has taken place during learning and what are they thinking about as they complete the exercise? In this classroom the formula, or rule, $C=\pi.d$ has been handed down to them by their teacher who has then proceeded to demonstrate how to substitute into the formula the value for the diameter and $\pi$ and subsequently calculate the value for the circumference. The students imitate the process with an example supplied by the teacher and then proceed to complete an exercise with ten parts which requires that the students repeat the process the teacher used ten times over, presumably to consolidate the learning.

What is the *nature of thinking* which has gone on during the learning process and the completion of the exercise? It will have varied from student to student. For some their thinking will have been laced with questions like: "Where did $\pi$ come from? Who came up with it?" and, "Hmm! that means that the circumference of a circle is always just bigger than three times the diameter . . does that seem right?" and this student might proceed to test out the relationship by roughly measuring out with finger spans the circumference of a circle and comparing this with the diameter. These students' thinking and learning is characterised by trying to make sense of what they are observing or being told. Their thinking is characterised by searching for connectedness and meaning. Others will have watched carefully, absorbed the process and while completing the exercise will have been asking themselves: "What do I do next? What was the value for π? In what order do I enter these into the calculator? Let's see - what did the teacher do?". These students are focussed on repeating and mimicking and their thinking gives little evidence of attempts to find connections with experience nor to make meaning out of the events - an approach which I label 'plug 'n chug' - 'plug' in the numbers and 'chug' out the answer. For still others the thinking will be framed in questions and musings like: "Why do we need to know this? How much longer till the end of this class? I wish I was at the beach!".

My experience in observing classrooms like this, and from having been a student in many classrooms and lecture theatres like this, leads me to believe that some students learn meaningfully in spite of the teacher. Most others have learned to learn in ways which are relatively mindless. They have learned to learn in ways which have actually been modelled by mindless teaching strategies used by many teachers. Mindless learning has also been rewarded by assessment practices which value 'the one right answer' or piece of information and which affirm 'the right way to do things'. Yet these very same teachers lament that students don't think, don't estimate, don't challenge, don't understand and can't transfer learning from one situation to another. Rather than examining their teaching strategies and assessment practices, their conclusion is that students need to be taught to think.

## *Classroom 2*

In a Year 8 Maths class a challenge has been posed. *"How does the distance across a circle through it's centre, the diameter, relate to the perimeter of the circle, the circumference?"* The students in this classroom are used to operating on such challenges and in small groups they gather resources - plates, jars, drink coasters, string, rulers, flexible tape measures, compass, dividers. In one group, after some discussion about how they can make sure they are going through the centre of the circle to measure the diameter, one student draws up a table and records a comparison of diameter to circumference for a variety of circles. Another quickly estimates from the figures that the circumference is about three times the diameter, another suggests that they calculate the exact ratio, which they do, and find that the circumference is a little more than three times the diameter in each case. Another speculates whether that looks right when you 'eyeball' the diameter and circumference. Meanwhile the teacher moves from group to group with a probing question here, friendly advice there, makes a suggestion in one group, settles an argument in another group, poses another challenge in yet another group. All groups, having completed their attempts at the challenge, then report back how they went about the task and what they have learned. From their responses and discussions the teacher then leads them on to the formula $C=\pi.d$ and explains the origins and nature of π. Discussions and questions follow. Further work involves some calculations of circumferences of circles in an exercise not unlike classroom 1 but, in addition, follow up work involves discussions and examples of the usefulness of this formula in everyday life, historical research on π, and an opportunity for students to express what they have learned about the circumference of a circle compared to its diameter in any form they wish - drama, song, mime, poetry, art, poster display etc. *In this classroom thinking has been deliberately encouraged. It has not been left to chance. In this classroom students have been thinking to learn.*

I happen to have chosen Maths classrooms to illustrate the point I want to make. The same contrasting scenarios can be viewed in any fields of study in most secondary schools. A History classroom I viewed recently involved students reading about human rights from a text book and then answering questions from the end of the chapter. From many students could be heard whispers of, "What paragraph has got the answer to question 6 - the one about what are the basic human rights?", whilst some others, whose faces showed distracted looks, I suspect were thinking in more depth about the questions or perhaps they too were wishing they were at the beach! In contrast, in other History classrooms I have observed, teachers first ensure that the students are engaged in thinking about the rights of all humans, perhaps initiated by a contemporary story from the media which represents an example of violation of human rights, and then lead students to a comparison of their thoughts with the *Declaration on Human Rights.*

My play on words in the title of this chapter is intended to re-direct, re-form the approach to teaching thinking. Many teachers are grasping at the teaching of thinking to address the lack of thinking in their classrooms and lecture halls, a lack of thinking brought about by the very teaching strategies and assessment practices they employ. *Students have learned not to think.* Thus, the starting point in encouraging and developing student thinking must be to design, deliberately, learning experiences which are infused with thinking.

What do we know about learning and thinking which might inform these attempts?

## Learning

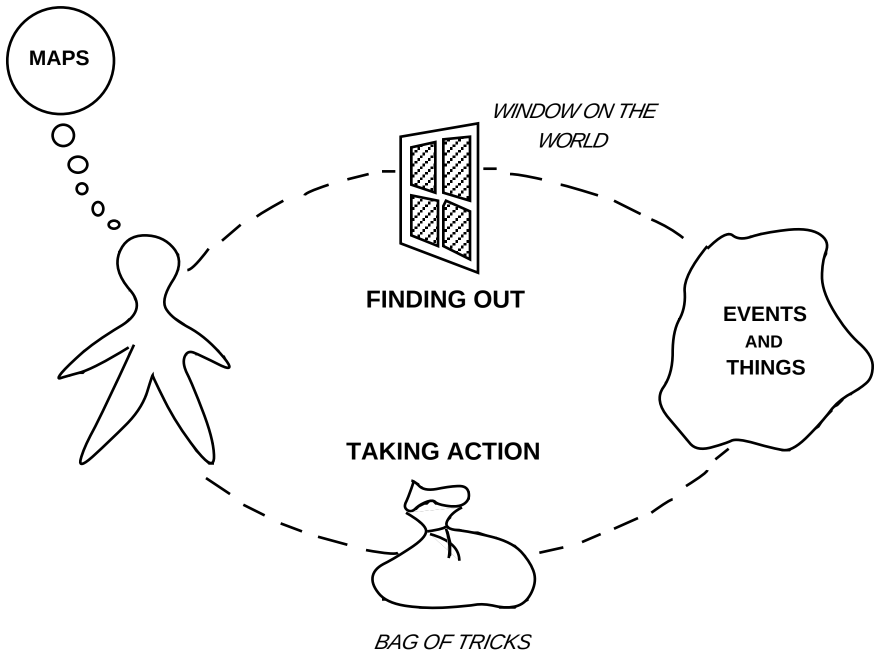
Over the past five years, in workshop settings, I have asked over five thousand teachers, adults who were not formally teachers, and students from age twelve upwards what the term learning means to them. The collective responses from each group have been strikingly similar. *Word responses* typically fall into five categories: gaining information, facts; making connections, understanding, insight; being able to do, applying; feelings, emotions - enjoyment, frustration; and, a fifth category which is related to the result or impact of learning - responses like *"Learning is changing."*.

