SPN 1022
Learning Science and Mathematics

Cognitive Theory
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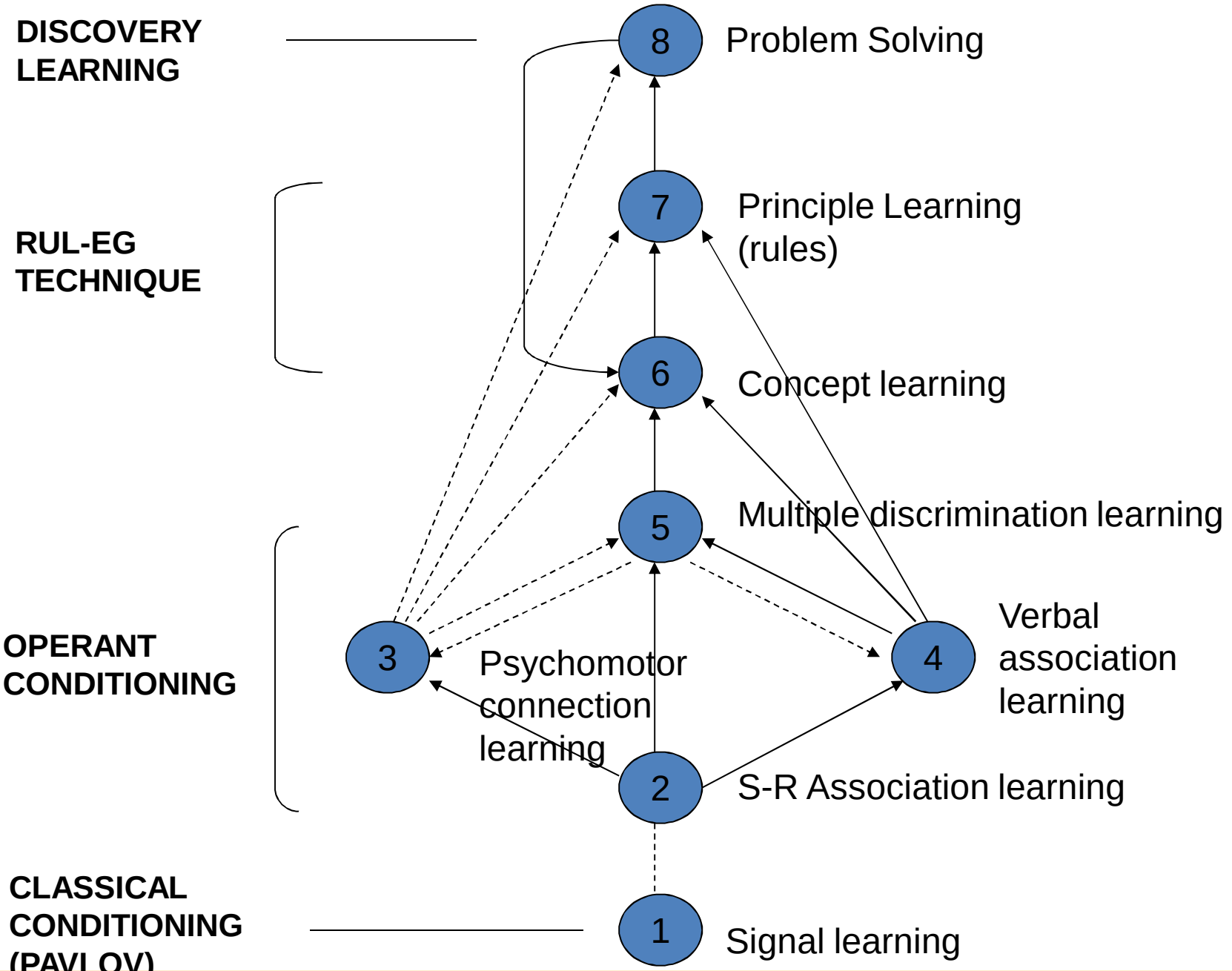
Learning by Hierarchical Steps

- Simple tasks function as real components of a more complex task.
- Basic skills are necessary to perform the most complex skill (problem solving).


