Information Processing Approach to Teaching-Learning Process

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Abstract

Cognitive theory emphasize that human mind is an active and individual processor of information. Knowledge is acquired by constructing a representation of the outside world. One's feelings, self-concept beliefs and existing knowledge influence acquisition of new knowledge. The realities and truths of external world also direct knowledge construction. Mental representations such as prepositional networks, concepts, cause and effect relations production rules reconstruct outside reality. Information processing theory holds this view of knowledge. It assumes that knowledge in encoded in long term memory in complex inter relationships of declarative knowledge, and procedural knowledge. As meta-cognitive knowledge and skills improve, learners develop the capacity for self-regulation.

General Principles

The first is the **assumption of a limited capacity** of the mental system. This means that the amount of information that can be processed by the system is constrained in some very important ways. Bottlenecks, or restrictions in the flow and processing of information, occur at very specific points.

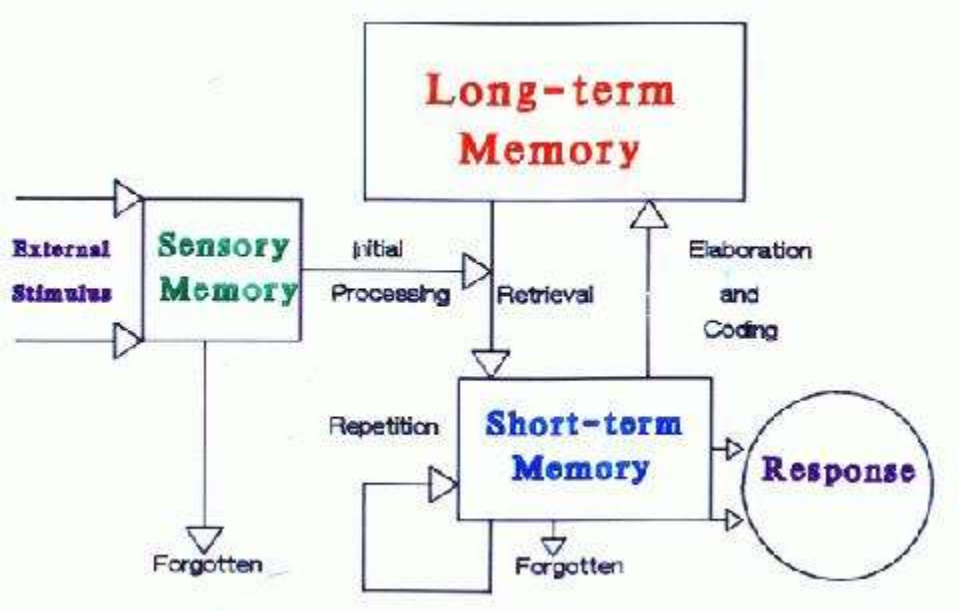
A second principle is that a control mechanism is required to oversee the encoding, transformation, processing, storage, retrieval and utilization of information. That is, not all of the processing capacity of the system is available; an executive function that oversees this process will use up some of this capability. When one is learning a new task or is confronted with a new environment, the executive function requires more processing power than when one is doing a routine task or is in a familiar environment.

A third principle is that there is a two-way flow of information as we try to make sense of the world around us. We constantly use information that we gather through the senses (often referred to as bottom-up processing) and information we have stored in memory (often called top-down processing) in a dynamic process as we construct meaning about our environment and our relations to it. A similar distinction can be made between using information we derive from the senses and that generated by our imaginations.

A fourth principle generally accepted by cognitive psychologists is that the human organism has been **genetically prepared to process and organize information in specific ways**. For example, a human infant is more likely to look at a human face than any other stimulus. Research has discovered additional biological predispositions to process information. For example, language development is similar in all human infants regardless of language spoken by adults or the area in which they live

Stage Model of Information Processing

One of the major issues in cognitive psychology is the study of memory. The dominant view is labeled the "stage theory" and is based on the work of Atkinson and Shiffrin (1968).



This model proposes that information is processed and stored in 3 stages.

Sensory Memory (STSS). Sensory memory is affiliated with the transduction of energy (change from one energy form to another). The environment makes available a variety of sources of information (light, sound, smell, heat, cold, etc.), but the brain only understands electrical energy. The body has special sensory receptor cells that transduce (change from one form of energy to another) this external energy to something the brain can understand. In the process of transduction, a memory is created. This memory is very short (less than 1/2 second for vision; about 3 seconds for hearing).It is absolutely critical that the learner attend to the information at this initial stage in order to transfer it to the next one.

