ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No.3, May 2013

A META-THEORY OF A COGNITIVE MODEL OF LEARNING PROCESS BASED ON TRANS-MULTIPLE ABILITIES

Noel Kok Hwee Chia[1], Norman Kiak Nam Kee[2]

National Institute of Education, Nanyang Technological University
SINGAPORE.

[1] kokhwee.chia@nie.edu.sg, [2] kiaknam.kee@nie.edu.sg

ABSTRACT

Learning is a complex entity that involves not only the cognitive faculties such as thinking, reasoning and judgment, but also elicits conative and affective responses. In this paper, the authors examined three cognitive models of the learning process – the modal model (Atkinson & Shiffrin, 1971), the process model (Sternberg, 1969) and the interactive model (Neisser, 1976) – and put forth their meta-theoretical model based on trans-multiple abilities (TMA) to explain the process of learning. The meta-theory of the TMA model of learning process takes into consideration of three mental potentials – cognition, conation and affect – that form the core components of the mind (Poland, 1974) and their interactions joined by sensation within the mental domains of episodic, semantic and procedural memories. It also introduces the developmental range of learning from peri-level (at concrete level) via rebus level to apo-level (at abstract level) from the learner's sensory self. In addition, the authors explained how the TMA model works with an illustration in learning/teaching basic numeracy skills.

Keywords: Affect, Cognition, Conation, Learning process, Sensation

INTRODUCTION

Learning can be described in three ways: firstly, it is an act or experience of a person who learns; secondly, it refers to the knowledge or skills acquired by instruction or study; and thirdly, it can also refer to the modification of a behavioral tendency by experience. Birkenholz (1999) has defined learning as a change in behavior that is demonstrated by those (e.g., curriculum planners, teachers, tutors and/or trainers) implementing knowledge, skills, or practices derived from education, training and/or professional development. The change is developmentally progressive. This means that foundation knowledge and lower-level skills are essential for every learner to develop advanced knowledge and higher-level skills, efficient thinking and concept formation (Feuerstein and Lewin-Benham, 2012).

The ability to learn is possessed, not only, by the human species alone. Animals (e.g., chimpanzees, dolphins, parrots and sharks), and to some extent, machines (e.g., robots and Interbots), can learn, too. Learning can be either a conscious or subconscious process based on experience and is triggered by extrinsic stimuli (i.e., sensory inputs) or intrinsic motivators (e.g., an innate desire to find out) can result in changes in a learner. Such changes can be relatively permanent. Learning can happen spontaneously (i.e., learning is "caught") especially in young children during the window period (known also as critical period) between 2 and 6 years of age when the mind of a young child seems to be able to absorb whatever he/she is acquiring. This period is also termed as *autogogy*, which literally means *self-leading* (Chia, 2011a). Beyond the critical period, as the child enters into formal education, learning becomes deliberate (i.e., learning is "taught") and has to be appropriately imparted via pedagogical instruction according to the learner's developmental needs. Hence, learning does not occur all at one go but it builds upon as well as is shaped by what the learner already knows.

To sum up briefly, learning is a process of acquiring new knowledge or modifying current knowledge as well as behaviors, skills values or preferences by synthesizing or analyzing information. At the heart of learning is the learner's mind: the complex entity of cognitive faculties that enables consciousness, perception, thinking, learning, reasoning and judgment. Moreover, the mind can be better understood in terms of three forms of memories – sensory, short-term and long-term – that are involved in the process of learning. The sensory memory involves registering of sensory stimulus information via three sensory channels: visual, auditory and haptic processes. These sensory inputs are then channeled into the executive function centre (EFC) in the short-term memory (STM). The EFC, in turn, channels the visual sensory information to the visual STM (also known as visual spatial sketch pad) and the auditory sensory information to the auditory STM (also known as phonological loop). The new information is then schema-matched with previous information retrieved from the mental storage in the long-term memory (LTM), which can be further divided into three mental domains: episodic, procedural and semantic. The schemata stored in these three mental domains are mental images, models or concepts, and Perkins (1992) defined them as "a holistic, highly integrated kind of knowledge. It is any unified, overarching mental representation that helps us work with a topic or subject" (p.80). Schemata do not resemble real objects or little pictures in the brains, but "they are neurons that trigger responses in other neurons" (Feuerstein and Lewin-Benham, 2012, p.72). However, the process of learning is not complete without taking into consideration the learning responses in terms of conation, affect or the mix of both.

THE LEARNING MIND

The term *mind* normally connotes the union of philosophy and psychology but it also reveals two conflicting schools of thoughts (Reber et al., 2009). On the one hand, the philosophical concept of mind focuses on the nature of the mind, mental episodes, mental functions, mental properties, consciousness and its relationship to the brain (Kim, 1995). This concept of mind can be divided further into two more schools of thoughts: dualism and monism (see Chia and Tan, 2011, for detail) but it is not within the scope of this paper to delve further on this issue. On the other hand, the psychological concept of mind concerns three aspects: the first being the intellect, i.e., the rational thought functions of the mind – a generic term covering the cognitive processes as a whole (Reber et al., 2009), the second is the mental awareness, and the third is mental sense (see Chia and Tan, 2011, for detail).