The dominant *images* and *analogies* which emerge are ones of growth, journey, transformation/creation, puzzle solving, and light bulbs going on. The image of learning being like a sponge often emerges but is quickly debated as people disagree with the passive, non-interactive process which it implies. The profferer of the sponge image usually modifies the image to speak of an organic sponge, living and growing in the ocean with the capacity to select, take in and integrate as well as the capacity to absorb.

Descriptions of the process of learning have a lot in common with Kolb's (Kolb 1984) model of experiential learning.In Kolb's view:

> *. . .learners have immediate concrete experience, involving themselves fully in it and then reflecting on the experience from different perspective's. From these reflective observations, they engage in abstract conceptualisation, creating generalizations or principles that integrate their observations into sound theories as guides to further action, active experimentation, testing what they have learned in new more complex situations. The result is another concrete experience, but this time at a more complex level. Thus experiential learning theory is best thought of as a helix, with learners having additional experiences, and then using them as guides to further action at increasing levels of complexity.*
>
> *(Claxton & Murrell 1987, p.5-26)*

Bawden (Bawden 1989, p.10) expresses his understanding of experiential learning in graphic form which provides a *model* of the learning process.In this view of the nature and process of human learning we experience the world around us, we reflect on these experiences and construct mental maps or patterns for making sense of our world. The effect of this mental pattern making, or map making feature is to simplify the bewildering array of stimuli that we face every moment we are alert. Our 'maps' give us our 'window on the world'. Our 'world-processing' system (Ornstein 1991), is equipped to distinguish contrasting features and to form, and later recognise, patterns. As we distinguish elements which do not fit the pattern we continually adjust and refine out pattern. In addition to developing patterns for making sense of our world we develop skills (our 'bag of tricks') which enable us to act, to do. In a spiralling fashion, further experiences and reflection lead us to refine and change our mental patterns and to fine tune and hone our skills.




*Adapted from: Bawden 1989, p.10-12*

**Figure 1** **Bawden's graphic representation of Kolb's (Kolb 1984) Experiential Model of Learning**

In terms of this model of the nature and process of learning, learning which occurs in *Classroom 1*, is focussed on teaching students to accept as given, and to re-state, a pattern that has been constructed by someone else. Some individual students will think through for themselves the meaning of the pattern, whether it seems reasonable to them, how it might have been constructed in the first place and so on. These students form a very small minority. In contrast, learning in *Classroom 2* is deliberately guided through a process which encourages students to construct their own pattern and then to compare their view with that constructed by earlier mathematicians.

The standard reply from many teachers to the above discussion is "But we don't have time to do all that. We know the formula for calculating the circumference of a circle. Why can't students just accept that." My response is simply because that is not how humans learn naturally. Numerous anecdotes about the need for the threat of a rap across the knuckles bear testimony to the forced nature of 'plug 'n chug' learning. A quick survey of adults around you who are not teaching Maths will reveal that very few can state the formula for the circumference of a circle and still fewer will be able to reveal any understanding of the nature of π or be able to give you an estimate of the ratio of the circumference of a circle to its diameter. In my view, *we do not have time for such non-learning*. We do not have time to teach in a way which does not actively engage students in constructing their own meaning.

We have talked about the nature of the process of learning. Can we define what learning is? Figure 2 is a concept map of a *verbal* or *propositional definition* of learning. In more formal discussions about the nature of learning among psychologists and epistemologists the term *constructivism* has been used widely to describe the nature of human learning.

> *There is a belief shared by most psychologists who study human learning, that from birth to senescence or death, each of us constructs and reconstructs the meaning of events and objects we observe. It is an ongoing process, and a distinctly human process. The genetic make up of every normal human being confers upon all of us this extraordinary capacity to see regularities in the events or objects we observe and, by age two or three, to use symbols to represent these regularities.*
> *(Novak 1992, p.1)*

This sounds distinctly like the collective understanding which has emerged from my discussions with thousands of adults and adolescents.

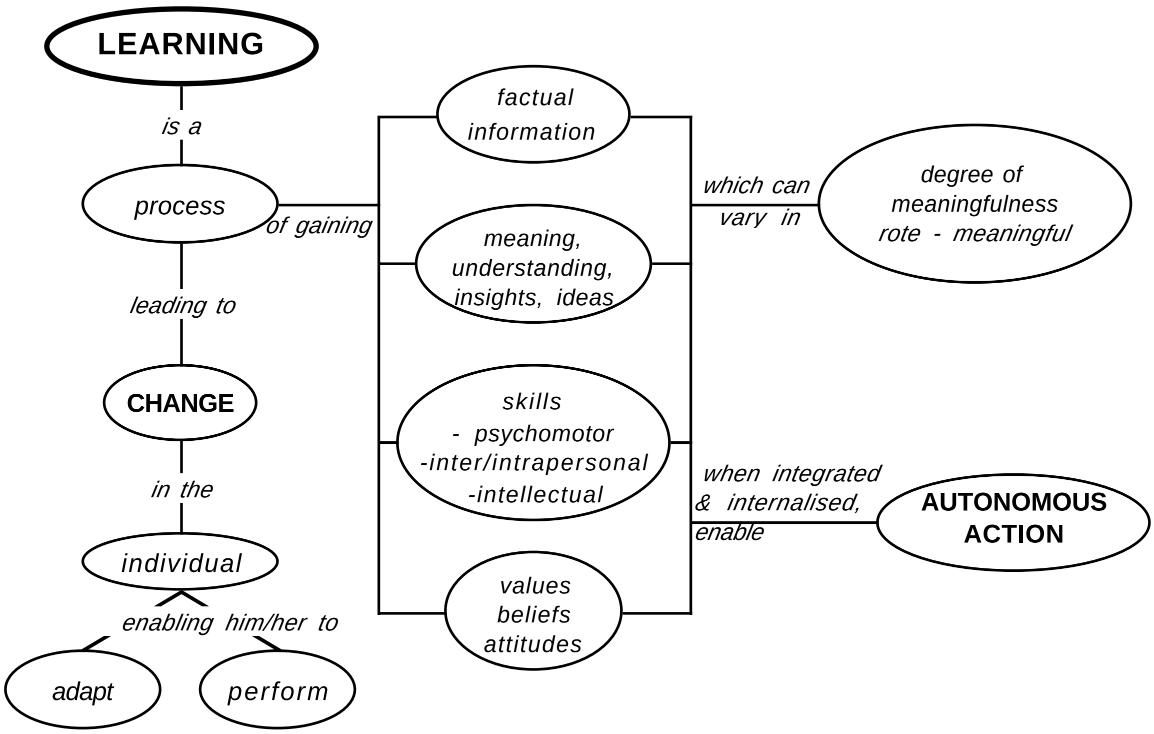



**Figure 2 A propositional definition of learning**

If constructivism is the predominant current view of the nature of human learning, how does it contrast with other views of learning? And what are the implications for the role of the teacher and teaching strategies? Table 1 overleaf (Bawden 1989, p.11) contrasts the focus and philosophies underlying different viewpoints on the nature and purpose of learning.