Short-term Memory (STM): Short-term memory is also called working memory and relates to what we are thinking about at any given moment in time. In Freudian terms, this is conscious memory. It is created by our paying attention to an external stimulus, an internal thought, or both. It will initially last somewhere around 15 to 20 seconds unless it is repeated (called maintenance rehearsal) at which point it may be available for up to 20 minutes. The hypothalamus is a brain structure thought to be involved in this shallow processing of information. The frontal lobes of the cerebral cortex are the structure associated with working memory. For example, you are processing the words you read on the screen in your frontal lobes. However, if I ask, "What is your telephone number?" your brain immediately calls that from long-term memory and replaces what was previously there.

Another major limit on information processing in STM is in terms of the number of units that can be processed an any one time. Miller (1956) gave the number as 7 ± 2, but more recent research suggests the number may be more like 5 ± 2 for most things we are trying to remember. Because of the variability in how much individuals can work with (for some it may be three, for others seven) it is necessary to **point out important information**. If some students can only process three units of information at a time, let us make certain it is the most important three.

Major Concepts for Retaining Information

There are two major concepts for retaining information in STM: organization and repetition. There are four major types of organization that are most often used in instructional design:

- Component (part/whole)--classification by category or concept (e.g., the components of the teaching/learning model);
- Sequential -- chronological; cause/effect; building to climax (e.g., baking a cake, reporting on a research study);
- Relevance -- central unifying idea or criteria (e.g., most important principles of learning for boys and girls, appropriate management strategies for middle school and high school students);
- Transitional (connective) -- relational words or phrases used to indicate qualitative change over time (e.g., stages in Piaget's theory of cognitive development or Erikson's stages of socio-emotional development)

Concept of Chunking

A related issue to organization is the concept of chunking or grouping pieces of data into units. For example, the letters "b d e" constitute three units of information while the word "bed" represents one unit even though it is composed of the same number of letters. Chunking is a major technique for getting and keeping information in short-term memory; it is also a type of elaboration that will help get information into long-term memory.

Repetition or rote rehearsal is a technique we all use to try to "learn" something. However, in order to be effective this must be done after forgetting begins. Researchers advise that the learner should not repeat immediately the content (or skill), but wait a few minutes and then repeat

Long-term Memory (LTM). Long-term memory is also called preconscious and unconscious memory in Freudian terms. Preconscious means that the information is relatively easily recalled (although it may take several minutes or even hours) while unconscious refers to data that is not available during normal consciousness. It is preconscious memory that is the focus of cognitive psychology as it relates to long-term memory. The levels-of-processing theory, however, has provided some research that attests to the fact that we "know" more than we can easily recall.

The two processes most likely to move information into long-term memory are elaboration and distributed practice (referred to as periodic review in the direct instruction model).

Examples of Elaboration

There are several examples of elaboration that are commonly used in the teaching/learning process:

- imaging -- creating a mental picture;
- method of loci (locations)--ideas or things to be remembered are connected to objects located in a familiar location;
- Peg word method (number, rhyming schemes)--ideas or things to be remembered are connected to specific words (e.g., one-bun, two-shoe, three-tree, etc.)
- Rhyming (songs, phrases)--information to be remembered is arranged in a rhyme (e.g., 30 days hath September, April, June, and November, etc.)
- Initial letter--the first letter of each word in a list is used to make a sentence (the sillier, the better).

Organization (Types) of Knowledge

As information is stored in long-term memory, it is organized using one or more structures: declarative, procedural, and/or imagery.

Declarative Memory (generally refers to information we can talk about)

- Semantic Memory-- facts and generalized information (concepts, principles, rules; problem-solving strategies; learning strategies)
    - Schema / Schemata -- networks of connected ideas or relationships; data structures or procedures for organizing the parts of a specific experience into a meaningful system (like a standard or stereotype)
    - Proposition -- interconnected set of concepts and relationships; if/then statements (smallest unit of information that can be judged true or false)
    - Script -- "declarative knowledge structure that captures general information about a routine series of events or a recurrent type of social event, such as eating in a restaurant or visiting the doctor" (Stillings et al., 1987)
    - Frame -- complex organization including concepts and visualizations that provide a reference within which stimuli and actions are judged (also called "Frame of Reference")
    - Scheme -- an organization of concepts, principles, rules, etc. that define a perspective and presents specific action patterns to follow