According to Chaplin (1985), the term *mind* is defined as "the totality of conscious experiences the totality of enduring structures employed to account for conscious experience and psychological activities" (p.282).

When the word *learning* is added to the term *mind*, the focus is how a learner's mind works in the process of learning. From the Triple-T model of learning, Chia and Kee (2013) have identified three key T-components in the model of learning: (1) *episTēmē* ("what" of learning); (2) *Techné* ("how" of learning); and (3) *Telos* ("why" of learning). Together, they are triangulated to form the Triple-T model of learning (see Figure 1) which is essential for educators to know and understand how they can go about to approach learning from the pedagogical perspective (see Chia and Kee, 2013, for detail). Each of these components is briefly described below:

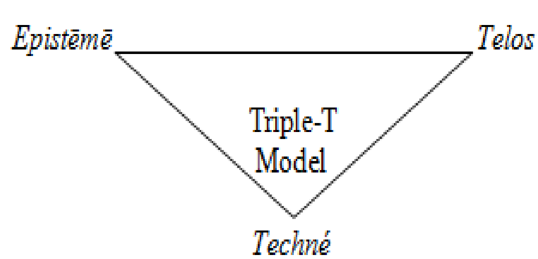

Figure 1. Triple-T model of learning (Chia and Kee, 2013)

Epistēmē

The first term *techné*, a Greek derivative for knowledge or "to know", refers to the "what of learning" or the content knowledge and skills needed to be taught to or learnt. "It resembles *techné* in the implication of knowledge of principles, although *techné* differs from *epistēmē* in that its intent is making or doing, as opposed to 'disinterested understanding'." (Chia and Kee, 2013, p.422-423).

Telos

The second term *telos*, a Greek derivative, refers to the end term of a goal-directed learning process or the final cause. It is the "why of learning" or the rationale or reasons behind the choice of content knowledge and skills selected to be included in the curriculum design (Chia and Kee, 2013).

Techné

The third and last term *techné*, a Greek derivative, refers to how an object or objective in learning is accomplished. It also refers to the "how of learning" (Chia and Kee, 2013) and it includes study skills and techniques.

Triangulating *episteme, telos* and *techne* illustrates the importance of what to learn, why the need to learn, and how to learn a given subject of study. To a learner, he/she must know what he/she is learning in terms of content knowledge and skills relevant to that particular subject of study and also to understand what is learnt or being taught. Equally important is to know the rationale behind learning the subject as such awareness helps to motivate a learner to perform well in his/her studies. Finally, the learner needs to know how to learn the subject matter and this involves study skills (e.g., note-taking and summarizing key points).

The Three Domains of Mental Potentials of the Mind: Cognition, Conation and Affect

Several studies (e.g., Chia et al., 2010; Parkison, 2010; Poland, 1974; Reeves, 2006) have identified three main domains of mental potentials that are essential to the performance in learning: cognition (Bloom et al, 1956), conation (Riggs and Gholar, 2009) and affect (Krathwol et al., 1964). There is a specific typology of learning and behavioral skills and abilities (see Chia, 2012, and Poland, 1974, for detail) in each of these three mental potentials. They are briefly discussed below.

Cognition

Cognition is the act of apprehending or ability to grasp or lay hold of mentally. According Poland (1974), cognition "has to do with intellect, the use of the mind, whether it is logical or illogical. Thinking is not directly observable, although an individual human may experience within himself or herself what is called thinking" (p.130). Bloom et al. (1956) identified six levels of skills in the cognitive potential beginning with knowledge and progressing upward through understanding, application, analysis, synthesis, and ending with evaluation. Recently, Anderson et al. (2001) have revised the six levels of cognition: remembering, understanding, applying, analyzing, evaluating, and creating.

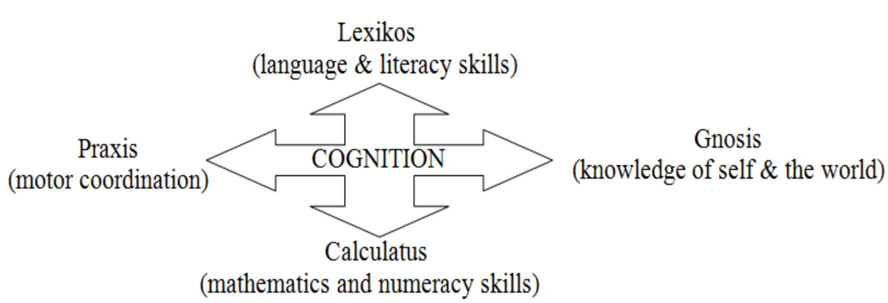

Figure 2. The four mental abilities of cognition

Chia (2010a, 2010b) divided cognition into four mental abilities: (1) linguistic ability (also termed as *lexikos*), (2) mathematical ability (also termed as *calculates*), (3) motor coordination ability (also termed as *praxis*), and (4) ability to know self in response to somatic needs as well as to interact with the environment in order to know the world at large (also termed as *gnosis*). Learning as a cognitive process involves all the four mental abilities (see Figure 2). This aspect will be elaborated further in the later part of this paper.