| | **Scientia** | **Techne** | **Praxis** |
|---|---|---|---|
| **Focus** | Learning for knowing | Learning for doing | Learning for being |
| **Knowledge produced** | Propositional | Practical | Experiential |
| **Structure** | Disciplines | Crafts | Issues |
| **Teaching style** | Exposition | Demonstration | Facilitation |
| **Teacher role** | Expert | Master | Collaborator |
| **Teaching strategies** | Lectures on theories | Practical demonstrations | Practicum and internships |
| **Basic Philosophy** | **Positivism** | **Utilitarianism** | **Constructivism** |

**Table 1 - Some distinctions between different educational traditions** ***Bawden1989, p.11***

If the constructivist view is representative of how people learn most meaningfully, why is it that teachers in formal educational settings, particularly secondary schools and universities, neither teach nor assess learning in ways which ensure thinking to learn? Most teachers have themselves been 'successes' in formal education settings which focussed on learning for knowing. Their own teachers played the role of experts and 'knowers' who handed down information to be learned. For whatever reason, as students they were motivated to learn in this fashion. Teachers who have learned in this way often remark that although they didn't understand what they were learning at the time, eventually it all 'made sense' - usually as they grappled with the same material in an attempt to teach it to someone else. Because this approach to learning 'worked' for them the assumption is that it will work for all others. The evidence is quite clear that it doesn't.

It is not easy for these teachers to teach in a way they have not personally experienced as learners. They have few, if any, models of teachers who have acted as facilitators to their learning. The had few, if any, teachers who set out deliberately to design learning experiences with a constructivist view of learning in mind. Thus, these teachers have at their disposal a limited repertoire of teaching strategies that will stimulate learning for those who *do not* 'learn meaningfully in spite of the teacher'.

What do we know about human thinking processes which can serve as an explicit guide for designing teaching strategies which ensure thinking which is critical for learning?

# Thinking

What is the nature of the mental processes involved in learning with meaning? How does our brain enable us to remember, to imagine, to feel, to think, to solve problems? How does our brain enable us to reflect, to do and to learn? In an attempt to be more explicit about the 'reflection' process of Kolb's model of learning, to be more explicit about the meaning-making aspect of a constructivist view of learning, I have found it useful to draw on what is known about the evolution of the human brain and what is known about how the brain processes information. Facets of cognitive functioning such as the features of working memory, short term memory, accessing information in long term memory and sensory modality preferences as well as more recent research on 'modules' and 'centres of talent' (Ornstein 1991), all serve to enrich our understanding of the nature and process of learning both at a generic level and at the level of individual differences in learning. Each area of understanding brings refinement and layers of depth to the general model of learning with meaning I wish to explicate here.

What follows is a ‘broad brush’ model. It serves to map the territory - to bring attention to the broad contours and to give us a sense of direction for the purpose at hand.

In what ways do we remember? When we recall an important event in our lives, an event for which we have a vivid memory, it seems that we remember in many modes; we remember in many codes. As you recall an important event in your life, as you re-imagine being in that place at that time it is likely that you will remember the sequence of events - *episodic* memory. It is likely that you will be able to re-imagine the *emotions* of the time and that you will be able to re-imagine *visual images*. You may also be able to recall *physical sensations* like what the temperature, light and weather conditions were like. People vary in their ability to re-imagine *sounds* and *smells*, though both of these modes or codes are powerful triggers to memory. We have all had experiences of hearing a song which was popular ten years ago and re-living our experiences of that time and we have, no doubt, had experiences of smelling a familiar scent which triggers childhood associations. In addition to these various modes of memory you could also describe your past experience in *words*. You may also be able to express and describe your experience through body language and mime. Recalling, re-imagining illustrates the many complementary modes or codes in which we remember.

A constructivist view of learning sees learning as more than merely remembering. How do we identify patterns, or regularities in events and how do we integrate new experiences with previous experiences? Engaging many modes of memory through direct experience and deliberate promotion of reflection processes to identify patterns and to integrate experience with previous experiences is the heart of learning with meaning.

## Three brains in one

Paul Maclean's triune brain theory (MacLean 1978) proposes that the human brain has three main evolutionary levels -Figure 3. It is as if it is three brains in one.

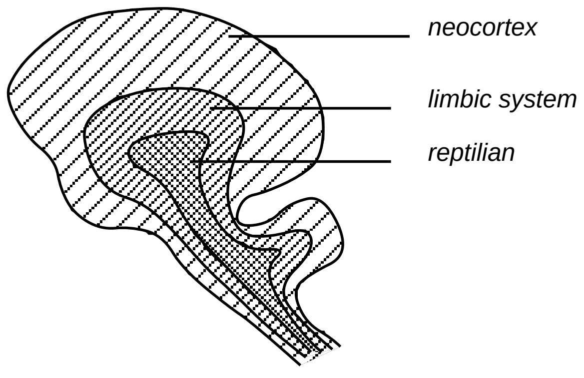



**Figure 3 Maclean's Triune Brain**

The first brain, the reptilian brain, is driven by instinct. The second brain, the limbic system surrounds the more primitive reptilian brain. The limbic system is the emotional centre of the brain. It registers rewards and punishments and controls the body's autonomic nervous system. The last part of the human brain to evolve is the neocortex or cerebral cortex which is the abstract thinking centre of the brain. It is believed the neocortex is most adept at learning new ways of adapting and coping.