DISCOVERY LEARNING
RUL-EG TECHNIQUE
OPERANT CONDITIONING
CLASSICAL CONDITIONING (PAVLOV)
8
Problem Solving
7
Principle Learning (rules)
6
Concept learning
5
Multiple discrimination learning
3
Psychomotor connection learning
4
Verbal association learning
2
S-R Association learning
1
Signal learning

Signal Learning

- Pavlov's classical conditioned response, where the individual learns to carry out a general conditioned response towards a given signal. Usually this response is emotional.
- Example: Pupil's reaction when teacher announces that a test will be administered. A feeling of fear caused by a loud sound. Joy at seeing a likeable toy.

Stimulus-Response Learning

- Skinner's operant conditioning, also called instrumental response. The individual shows a certain Response (R) to a discriminated Stimulus (S). Nearly all examples of S-R learning, including vocalization involving intentional motor behavior.
- Example: Mastering Response to obtain a reinforcement or reward. Children start to learn words by repeating the sounds and words of adults.

Psychomotor connection learning

- Often called the learning of skills. This type involves the combining or connection of two or more units of S-R learning. The connection is limited to the physical and non-verbal sequence. Pre-condition to stabilize the connection is that every S-R bond has to be formed before building the link.
- Eg: Turning the spring of children's toy. Writing. Running. Catching and throwing a ball. The strength of the association learnt depends on exercise, past experience and reinforcement.

Verbal association learning

- One form of association. But association between verbal or language units. Naming an objects is the easiest connection. In this case, the first S-R association involves the observation of the object and the second S-R association is achieved when the children name the object.
- Eg: Remembering poems, formulae or the alphabet in sequence. Individually, this learned behavior is not considered an important aim of learning. However as hierarchical level, this association is the first step to more important higher levels in learning.

Multiple discrimination learning

- Separate associations which have been learnt are connected to form multiple discrimination. Again, preceding associations needed at a lower hierarchical level should be learnt earlier. At this level, a person learns different responses to different stimuli. Because of this, he learns to identify associations which may be confused with objects or phenomena resembling each other.
- Eg: Recognizing the names of the children in a class. Differentiating solids, liquids and gases.

Concept learning

- Concept learning means learning to respond to a stimulus according to abstract characteristics such as position, shape, color and number and not according to the concrete physical characteristics.
- Eg: A child learns to call a 5 cm cube a ‘block’ and uses this name for other objects that are different in size and shape. Then he learns the concepts of cube and with this he can identify a class of objects that differ in characteristics such as material, color, texture and size. Many concepts are learnt by children through trial and error without planning. The teacher’s role is to design an effective learning sequence with the aim of learning a concept.

Principle learning

- A principle is a chain of two or more concepts. In principle learning, one needs to associate more than one concept.
- Eg: The relationship of the circumference of a circle with its diameter. Three concepts: the circumference, pi, and diameter are related. Identifying the number of legs to classify invertebrate animals.

Problem solving

- In problem solving, a person uses principles that have been learnt to achieve an aim. Besides achieving the aim, he acquires the skill to use his new knowledge and in time his skill is enhanced. He will be able to handle similar problems. What has been learnt is a higher-order principle that combines many lower-order principles.
- Eg: Experimenting to test the effect of different types of fertilizer on plant growth.

Learning domains

- Five types of learning outcomes:
  1. Intellectual skill
  2. Cognitive strategy
  3. Verbal information
  4. Motor skill
  5. attitude

Intellectual skill

- Ability to interact with surroundings using concept symbols
- Eg:
  - Identifying the diagonal of a square.
  - Explaining why ice freezes at 0 C.
  - Predicting the rate of growth of a plant based on conditions of water, soil, light, etc.

Cognitive strategy

- Ability to control the individual's behavior to learn remember and think.
- Eg:
  - To draw a chart for organizing data.
  - To reason backwards to solve a problem.
  - Breaking up a problem into various parts.

Verbal information

- Development of information using language.
- Eg:
  - Naming the parts of an electric circuit and the function of each part.
  - Listing objects that can be recycled.
  - Stating the characteristics of light.