Conation

Conation is that faculty of desiring or willing. It is a term that "has been ignored by most educators in academe and at the same time, it is also being confused with psycho-motion. Psycho-motion is associated with skilled behavior; conation, with action" (Chia and Kee, 2013, p.34). According to Poland (1974), conation is referred to the inherited potential for action, which is an observable behavior (e.g., dancing, laughing and talking). For instance, a toddler is able to move, awkwardly and ineptly at first, but with a growing and developing smoothness and skill as the years pass, his walking becomes more stable and steady. "Actions are sometimes referred to as conative behaviors, which can include a great variety of automatic behaviors such as walking and habits such as smoking or repeatedly wiggling a foot while sitting in a chair" (Poland, 1974, p.13).

There are six levels of skills listed in the conative potential: belief, courage, energy, commitment, conviction, and change (see Riggs and Giholar, 2009, for detail). Since conation creates changes within a person, Parkison (2010) has simplified the conative framework into four levels of skills: personal discovery, transition, transformation, and transcendence.

Chia (2010a, 2010b) divided conation further into three parts: (1) self-awareness, i.e., consciousness or cognizance of self in relation to oneself and/or others, (2) self-regulation, i.e., the ability of self to adjust and govern one's activities, and (3) self-will – also known as volition – refers to an exercise of the will by an individual, and it constitutes the main component of conation. Learning as a conative process involves the will or perseverance to learn and may include interest and motivation to do so.

Affect

Affect refers to an emotion or emotional state that is associated with or causes an idea or an action. According to Poland (1974), affect concerns feeling that is the genetically based potential (also known as affective behavior). "[I]t has to do with a wide variety of behavior ranging from sadness and depression through happiness and ecstatic joy. Feelings are not directly observable, although they often may be expressed through action" (Poland, 1974, p.13).

Krathwohl et al. (1964) have listed five levels of affective potential: receiving, responding, valuing, organization, and organization by value. These affective levels are based on the principle of internalization, which refers to "the process whereby a person's affect toward an object passes from a general awareness level to a point where the affect is internalized and consistently guides or controls the person's behavior" (Seels and Glasgow, 1990, p.28).

Chia (2010a, 2010b) divided affect into three parts: the first two parts are shared with conation, i.e., self-awareness and self-regulation as mentioned in conation; and the third part is self-esteem (also referred to as self-worth or self-image), which is described as a global evaluative dimension of the self. Learning as an affective process involves feelings, emotions and moods. For example, a learner performs better if he/she is in a happy mood.

Triangulation of Cognition, Conation and Affect

Figure 3 illustrates the triangulation of cognition, conation and affect. It shows how each can affect the other two. That means how a learner thinks or perceives can affect how he/she feels and how he/she reacts in response to the external factors. For example, a learner is orally praised by his/her teacher for a piece of written assignment well done, the learner receives the verbal message (sensation) and he/she will be reinforced to know that he/she has understood the lesson well and attain the mastery of the skill taught (cognition). Moreover, the learner will feel happy and become more motivated to want to learn (affect), and will smile (conation) in response to the teacher's verbal praise (sensory stimulus).

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No.3, May 2013

However, the model is incomplete without sensation or sensory domain, which links all the other three domains together. As in the example illustrated above, the reception of the verbal message (i.e., oral praise) is sensory and the sensation (i.e., sensory processing) plays an important role in receiving the input, registering it, managing it and finally, responding appropriately to it.

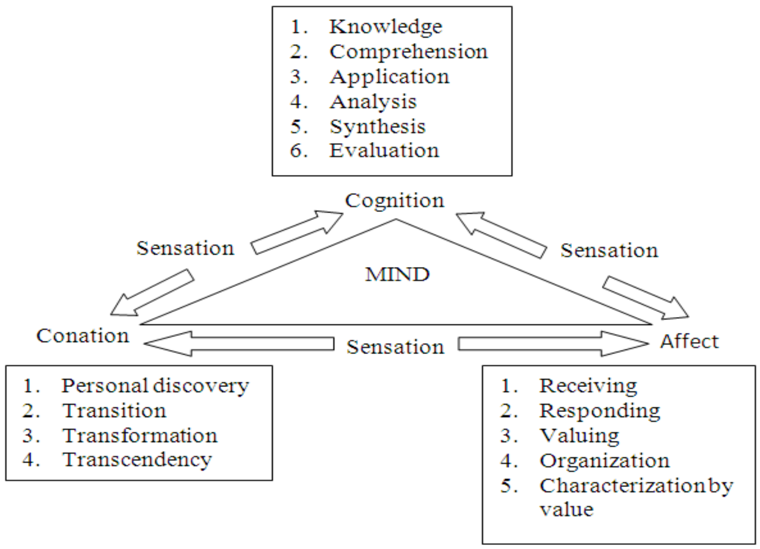

Figure 3. Triangulation of cognition, conation and affect

The Connecting Sub-Potential of the Mind: Sensation

Sensation consists of two main sensory systems: interoceptive and exteroceptive senses. According to Chia (2010b), the interoceptive sensory system is made up of vestibule and proprioception that can impact on the exteroceptive sensory system which consists of five sensory organs: eyes (visual), ears (auditory), skin (haptic), nose (olfactory) and tongue (gustatory).