> *The first and oldest two layers are concerned mainly with more and more complex processes of keeping alive; the third and newer part of the brain seems most*

> *specialized for creating anew - not only adapting to the world as it is found, but changing the world to adapt to the organism. . . .*
> *The oldest part of the brain is similar to the entire brain of many reptiles and looks like the brain of a crocodile. Called the brainstem, it evolved to its present state about 500 million years ago. It accounts largely for our general alertness and the basic mechanisms of life support. It lies below much of the later developments of evolution, and although basic life support is of some importance to us, it is not the locus of much of the activities we consider "mind".*
> *On top of the brainstem is the limbic system, which presided over the transition from sea-dwelling to land animals and reached its current state of development about 200 million years ago. It is different in appearance, different in structure, and different in kinds of neural activity it contains. In order to exist on land, a new kind of brain had to evolve, body temperature and thirst had to be placed under precise regulation, and reactions to danger had to be programmed, as these problems are more of a problem on land than in the sea.*
> *Along with this quite precise and new kind of brain also came food and weight regulation, the great expansion of emotional reactions, the responses to emergencies, and many of the complex actions that ensure survival in much more diverse and challenging circumstances encountered by land mammals. Many of the developments of the limbic system are still with us today, as we have pretty much the same basic emotional apparatus as our remote ancestors had.*
> *The cortex was the last part of the brain to evolve. In the cortex decisions are made, schemas are hatched, language is heard, music is written, mathematics is created. The cortex is like a quilt that covers the rest of the brain; it is folded so that it can fit within the small human head.*
>
> *(Ornstein 1986, p.48-49)*

The functions of the three brains are not seen to be distinct. Each level appears to replicate, to some extent, the functions of the previous evolutionary level. However, they differ in style. As noted above, the *reptilian brain* and the *limbic system* are thought to control instinctive behaviours - genetically determined behaviours such as territoriality, establishment of 'pecking order'- social hierarchies, flocking, mating rituals, hunting, nesting, playing, preening and grooming, and signalling. And these two brains control the body's internal involuntary responses such as heartbeat, the 'fight or flight' response to fear, and so on. The *neocortex,* on the other hand, appears to be responsible for our more voluntary behaviour and capacity for thinking, speaking and acting in a deliberate way.

When we are under threat it is as if we 'downshift' towards relying on our more primitive brains - we resort to more instinctive behaviour. Under threat we become less flexible and are able to call on only part of our brain for learning. For optimal learning, for integrating activity within all layers of the brain, we need to be *challenged but not threatened*. Depending on past experiences and self perception, what is a threat to one person may well be a challenge to another.

## How does the brain process information?

The brain is divided into two hemispheres. At the level of the neocortex, the two hemispheres communicate by a bundle of connecting fibres, the corpus callosum. At the level of the limbic system, also a bilateral structure, communication between the two sides occurs via the hippocampal commissure. The brain has two quite distinct ways of processing information attributable to its two hemispheres. The complexity of the brain and the ways in which it processes information are much greater than the simplicity implied by the two hemispheres. However, an understanding of the processing modes of the two hemispheres serves as a useful starting point in understanding the nature of mental processing in learning.

> *The cortex is divided into two hemispheres, connected by a large structure of 300 million neurons called the corpus callosum. The division of functions into two separated hemispheres is what makes us distinctively human, distinctively creative, and distinctly isolated from our mental processes. It is the most recent development in human evolution, less than 4 million years old.*
> *The left hemisphere . . . controls language and logical activities - things that happen in a specific order. The right hemisphere . . . directs spatial, simultaneous things-which happen all at once-and artistic activities. . . . .*
> *In the 1960's Roger Sperry and Joseph Bogen of Cal Tech invented a radical treatment for severe epilepsy in human beings. They cut the corpus callosum, producing a split brain. After the surgery, if patients held an object, such as a pencil, hidden from sight, in the right hand, they could describe it verbally. However, if the object was in the left hand they could not describe it at all. Recall that the left hand informs the right hemisphere, which has a limited capability for speech. With the corpus callosum severed, the verbal (left) hemisphere is no longer connected to the right hemisphere, which communicates largely with the left hand. Here the verbal apparatus literally does not know what is in the left hand.*
> *Sometimes the patients were presented with keys, books, pencils and the like, all out of sight. They were asked to select the previously given object with the left hand. The patients chose correctly, although they could still not verbalize what object they were taking. . . .*
> *The surgery revealed two systems at the "top" of the human brain. They govern our abilities to create, in language and in art, and to discover new connections in the world. To do this, we evolved such mental regional authorities, which can work efficiently while not knowing what is going on in the rest of the head. In part this works because the sequences of information underlying language are a different adaptation than the all-at-once ideation that underlies art and movement in space. How well could you dance if you thought about each foot and arm movement? And how well could you read if you did not read every word in cor*
>
> *(Ornstein 1991, p.133)*

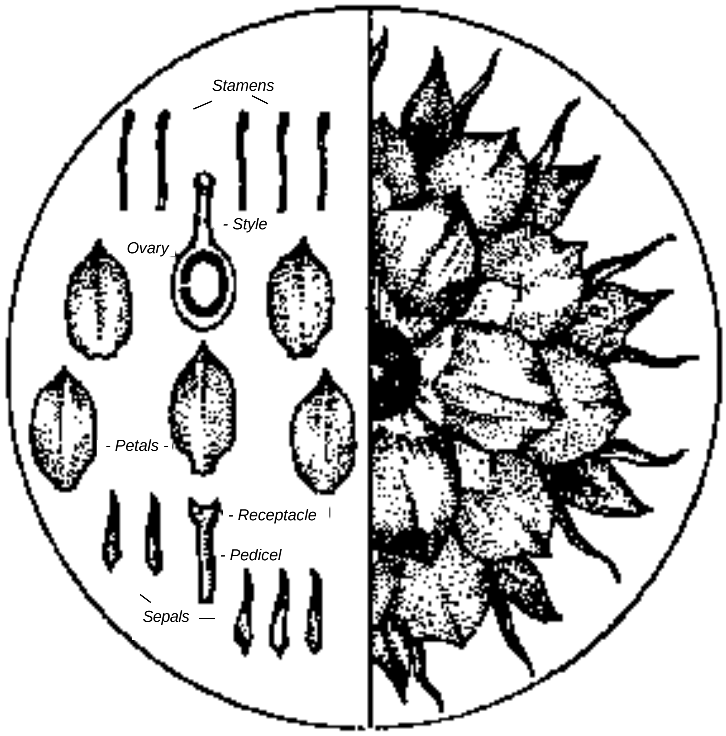
Ornstein entered this field of study in 1969 in order to carry out research on how normal brains operated in normal people engaged in normal activities. By measuring electrical activity in the brain through an electroencephalogram (EEG) he and his co-researchers were able to show that the two hemispheres of the intact brain were activated differentially in certain tasks. They showed that . .

> *. . most people activate and suppressed their hemispheres, one at a time, when they were reading or drawing, thinking critically or creatively, reading technical material or stories.*
> *I characterised these two minds as rational and intuitive, the rational faculties depending predominantly upon left hemisphere processes, the intuitive (immediate knowing of the environment) on the right.*
>
> *(Ornstein 1986, p.53)*

Although Ornstein's more recent research has led him to explore the notion of 'multimind' and to investigate smaller more independent units of ability or centres of talent in the cortex, I don't believe that educators have yet acted on the implications of the notions of the processing modes of the two hemispheres. The processing modes have become known as 'right brain' processing and 'left brain' processing. Not everyone actually uses the left side of their brain for analytical processing and the right side for intuitive processing. Left handers especially may (or may not) have the location of the types of processing reversed. However, it seems that we all use two distinctly different forms of processing information - a holistic, pattern making process called *'right brain' processing* which focuses on the forest, and a logical, analytical processing called *'left brain' processing* which focuses on the trees. [For a summary of the research in this field see Springer and Deutsch].