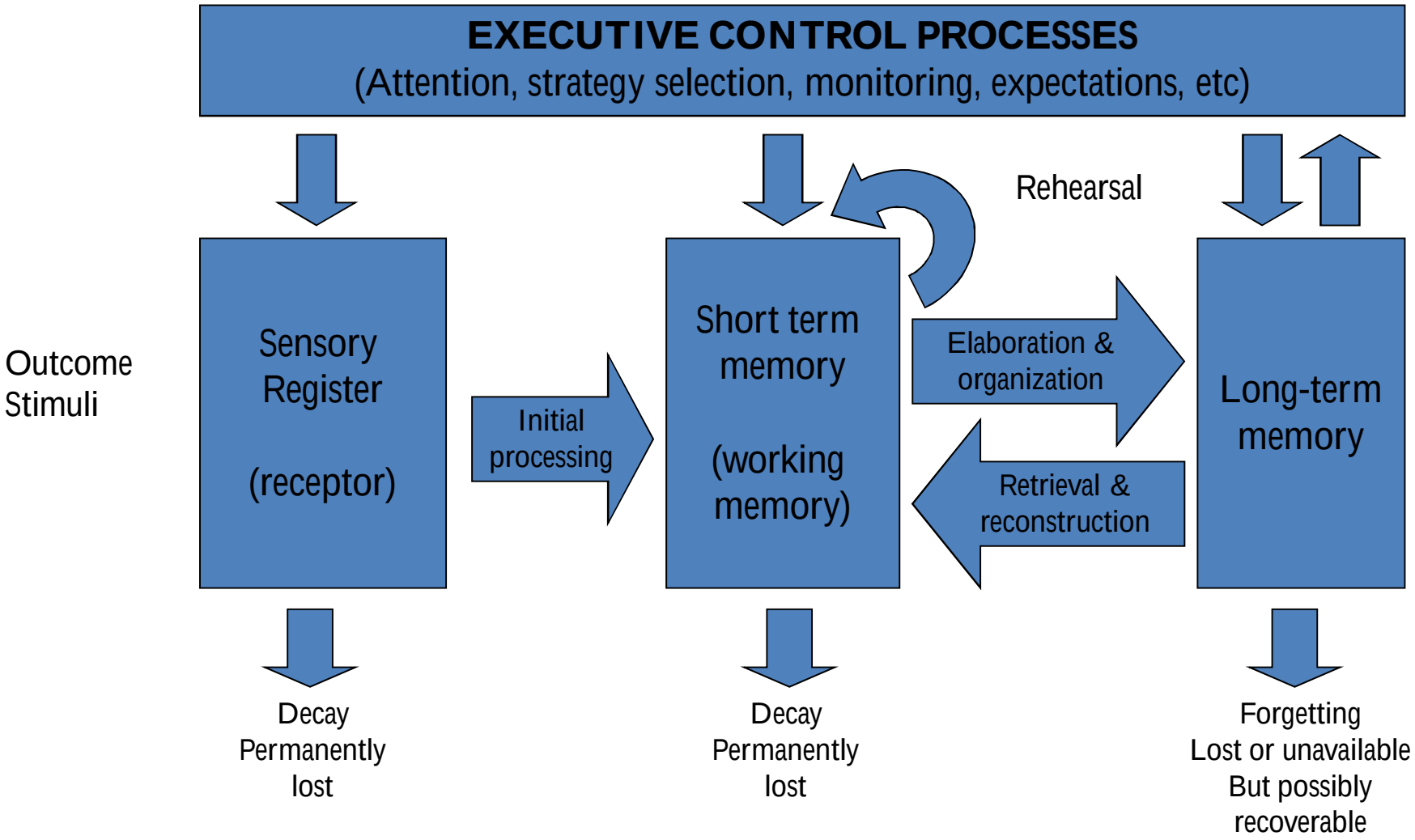
Motor skill

- Manipulative skill and carrying out routine work.
- Eg:
  - Preparing a microscope slide.
  - Building a model of a simple machine.
  - Measuring the weight of an object using a balance.

Attitude

- Change of attitude towards an object, another person, situation or change in effective domain.
- Eg:
  - Making choices in the preparation the preparation of an insects collection.
  - Visiting a science museum voluntarily.
  - Making choices in borrowing a book on dinosaurs.