Sensation is the first among the processing domains to register any incoming sensory data such as a flickering florescent tube, the sound made by someone blowing a trumpet, and the smell of smoke coming out of an open window of a burning house. It is sensation that channels sensory information to the appropriate mental domains, i.e., cognition, conation and/or affect. For instance, in smelling something burning, an individual's cognition will be triggered to think of fire. His conation will be alerted and the individual starts looking around for some signs of smoke or listening to some crackling noise made by fire burning something. His affect is feeling about something not right that is happening. The combination of both conation and affect forms what is known as *orexis*, a Greek term, which refers to the appetitive aspect of an act in order to satisfy some psycho-somatic desire (Chia and Kee, 2013) such as curiosity, love or sex.

Sensation linking conation and affect involves self-awareness and self-regulation (Chia, 2011b). Self-awareness through sensation heightens an individual's sensibility (to think/reflect before speaking/acting), sensitivity (to feel for or empathize with others), and sense-ability, which, according to Helmering (1999), is "the ability to observe your thoughts, your feelings, and your behavior" (p.1-2) and it lets you "see how your thinking creates many of your feelings and how your thoughts and feelings influence your behavior" (Helmering, 1999, p.2). Sense-ability makes an individual "aware of others and provides real-time feedback as to how one's feelings and behavior affect others: inhibiting or inviting closeness, empathy, tolerance, emotional intimacy, interconnectedness, and oneness" (Helmering, 1999, p.2).

Self-regulation through sensation concerns an individual's ability to modulate his/her behavior in terms of registering the sensory information that comes from stimuli outside, managing it and responding appropriately to the stimulus. The individual can be easily irritated by too much sensory input (e.g., loud noise and strong stench) resulting in hyper-responsivity or shows no response to it at all resulting in hypo-responsivity.

Learning as a sensory process involves using sensory organs such as eyes to see and ears to listen. For instance, a student with visual impairment will not be able to see but can still use touch to learn through Braille. In another instance, a student with hearing impairment will not be able to hear and talk but can use gestures and hand signals to communicate.

THE COGNITIVE MODELS OF LEARNING PROCESS

For many decades, in the field of cognitive research on learning process, the meta-theory (i.e., a set of assumptions and guiding principles) has been the information-processing approach. According to Ashcraft and Radvansky (2010), "[T]his broadly defined approach described cognition as the coordinated operation of active mental processes within a multi-component memory system" (p.30). Originally, the information processing has a narrow connotation that emphasized a one-by-one linear sequence of mental operations in which one operation was assumed to complete before another could commence.

The authors of this paper have selected three cognitive models of learning process for a brief discussion before they introduce their proposed model. They are the Atkinson and Shiffrin modal model, the Sternberg process model and the Neisser interactive model. Each of the three models is briefly described below.

The Modal Model of Learning Process

The modal model of human learning process came about in the early 1970s (Ashcraft & Radvansky, 2010). One of the examples of this model that has received widespread acceptance is the one proposed by Atkinson and Shiffrin (1971). Briefly, the model of this information-processing approach shows the flow of information through the different memories, i.e., sensory memory (SM), short-term memory (STM) and long-term memory (LTM), in the memory system (see Figure 4).
sense of the information that is being processed.

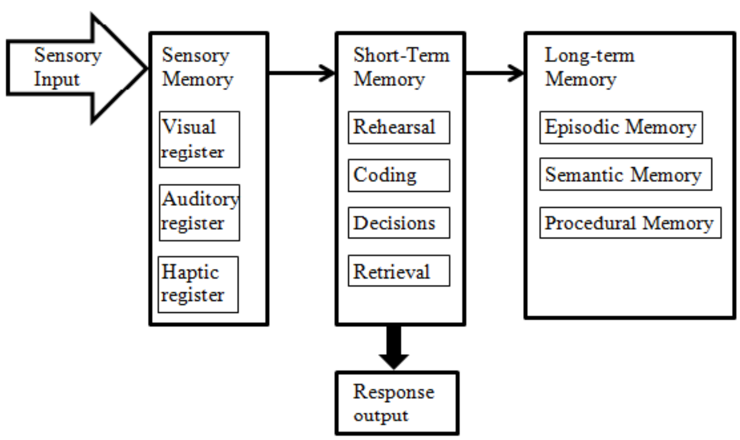

Figure 4. The modal model of learning process

In this modal model, sensory input comes from the environmental stimuli and flows into the SM where the sensory registers (visual, auditory, haptic) will pick the information up. Some of the information will be selected and sent to the STM where the visual-spatial sketch-pad (VSSP) and the phonological loop (PL) will receive visual and auditory data respectively. These sensory mental data

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No.3, May 2013

will be stored temporarily in the STM while relevant information that is stored in the LTM will be searched out and retrieved from storage to be schema-matched with the new information in the STM. Whatever information that cannot be schema-matched will be treated as new data that will be made more sense by association with old or familiar data. In other words, the current knowledge is extended when new information is acquired. It is in the STM that many mental activities such as coding and decision making of information take place.