In any situation we have available to us distinctly different, complementary modes of processing. You can experience these two distinct modes of processing as you work to unscramble NESNIT to form a familiar word. Left hemisphere processing approaches such tasks in a systematic, step by step fashion. In approaching this anagram or scrambled letters problem it would work something like this. *Hmm! Let's try all the possible arrangements of letters for words beginning with N. Now all the words beginning with E* etc. If a computer were programmed to complete this task it would probably take around an hour to an hour and a half to generate all possible combinations of letters for the word and then to solve the anagram by matching up the possibilities against known English words. The human brain readily solves these tasks in far less time. Sometimes in a fraction of a second. Right brain processing is responsible for our facility and speed with such tasks. The right brain recognises, despite the jumble, that these letters make up a pattern it recognises. In a nonverbal flash of insight the answer 'pops' out. It is as if the mind moves from A to D with no intervening steps, in a holistic fashion and it can't verbalise how it got there. In its search of patterns it can be helped by clues as clues effectively reduce the number of patterns that need to be searched to find the matching one. In contrast, left hemisphere processing effectively works through A. . B. . C. . D to get from A to D in a linear, sequential manner. Many people, when solving anagrams iterate rapidly backwards and forwards between right and left. Left hemisphere processing is responsible for making a systematic arrangement of letters (if for example a crossword gives you some clues about the position of letters in the word) or if you start to set out possibilities in a systematic stepwise fashion, perhaps drawing on what you know about the patterns of the use of letters in the English language.

Left hemisphere processing seems to provide the basis of our verbal, analytic, objective ways of knowing while right hemisphere processing seems to provide the basis for our subjective, intuitive, non-verbal ways of knowing. Williams (1983) has captured her way of knowing about the processing modes of the human brain in Figure 4. Which view of 'flower' reminds you of learning in Science class? Most people indicate that the left side of the diagram provides the more powerful association with their learning experiences in Science. However, those that contend that they learned Science in a meaningful fashion indicate that learning Science invoked both modes of processing. For them Science was rich in wonder, in awe and in making sense of their world. For those who have strong associations with the left side of the diagram there are also strong associations of rote learning and ready forgetting. Similarly, if you imagine an equivalent diagram for the humanities, there are those people who say that their learning in the humanities was characterised by 'parroting' the five causes of the second world war and they associate such learning with the left half of the diagram. For others, learning in the humanities was rich in making connections and gaining insights into the human condition. Their associations are with both sides of the diagram. Right hemisphere processing is *critical* for learning with meaning. Note that I am not claiming that right hemisphere processing is sufficient for meaningful learning. My thesis is that effective learning with meaning involves integration of feeling, experiencing, thinking (analytically as well as intuitively) and acting - integration of our many ways of knowing.

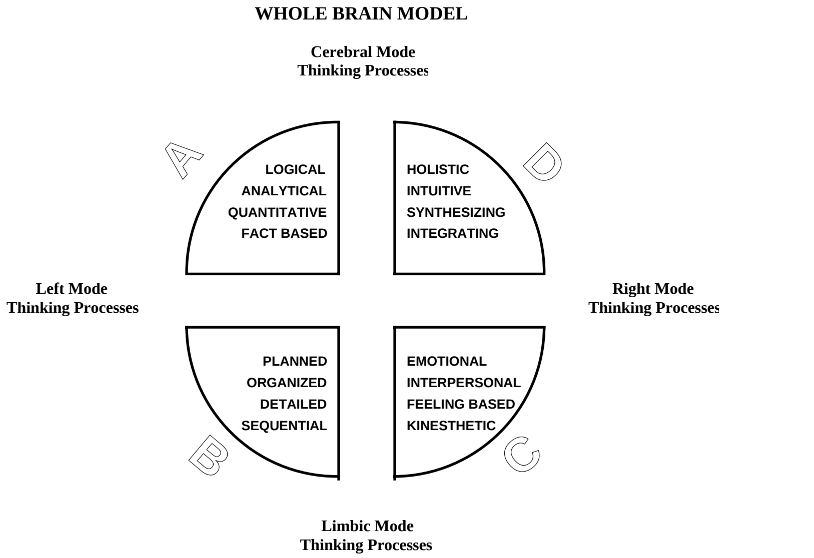



*Source: Williams 1983, p.3*

**Figure 4 Contrasting ways of knowing of the right and left hemispheres**

## A four quadrant model of brain processing

The two hemisphere model of brain processing is a useful starting point in understanding our different ways of knowing. This understanding has been extended to a four quadrant model of brain processing (Herrmann 1989). On the one hand we have styles of processing attributed to different sides of the brain - the one more analytical, logical, factual, sequential, objective and controlled, the other more holistic, intuitive, subjective and spontaneous. And we have at least two different ways of processing corresponding to two different levels of the brain - the one more abstract and conceptual [neocortex], the other [limbic] more to do with emotions, sensing and doing rather than reflecting. Herrmann describes his four quadrant model of brain processes, Figure 5, as a metaphor for how the brain processes information. His whole brain model identifies four main processing modes. He describes each mode as a cluster of specialsed but similar processes. In the model we find expressed our different ways of knowing the world, our different ways of responding to the world. We experience - we know how we feel, we intuit, we analyse, we act - we learn.




*Adapted from Herrmann 1989, Appendix E*

**Figure 5 Herrmann's Whole Brain Model - A metaphorical model.**

## Preferred ways of thinking - thinking styles

Just as most individuals show a preference for handedness, individuals differ in the way they favour or prefer the different ways of processing - the different ways of thinking and knowing. Individuals have preferred thinking styles. At this point it is important to distinguish between 'preference' and 'capability' or 'capacity'. The fact that some individuals prefer to process information or solve problems in certain ways does not mean they are not capable of using other modes nor does it mean they are unable to become more proficient in the use of the less preferred modes. The positive and optimistic thing about Herrmann's whole brain processing model is that it points the way to helping individuals understand themselves and others and indicates ways in which less preferred modes can be accessed and developed.

In Herrmann’s terms, individuals show different brain dominance patterns. In contrast to some other learning style or thinking style models, Herrmann’s model does not put you in a ‘box’, it does not label you as if you had half a brain. We each have a functional whole brain. Ned Herrmann has developed an instrument [questionnaire], called the *Herrmann Brain Dominance Instrument*, to determine your brain dominance pattern [HBDI]. The diagrams which follow represent the brain dominance profiles of three different individuals. The patterns indicate that individual A has a stronger preference for left mode processes and shows a particular preference for limbic left processes. Can you predict what sort of work this person would like? Individual B shows a fairly even distribution of preferences for each of the quadrants, while individual C shows a distinct preference for the lower right quadrant. Can you predict what these people would be like?