Information processing model



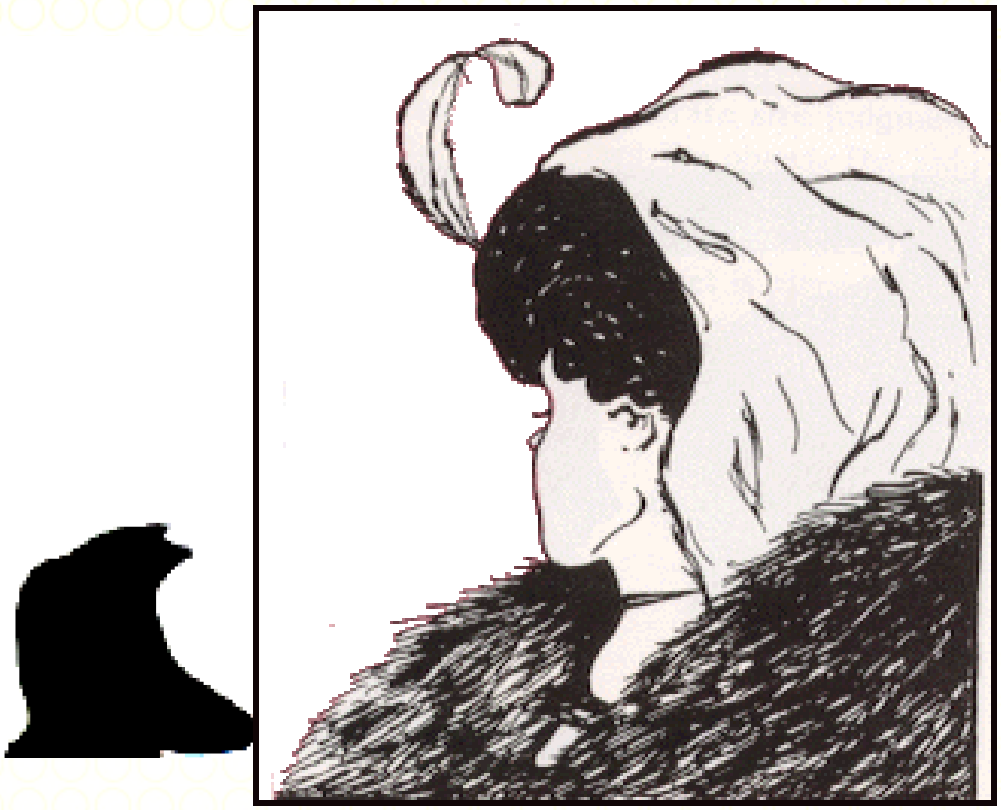
Sensory Register

- Sensory memory is affiliated with the transduction of energy (change from one energy from 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 transducer (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).

Sensory Register

- It is absolutely critical that the learner attend to the information at this initial stage in order to transfer it to the next one.
- There are two major concepts for getting information into Short Term Memory:
  1. **interesting feature**.
  2. **known pattern**.

What do you can see?



Short Term Memory

- also called working memory or conscious memory and relates to what we are thinking about at any given moment in time.
- 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.

Short Term Memory

- The hypothalamus is a brain structure thought to be involved in this shallow processing of information.
- The frontal lobes of the cerebral cortex is 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.

Short Term Memory

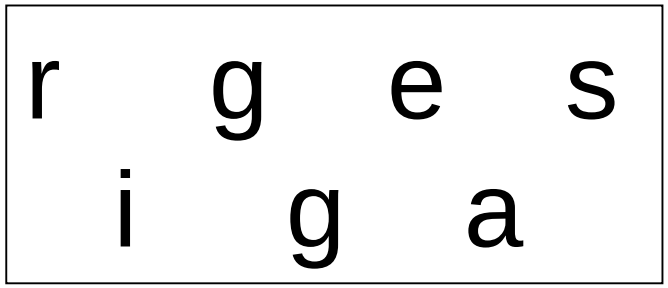
- Another major limit on information processing in STM is in terms of the number of units that can be processed an any one time.
- Research suggests the number may be more like **5 ± 2** for most things we are trying to remember.
- It is necessary to **point out important information**.

Short Term Memory

- There are two major concepts for retaining information in STM:
  1. **organization**
  2. **repetition.**
- There are four major types of organization that are most often used in teaching and learning:
  1. Component (part/whole)--classification by category
  2. Sequential -- chronological; cause/effect; building to climax
  3. Relevance -- central unifying idea or criteria
  4. Transitional (connective) -- relational words or phrases used to indicate qualitative change over time

Short Term Memory

- A related issue to organization is the concept of chunking or grouping pieces of data into units.
- 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.