The mental storage in the LTM can be divided further into three different memories (or mental storage compartments) with each for different type of information. They are episodic, semantic and procedural memories.

Episodic Memory

The episodic memory is an explicit mental collection of past personal experiences that happened at a specific time and space. It stores autobiographical events (e.g., times, places, associated emotions, and other contextual knowledge) that can be explicitly stated. An example is the recall of one's birthday party celebration. The importance of episodic memory in learning is that it can provide background information and previous experiences needed when a student is asked to write and share about his/her experience (e.g., a visit to the zoo).

Semantic Memory

The semantic memory is a conscious recollection of meanings, understandings and concept-based knowledge (including factual and general knowledge about the world). It gives meaning to otherwise meaningless words, symbols, equations and sentences. It does not involve memory of a specific event. Together with the episodic memory, it forms the domain of explicit or declarative memory. In learning, semantic memory plays a very important role in helping the learner to know and understand what he/she is learning. For example, *auding* – the process of listening to spoken words to get their meaning – requires input from the semantic memory. Another example is the understanding of what is read depends on the input from semantic memory known as *rauding*.

Procedural Memory

The procedural memory is an implicit mental collection of actions of many different performances and it guides the processes of performance mostly below the level of conscious awareness. Procedural memories can be automatically retrieved and utilized to execute a certain task (e.g., driving a car, riding a horse, swimming in a pool) as and when needed without the need for conscious regulation or attention. The implicit procedural learning is important to the development of many motor skills (e.g., the traditional dance movements as in *Sri-Nuan*, a typical dance of Central Thailand) or mechanical operations such as recitation of times tables.

The Process Model of Learning Process

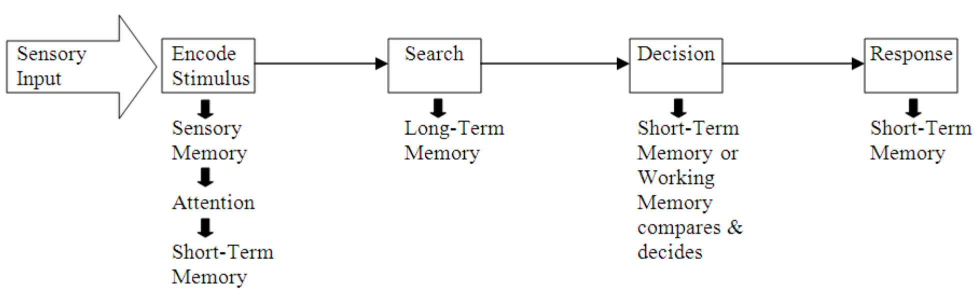

Figure 5. The process model of learning process

Another simpler cognitive model of learning process is the process model. It is based on the hypothesis of "specific mental processes that take place when a particular task is performed" (Ashcraft and Radvansky, 2010, p.39). One good example is the general process model adapted from Sternberg (1969) as illustrated in Figure 5 below. The first phase of information processing involves the encoding of sensory input, which can be visual, auditory or haptic, and then transferring it to the STM. While the stimulus is in the STM, some kind of search through the LTM begins. The outcome of the search is returned to the STM and forms the basis for the individual's decision before a response output (e.g., answering a question, reading a word aloud) is made by the individual.

The Interactive Model of Learning Process

In the third cognitive model of learning process, there is a slight difference from the two previous models. The three memory domains – SM, STM and LTM – have been re-arranged into a triangle to show that all three affect each other (see Figure 6). The mechanism of attention is added to the diagram to show that it has an explicit impact throughout the process of learning. This model is adapted from Neisser's (1976) notion of the perceptual cycle.

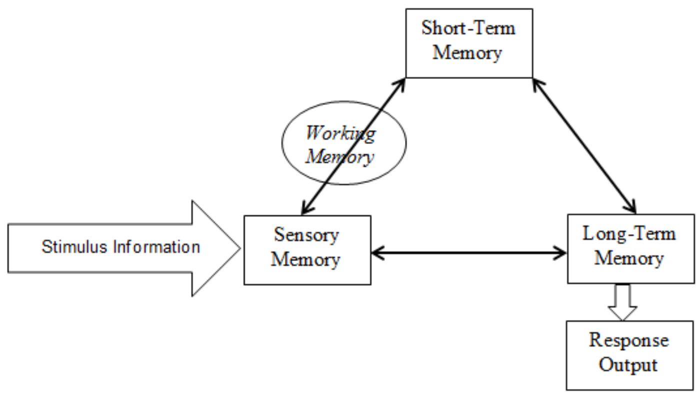

Figure 6. Interactive Model of Learning Process

Brain studies (e.g., Barrett and Kurzhan, 2006; Fodor, 1983) have shown that different cognitive components (memories) and processes are operating all the time and at the same time, too. There is neurological evidence to show that different cortical regions of the brain are more specialized for different processing tasks (e.g., encoding and regulating thoughts) (Anderson et al., 2007).