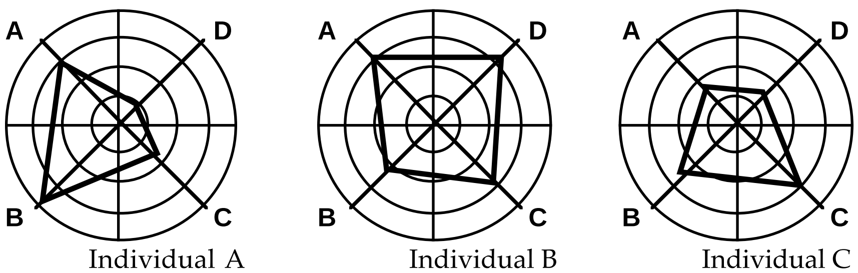



**Figure 6 Herrmann Brain Dominance profiles for three individuals**

It is important to re-emphasise that dominance in one or more quadrants does not mean that the person does not access or use the other modes. Dominance simply indicates a leading mode or modes. People show a range of preferred ways of learning. Individual C [Figure 8], for example will probably like to learn from experience, from interacting with others and will have a certain spontaneity about his approach but he will still prefer a certain degree of order and structure to the task. He won't have a strong need for theorising about what he is learning.

On the other hand, Individual A will demonstrate a great need for structure. She will want to know exactly what is required of her, by when and exactly how she will be assessed. She will want to know the facts, the sequence of events, will have a preference for building up from the parts to the whole and will prefer to focus on one thing at a time. She is likely to feel uncomfortable in learning environments which are unstructured and open ended. Individual B does not show a markedly strong preference in any one direction although there is a skew to the upper right. Individual B is likely to engage all thinking modes in learning but perhaps would show a tendency towards needing to see the 'big picture', needing to understand ‘why’.

There are numerous implications of Herrmann’s model of preferred thinking styles for teaching styles, learning styles, leadership and management, teamwork, self understanding, enhancing creativity, problem solving and career choice. His model has received considerable attention in a variety of fields and is being applied widely. The usefulness of his model of brain processing for a theory of learning, is its power to make more explicit the nature of our different modes of thought, to make more explicit the nature of the thinking processes critical for learning. Through its increased explicitness it makes possible the deliberate use of strategies to promote and invoke different ways of knowing.

Some learning style proponents encourage teachers to ‘teach to all styles’ - to use teaching strategies which engage different processing modes because they claim in that way teachers will reach all learning styles. I too would encourage teachers to use strategies designed to deliberately access all four modes of thinking but not for the same reason. It is quite clear that as learners and thinkers we do not always employ the appropriate thinking mode, or modes, for the task. Our style might be quite inappropriate for the particular task. Logical, analytical, fact based thinking is not an appropriate mode of thinking to employ when you wish to write in a way which captures and expresses emotion, yet it may well be quite an appropriate mode to employ when engaged in a debate or writing a report. *Effective learning, problem solving and performing involve applying the appropriate style of processing to the task.* If a learner is highly inclined towards one mode of processing - one quadrant or one side of the whole brain model, or the limbic versus the cerebral, he will tend to approach tasks in that mode even when it's not the most appropriate mode - even when it's not likely to lead to success. The art of being an effective learner and 'doer' is having the ability to draw on the appropriate mode for the task. Part of the art of being an effective teacher is to engage the learner in the appropriate thinking mode(s) for the task. People who claim that their school or college learning was characterised by rote learning did not necessarily want to learn in this fashion - they didn’t know how to learn in any other way. The evidence is quite clear that we are not always in ‘our right mind’.

> *So ordinary people doing everyday things shift the parts of the brain that are active. Sometimes people appear to use one part or another when it isn’t the best: they’re not in their right mind. The lawyer who cannot appreciate art, the ceramicist who has poor verbal skills - both are examples of people who are stuck in one mode or another of brain function.*
> *However, in a later experiment, Charles Swencionis and I found that people can change their patterns of brain activation. We recorded brain activity while people mentally rotated objects. This operation normally involved the right*

> *hemisphere. When asked to do the task analytically, by counting the boxes, subjects by and large "switched over" to their left hemisphere. People can use their hemispheres differently in problem solving at will.*
>
> *(Ornstein 1991, p.136)*

The work of Edwards (1979, 1986) in teaching people to draw more effectively by accessing the appropriate processing mode provides another example of the evidence supporting this view. Herrmann's work on enhancing creativity (Herrmann 1989) and my own research work with the meaningful learning of chemistry (Atkin 1977) are just some of the examples of the application of this notion to improving thinking, learning, creating, planning, problem solving and many other areas of human endeavour. The anecdotal evidence from teachers with whom I have worked in workshops on *Teaching for Effective Learning* also provides considerable 'soft' evidence for the power of the approach.

The approach entails identifying the processes which effective learners, thinkers, problem solvers or performers use (naturally and often unconsciously) and helping others use these processes for the particular tasks. It's a matter of identifying and teaching the use of the most effective strategies. Thus, an understanding of thinking processes and preferred thinking styles, gives us a much more explicit understanding of individual differences and what can be done to maximise our potential. Not only is intelligence not one thing, it is not fixed - we can learn to be more intelligent. If an individual already shows a certain flexibility in his thinking style, his performance can be improved by his being more conscious of what constitutes appropriate processing for the task and by employing deliberate strategies to enhance this processing. Understanding preferred styles of processing and recognising when and how to consciously control thinking and processing is a large part of what learning to learn is all about. This understanding adds another 'string' to the metacognitive 'bow'.

What light does this model throw on a constructivist view of learning?

## *Integral Learning* - A model of the mental processes required for learning with meaning

How can Hermmann's model of whole brain processing be integrated with our earlier discussions about the nature of learning? How can it be integrated with Kolb's experiential model, with a constructivist view of learning?

People's word responses to the meaning of the term learning reported earlier, bear a distinct resemblance to the four main processing modes of the brain:

1. gaining information, facts - PROPOSITIONAL KNOWLEDGE such as 'the earth is round' - *A quadrant processing*
2. making connections, grasping the pattern,insight - UNDERSTANDING such as seeing a model - the globe of the world, or even more powerfully, seeing a photo of the earth from outer space- *D quadrant processing*
3. being able to do, applying PROCEDURAL KNOWLEDGE such as remembering the sequence of a trip from Sydney to London or planning a world trip- *B quadrant processing*
4. feelings, emotions PERSONAL, EMOTIONAL KNOWLEDGE from experiences of travelling the world- *C quadrant processing*

In workshops I have engaged participants in solving the following puzzle. The discussion which follows will probably hold more meaning for you if you first take a moment or two to solve the puzzle yourself. Feel free to solve the puzzle in any way you wish - act it out, draw pictures, solve it musically or solve it mathematically. Allow yourself to solve the puzzle which ever way(s) comes naturally to you.