- Program -- set of rules that define what to do in a particular situation
- Paradigm -- the basic way of perceiving, thinking, valuing, and doing associated with a particular vision of reality (Harman, 1970)

- Model -- a set of propositions or equations describing in simplified form some aspects of our experience. Every model is based upon a theory or paradigm, but the theory or paradigm may not be stated in concise form. Episodic Memory-- personal experience (information in stories and analogies)

Procedural Memory-- how to (driving a car, riding a bike)

Imagery – pictures

Metacognition: Knowledge and Control of Cognitive Processes

In information processing memory stores (sensory memory, working memory, and long term memory) retain information, whereas cognitive processes (attention, perception, rehearsal, encoding, and retrieval) move information from one store to the next. However, cognitive processes must be integrated strategically to derive meaning out of raw information. Metacognition which consists of knowledge about and control of cognitive processes serves this purpose.

Metacognition includes (a) people's knowledge or awareness of their cognitive processes, and (b) the ability to use self-regulatory mechanisms to control these processes. Metacognition is learner's awareness of his own cognitive machinery and how the machinery and how the machinery works metacognition literally mean cognition about cognition or knowledge about knowing and learning. This metacognitive knowledge is used to monitor and regulate cognitive process such as reasoning comprehension, problem solving, Learning, and so on.

Meta Cognitive Knowledge and Regulation

Metacognition involves three kinds of knowledge: (a) declarative knowledge about yourself as a learner, the factors that influence your learning and memory, and the skills, strategies and resources needed to perform a task-knowing what to do;(b) procedural knowledge

or knowing how to use the strategies; and (c) conditional knowledge to ensure the completion of the task-knowing when and why to apply the procedures and strategies(Bruning, schraw,&Roanning,1999).Metaognition is the strategic application of this declarative, procedural and conditional knowledge to accomplish goals and solve problems(Schunk,2000).

Metacognitive knowledge is used to regulate thinking and learning (Barown; Nelson, 1996). There are three essential skills that allow us to do this: planning, monitoring and evaluating.(i)Planning involves deciding how much time to give to a task, which strategies to use, how to start, what to skim and what to give intense attention to, and so on.(ii) Monitoring entails asking, "how I am doing? Is this making sense? Am I trying to go too fast? Have I studied enough?"(iii) Evaluating involves making judgments about the processes and outcomes of thinking and learning. For instance, asking 'should I change strategies, Get help? Give up for now? Is this assignment (painting, model, poem, plan, etc.)Finished?

Making Information More Meaningful

Meaningfulness describes the number of connections, or associations, between one idea and other ideas in long-term memory (Gane,etal., 1993)

Johnson (1975) in a review of research on meaningful learning concludes that 'Learning may be said to b meaningful to the extent that the new learning task can be related to the existing cognitive structure of the learner that is, the residual of earlier learning's'(p.427). The belief is that memories are more likely to be retained in LTM if they are related to what is already remembered. New idea associated with the old one is likely to be remembered more. The degree of meaningfulness depends on the 'associational ackground of the learner' (Johnson, 1975). It is connecting 'what is to be learned' with 'what the learner already knows'.

Information that is meaningful is interconnected with is meaningful is interconnected with other information in memory, and an important goal in teaching is to help learners to increase the number f connections between individual items of information. A teacher can help learners in making information more meaningful by putting them in the most active role

possible, encouraging visual imagery, organizing content in various ways, and encouraging learners to elaborate on their own understanding

Although all cognitive views of learning focus on learners being active, constructivism places more emphasis on learners constructing their own understanding than do other cognitive theories. Constructivists disagree on the nature of knowledge, but they generally agree that new learning exists in the context of prior understanding; Learning is enhanced by social activity; and authentic tasks promote learning. Many constructivists suggest that teachers should create a 'learning community' Where teachers and students work together to solve problems.

Conclusion

Cognitive theories emphasize that human mind is an active and individual processor of information. Active thinking is influenced by one's feelings, self concept or identity, beliefs, and existing knowledge and in turn is bound to influence the structure of new thoughts. Knowledge is acquired by constructing a representation of the outside world. The realities and truths of the external world direct knowledge construction. Individuals reconstruct outside reality by building accurate mental representations such as prepositional networks, concepts, cause and effect relationships, and condition action production rules that reflect "the way things really are". Information processing holds this view of knowledge

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