The Proposed Trans-Multiple Abilities (TMA) Model of Learning Process

In view of the three cognitive models of learning process briefly described above in addition to the current understanding of the learning mind, the following cognitive model of learning process based on trans-multiple abilities (TMA) is created. The TMA model of learning process is based on the following meta-theoretical assumptions:

1. Learning can be "caught" (spontaneous) or "taught" (deliberate).
2. Learning is a *mind* process.
3. Learning is not a linear sequential process.
4. Learning is a trans-multi-faceted process involving cognition, conation and affect that are interlinked by sensation.
5. Learning as a process can operate at the conscious or below the conscious level at all the time and at the same time, too.
6. Learning involves interactive operations among the three memories: sensory memory, short-term or working memory and long-term memory.
7. Learning process can be explicit (involving episodic and semantic memories) or implicit (involving procedural memory).

Any normal child can learn and early learning is spontaneous during the critical period of autogogy. The brain is developing very rapidly during that period and so is the learning mind that has been

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No.3, May 2013

already described at the beginning. In the post-critical period, learning becomes deliberate and it so happens when the child enters primary school for formal education.

Any normal individual can be a learner and the learner is a Sensory Self, i.e., a sensory being who is fully aware of his/her existence and the surrounding context he/she is in. The Sensory Self can communicate/socialize (*Lexikos*) and compute/reason (*Calculatus*) as well as coordinate to perform (*Praxis*) and make sense to himself/herself through meaningful association with the world at large (*Gnosis*). These four mental domains of the Sensory Self – *Lexikos*, *Calculatus*, *Praxis* and *Gnosis* – are not independent of each other but are interdependently connected by senses (sensation). Each of them can impact on the others (see Figure 7) and learning can take place at any time and space in any or more of the four domains or even between them. For this reason, learning is not a linear sequential but trans-multi-faceted process involving the four domains as well as sensation.

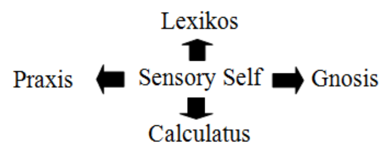

Figure 7. Learner as a sensory self

Briefly, *Lexikos* is concerned about learning language and literacy skills essential for thinking and thought development. As mentioned earlier, it concerns linguistic ability. *Calculatus* is concerned more about mathematics and numeracy skills essential for logical reasoning and problem solving. It concerns mathematical ability. In *Praxis*, a young learner can acquire knowledge and skills through imitation from others and can continue to do so through role learning and proper sensory perceptuo-motor coordination. *Praxis* concerns motor coordination ability. Such learning can become a mechanical procedure that functions below the conscious level. Finally, there is *Gnosis*, which has been described earlier. It functions at conscious level and it concerns knowing self and the world surrounding self. It can be further divided into two parts. The first is known as *autognosis*, i.e., self-awareness. This discovery of oneself forms the initial step to acquiring knowledge from beyond the Sensory Self. The second is known as *ecognosis*, i.e., knowing and understanding the world at large beyond the Sensory Self.

Interestingly, the *Praxis* falls neatly into the procedural memory; the *Gnosis*, the semantic memory. Both procedural and semantic memories also include *Lexikos* and *Calculatus*. Between *Praxis* and *Gnosis* overlapping *Lexikos* and *Calculatus* is the experiential or episodic memory. Figure 8 shows the areas involving the three memories – green box = experiential/episodic memory; blue box = the procedural memory; and red box = semantic memory – and the four mental domains fall within two or three of the memories. For example, *Praxis* involves procedural and experiential/episodic memories while *Gnosis* involves semantic and experiential/episodic memories. However, *Lexikos* and *Calculatus* involve all three memories.

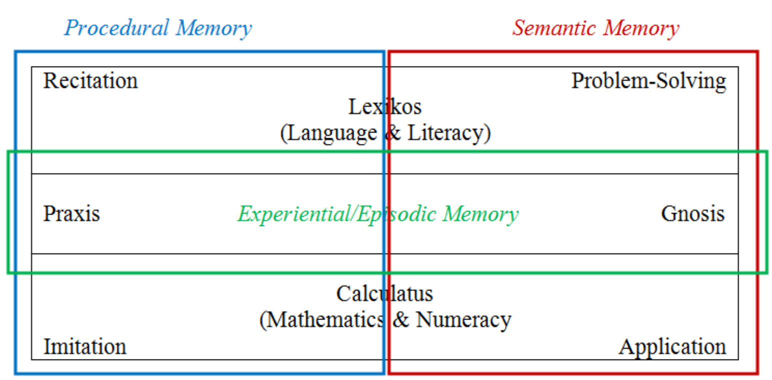

Figure 8. Incorporating the memories

Here is one illustration to explain how learning works in this model. Say, a child is taught counting from one to nine. He learns to recognize the numerals[††††††††††††††††††††] by their respective numbers[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡]. He is able to count, sequence, reproduce them by writing, and match them with the correct quantities. Counting, sequencing and reproducing the numerals can be acquired through rote learning and it depends very much on procedural memory. When the child begins putting the concept into real life application, e.g., buying four apples and is able to pick exactly four apples, he/she has understood the concept of "fourness".