*A man and a woman are standing side by side with their weight on their right feet.*
*They begin walking so that each steps out on his or her left foot.*
*The woman takes three steps for each two steps of the man.*
*How many steps does the man take before they step off together again with their left feet?*

*Adapted from: McKim 1980*

Typically, in a group of people, there will be demonstrations of different approaches to solving the problem. Some people will solve the problem by getting up and acting it out - by 'doing' it. Some will make a mental image of what is going on and will most likely support their thinking by drawing an image on paper. Those musically inclined are seen tapping out two:four time and three:four time simultaneously on different knees. While others will use the concepts of ratio and odd and even numbers - mathematical thinking - to solve the problem. Often, having got an answer to the problem through one mode of thinking, people will verify their thinking by switching to a different mode. Although individuals show preferences for the way in which they attack the problem it is likely that all individuals employ a combination of different processing modes in an iterating fashion. [The answer, by the way, is that the man will have taken four steps prior to them stepping off together again with their left feet].

At one level the different processing methods of solving the problem correlate with the learning process described by Kolb (in Claxton & Murrell, 1987) - experiencing, reflecting, constructing mental maps of experience and active experimentation. The power of Herrmann's whole brain model is that it makes those general processes more explicit. The different methods of finding a solution to the puzzle above illustrate the employment of different processing modes.

1. *acting out* - experiencing/doing - Limbic mode, *B* and *C quadrant* processing in Herrmann's model
2. *drawing or invoking mental images , tapping out time on your knees*- reflection on experience to "grasp in the mind's eye", to capture the pattern- *D quadrant* processing
3. *employing concepts of ratio , lowest common multiple, odd an even numbers* - use of language, rules, principles, laws, formulae to represent experience and meaning - *A quadrant* processing
4. *application of rules, principles , patterns to specific examples* - iteration between styles of processing.

Independently, these are all valid and useful modes of thought. Played as an orchestra of integrated thinking modes they present an extremely powerful way of knowing and responding to our world. Unfortunately, in most educational institutions in the Western world it is only logical, analytical, fact based thinking - *A* quadrant processing - which is held in high esteem. Yet, it appears that regardless of preferred processing style, learning occurs most readily when whole brain processing is engaged. The general progression of the process of learning moves from experience to reflection on experience so that a "pattern" or framework allows the learner to grasp the meaning in the 'mind's eye' and finally learning moves on to a facility to use language, rules, laws, principles for accuracy and efficiency in thinking, doing and further learning. The language is a symbol for what's grasped in the 'mind's eye' which in turn is a mental representation of what has been experienced. The nature of the thinking mode [1-4 above] a person will engage in solving the puzzle will depend on their preferred processing style but it will also depend on where their learning is about ratio and patterns which can be expressed as a ratio, on the spiral of progression from 1 to 4 and back again. Take a specific example of a learning situation. Imagine someone who has had considerable experience in working with fabrics. In learning about the suitability of particular fabrics for various clothing designs, he could enter the learning process by "grasping in the mind's eye" the relationships between the nature of fabrics and their likely suitability for aspects of body movement, fall, look etc. Someone with less experience in working with fabrics is likely to respond by exploring the characteristics of fabrics - by engaging limbic mode processing and leading on to "grasping in the mind's eye" the relationship between types of fabric and suitability for particular garments. My point is that if the learner engages in actively working with fabric, the learning will be more meaningful than if he simply gathered information others have recorded about the nature of fabrics. There is a danger in expressing the general progression of the learning process in terms of 'steps'. The image is not one of a simple hierarchy - rather it is of a spiralling, iterative nature.

The model of *Integral Learning* I propose is presented in image form in Figure 7. It is consistent with a constructivist model of learning; it is essentially an experiential model of learning, and it is a 'whole brain' model of learning. So why another name? My way of knowing about human learning was not fully captured by any of the other models alone. A synthesis of the ways of knowing each model represents comes closest to representing my own current understanding about learning. Learning which involves the integration of our experiences, our feelings, our reflections, and our actions is *integral* to being human.

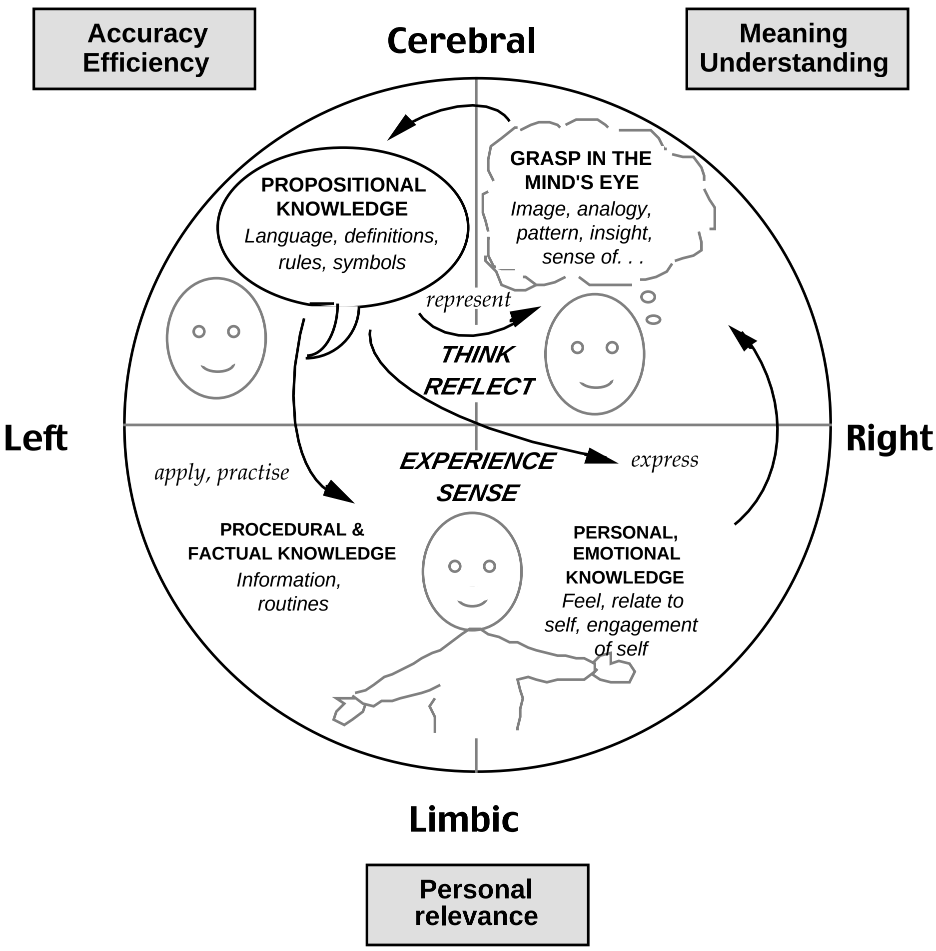



**Figure 7** **Integral Learning - A whole brain model of learning**

Why then is the nature of the learning different for individuals in the same classroom? Why do some 'learn meaningfully in spite of the teacher', while others resort to rote memorising? It seems to me that it has to do with preferred processing styles and with whether or not the process of reflection on experience has been 'nudged' by the teacher or by personal interest and motivation. Often learners have already had experiences which are fundamental to learning but have not engaged in a process of conscious reflection which enables them to build up their 'mental map' of the experience. Their 'knowing' from the experience tends to be confined to a 'sense of' or an 'intuition about'. Their knowing from the classroom has been in the tradition where teaching presents a completed thought. Thought is presented as fact. Such teaching short circuits learning.