Procedural learning (or rote learning) can become meaningful learning if it is eventually transitioned from *Praxis* (Procedural Memory) to *Gnosis* (Semantic Memory), from experiential practice (e.g., adding figures in $ and ¢ given in practice exercises) to episodic know-how (e.g., visiting a supermarket to shop for things needed and then paying for them in correct $ and ¢). For instance, after having learnt how to add two or more single-digit numbers mechanically through many practice exercises (*Calculatus-Praxis*), a learner can now apply the arithmetic operation in a real life situation such as adding the prices of items to be purchased before making payment at the cashier counter (*Calculatus-Gnosis*). This is transition from *Praxis* to *Gnosis* (or from mechanical imitation to meaningful application).

However, learning language or mathematics (literacy or numeracy) can take place through many mechanical practices or in real life application. It can be divided into six developmental levels of learning ranging from Concrete (realia to manipulatives) via Rebus (photographs to drawings or illustrations) to Abstract (symbols to ideas or concepts).

Figure 9 shows the progression of initial learning that starts from something closer (termed as *peri*-level; *peri* means "near") to the Sensory Self at the Concrete-Realia (C1) level to Abstract-Idea/Concept (A2) level, which is further away from Sensory Self (termed as *apo*-level; *apo* means "far"). For a learner, who lacks the confidence of what he/she has learnt or unsure of the concept learnt, he/she tends to fall back to the foundation knowledge or lower-level (or peri-level) skill which is more concrete than representational (rebus) or abstract (higher-level or apo-level skills or advanced knowledge). The developmental range of learning can be expressed in the following sequence: C1=Concrete-Realia, C2=Concrete-Manipulatives, R1=Rebus-Photograph, R2=Rebus-Drawings, A1=Abstract-Symbols, and A2=Abstract-Ideas.

Here is an example to illustrate how the developmental range of learning works in learning or teaching basic numeracy skills:

C1=Concrete-Realia: Real cookies are used to teach counting from 1 to 9. If the child can count the number of cookies correctly, these cookies can be used as a form of reward. However, it is important to remember the target learning objective and not to confuse the child between counting 1-9 and cookies as reward.
C2=Concrete-Manipulatives: Instead of using cookies now, plastic counters are used in counting 1 to 9.
R1=Rebus-Photographs: Photographs of different amounts of cookies or other items are shown to the learner to perform the counting task.
R2=Rebus-Drawings: Instead of using photographs, illustrations or drawings are used in the counting activity.
A1=Abstract-Symbols: Numerals or figures (e.g., 1, 2, 3, 4, 5, 6, 7, 8 and 9) are used in the counting task. They substitute all the realia, manipulatives, photographs and drawings of things used previously in counting.

[††††††††††††††††††††] A numeral is any name or symbol for a specific number (e.g., 4, IV,四).
[‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡‡] A number, e.g., four, is a concept or abstract property of "fourness" shared by any set of four items.

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No.3, May 2013

A2=Abstract-Ideas: Number concept is used in any counting task instead or real objects (realia and/or manipulatives) or representational items (photographs and/or drawings).

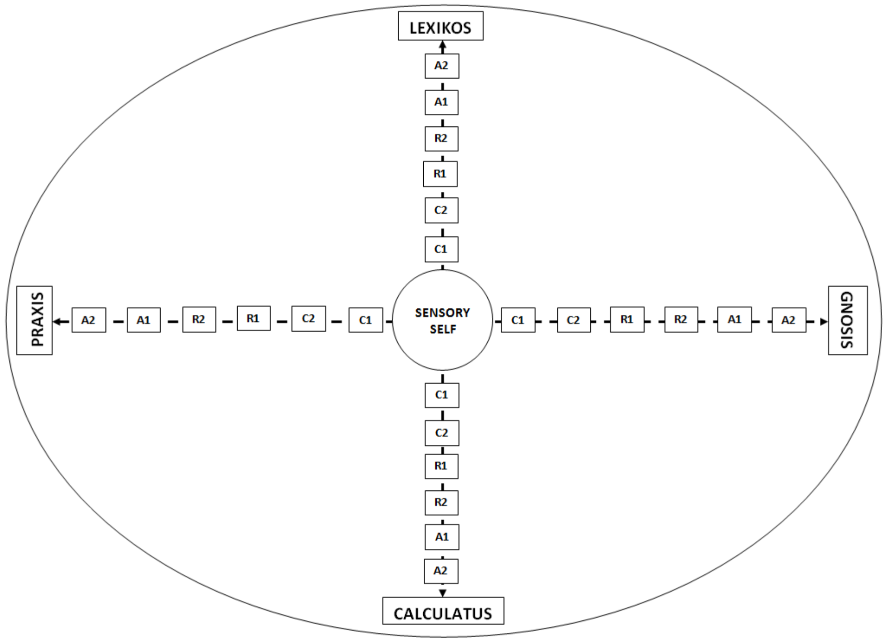

Figure 9. Developmental levels of learning from C1 to A2

Key: *Peri-level (closer to Sensory Self)*
C1 = Concrete-Realia
C2 = Concrete-Manipulatives
R1 = Rebus-Photographs
R2 = Rebus-Drawings/Illustrations
A1 = Abstract-Symbols
A2 = Abstract-Ideas/Concepts
Apo-level (further away from Sensory Self)

CONCLUSION

The trans-multiple abilities model of learning process provides a real illustration of the complexity of learning as a process. It is also a better model to explain clearly why certain learners failed to acquire advanced content knowledge or higher-level skills and continue to fall back on the foundation knowledge or lower-level skills in order to preserve the learner's Sensory Self. This peri-level gives the weak learners a sense of what would be termed as cognitive security. Learners who can progress higher are those who have established a confident Sensory Self and they dare to venture further into the apo-level of knowledge and skills.

REFERENCES

Anderson, L.W. et al. (2001). *Taxonomy for Learning, Teaching and Assessing: A revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Anderson, J.R. et al. (2007). Information-Processing Modules and Their Relative Modality Specificity. *Cognitive Psychology*, *54*, 185-217.

Ashcraft, M.H., & Radvansky, G.A. (2010). *Cognition* (5th ed.). Upper Saddle River, NJ: Pearson.

Atkinson, R.C., & Shiffrin, RM. (1971). The Control of Short-Term Memory. *Scientific America*, *225*, 82-90.

Barrett, H.C., & Kurzhan, R. (2006). Modularity in Cognition: Framing the Debate. *Psychological Review*, *113*, 628-647.

Birkenholz, R.J. (1999). *Effective Adult Learning*. Danville, IL: Interstate.

Bloom, B.S. et al (1956). *Taxonomy of Educational Objectives: the Classificaiton of Educational Goals: handbook I: Cognitive Domain*. New York: David McKay.

Chaplin, J.P. (1985). *Dictionary of Psychology* (2nd ed.). New York: Dell.

Chia, N.K.H. (2010a). *Counseling Students with Special Needs*. Singapore: Pearson/Prentice Hall.

Chia, N.K.H. (2010b). Basic Learning and Behavioral Support Activities for Children with Mild/Moderate Autism. In *Practical Tips for Teaching Children with Mild/Moderate Autism in Mainstream School* (Paper No. 3). Singapore: Cobee Publishing House.

Chia, N.K.H. (2011a). A Brief Theoretical Examination of the Developmental Process of Continuous Learning and Teaching: From Antegogy to Gerontogogy. *International Journal of Theoretical Educational Practice*, *1*, 30-43.

Chia, N.K.H. (2011b, Fall). What We need to know and understand about Courage: Part 1. *Unlimited Human!* 8-13.

Chia, N.K.H. (2012, Summer). What We need to know & understand about Courage (Part 2): Meta-Conceptualization of Courage. *Unlimited Human!* 33-38.

Chia, N.K.H. et al., (2010). Identifying and Profiling Autistic Learning and Behavioral Difficulties in Children. In *Autism: Practical Tips on Teaching Children with Mild/Moderate Autism in Mainstream Schools* (Paper 1). Singapore: Cobee Publishing House.

Chia, N.K.H., & Kee, N.K.N. (2013). An Integrated Teaching-Learning Framework for Special Education in Singapore. *Academic Research International*, *4*(2), 416-426.

Chia, N.K.H., & Tan, S.S.K. (2011, Spring). Understanding the Concept of Mind: mental Awareness and Mind Sense. *Unlimited Human!* 31-36.

Feuerstein, R., & Lewin-Benham, A. (2012). *What Learning looks like: Mediated Learning in Theory and Practice, K-6*. New York: Teachers College Press.

Fodor, J.A. (1983). *The Modularity of Mind*. Cambridge, MA: MIT Press.

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No.3, May 2013

Helmering, D.W. (1999). *Sense Ability: Expanding Your Sense of Awareness for a Twenty-First-Century Life*. Darby, PA: Diane Publishing.

Kim, J. (1995). Mind-Body problem. In T. Honderish (Ed.), *Oxford Companion to Philosophy* (p.199). Oxford: Oxford University Press.

Krathwohl, D.R. et al., (1964). *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook II: Affective Domain.* New York: David McKay.

Neisser, U. (1976). *Cognition and Reality: Principles and Implications of Cognitive Psychology*. San Francisco, CA: W.H. Freeman.

Parkison, P. (2010). *Learning Outcomes Workshop: Cognitive, Affective, Conative Taxonomies*. Evansville, IN: University of Southern Indiana.

Perkins, D. (1992). *Smart Schools*. New York: Free Press.

Poland, R.G. (1974). *Human Experience: A Psychology of Growth*. Saint Louis, CO: C.V. Mosby.

Reber, A. et al. (2009). *The Penguin Dictionary of Psychology* (4th ed.). London: Penguin Books.

Reeves, T.C. (2006). How do You know They are Learning? The Importance of Alignment in Higher Education. *International Journal of Learning Technology*, *2*(4), 294-308.

Riggs, E.G. & Gholar, C.R. (2009). *Strategies that promote Student Engagement: Unleashing the Desire to Learn* (2nd Ed.). Thousand Oaks, CA: Corwin.

Seels, B., & Glasgow, Z. (1990). *Exercises in Instructional Technology*. Columbus, OH: Merrill Publishing Co.

Sternberg, S. (1969). The Discovery of Processing Stages: Extensions of Donder's Method. *Acta Psycholgica*, *30*, 27