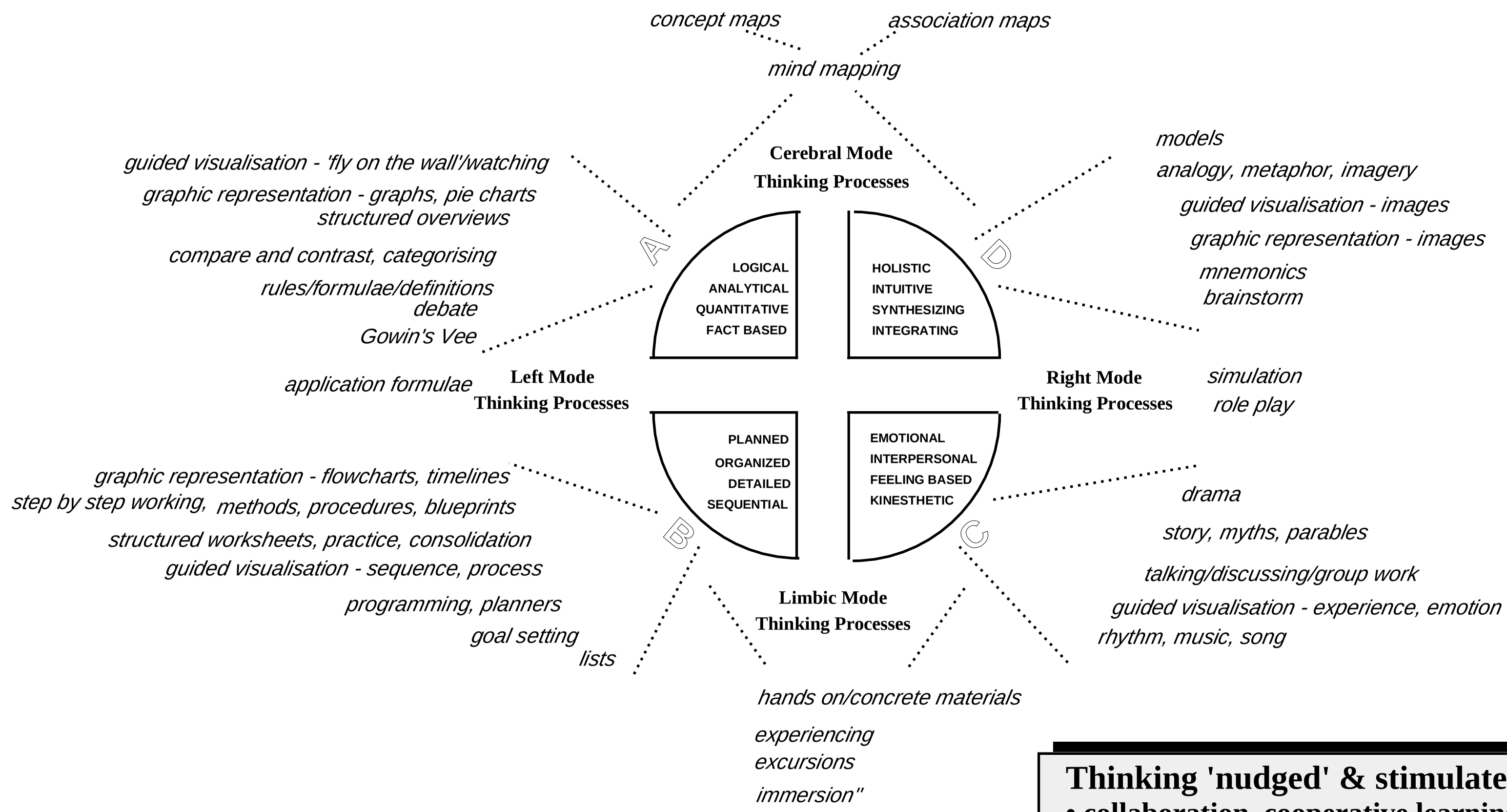
What of effective learners? Do they necessarily follow the learning process outlined? My proposal is that the most effective learners, learners who have internalised what they have learned and can transfer their learning to new situations, have generally engaged whole brain processing in the learning process. The right brain processing mode is non-verbal and sometimes relatively subconscious and it is quite possible that individuals who are learning effectively are not aware that what is going on inside their minds is not necessarily going on in the minds of other learners. My claim is that when effective learners are exposed to new information presented in *A* quadrant mode, they ask "What is that like? What is an analogy/ image/pattern that applies? What is an example of this? How does this relate to other examples/situations I've experienced? Now let me see. . " They essentially unpack the language into *D* and *B* and *C* quadrant representations. They reverse the direction of the process of the model of integral learning.

To be effective for all learners, teaching needs to ensure that learners iterate around the whole brain processing model. Learning experiences need to be designed deliberately to engage personal relevance. Reflection processes which help the learner make connections and develop patterns and relationships must be developed in parallel with the language and symbols which can be used to represent them. Opportunities must be provided for the learners to express their learning in a variety of modes and to actively try out their 'mental maps' in their own world.

In Figure 8, I have mapped some teaching and learning strategies onto Herrmann's whole brain model to indicate which strategies promote processing in each of the four main modes. Most of these strategies are not 'new' to teachers. What is new is the understanding which can guide the deliberate use of these strategies to stimulate all of our ways of knowing to ensure integral learning. Perhaps, then, we will be able to broaden our educational focus from 'knowing that' to the more richly human endeavour of making meaning from our experiences - meaning which includes the ways of knowing of storytellers and artists.

Teaching has often been labelled as an art. It has been claimed that 'good teachers are born not made'. I have little doubt that 'born' teachers will recognise their artistry in the framework of thinking for learning I have presented here. In the current generation of teachers I believe there are also many teachers who have 'unlearned' how to learn, who have 'unlearned' how to teach. The challenge to re-learn is both exciting and daunting. I hope that the model of thinking for learning presented here will serve to stimulate all of us to design learning experiences for our students which have a focus on thinking to learn as well as on learning to think.

# *Strategies to Promote Integral Learning*




**Thinking 'nudged' & stimulated by:**
- **collaboration, cooperative learning**
- **questioning**
- **posing problems, challenges**
- **design process**
- **games**
- **predict -observe-explain**

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