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Short 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.
- For the most part, simply memorizing something does not lead to learning (i.e., relatively permanent change).

Long Term Memory

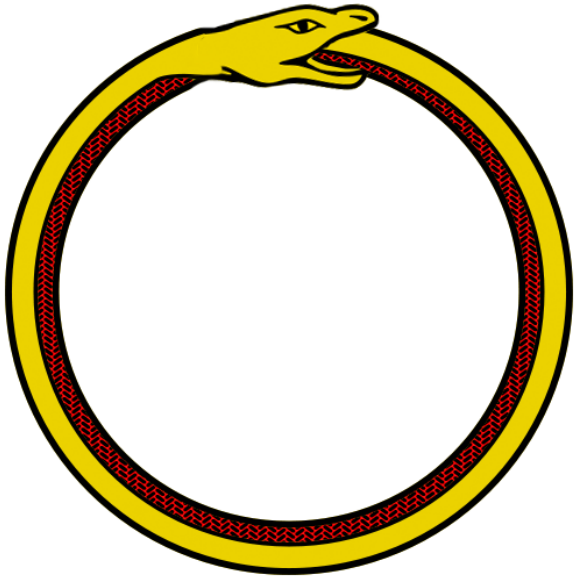
- also called preconscious and unconscious memory.
- Preconscious means that the information is relatively easily recalled (although it may take several minutes or even hours) while unconscious refers to data that is not available during normal consciousness.
- The two processes most likely to move information into long-term memory are elaboration and distributed practice

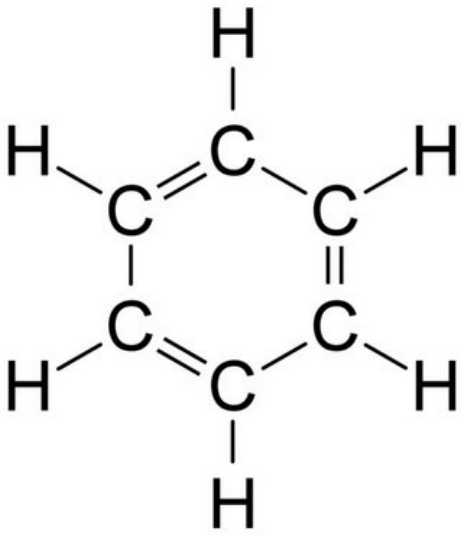
Long Term Memory

- There are several examples of elaboration that are commonly used in the teaching/learning process:
  1. imaging
  2. method of loci
  3. pegword method
  4. Rhyming
  5. Initial letter

Long Term Memory

- imaging -- creating a mental picture;





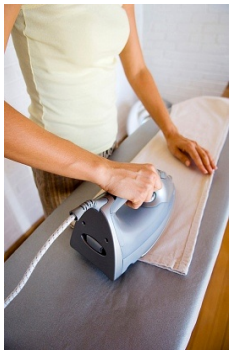
Long Term Memory

- method of loci (locations)--ideas or things to be remembered are connected to objects located in a familiar location;

Fluorine ---- Floor ---- ruang tamu

Chlorine ---- Chlorox --- bilik air

Bromine ---- Brush teeth --- toilet



Iodine ---- iron --- bilik tidur

Astatine ---- asap --- dapur

Long Term Memory

- pegword method (number, rhyming schemes)-- ideas or things to be remembered are connected to specific words
- (e.g., one-bun, two-shoe, three-tree, etc.)

Long Term Memory

- Rhyming (songs, phrases)—
- information to be remembered is arranged in a rhyme
- ABCDEFG
  HIJKLMNOP
  QRSTUV
  WXYZ
- Twinkle-twinkle little star song

Long Term Memory

- Initial letter--the first letter of each word in a list is used to make a sentence (the sillier, the better).
  - Ka - kalau
  - Na - nak
  - Ca - kahwin
  - Mg - mesti
  - Al - ada
  - Zn - zakat
  - Fe – fitrah
  - St – supaya
  - Pb - perkahwinan

Application of Information Processing Model in Science T&L

USING THE INFORMATION PROCESSING APPROACH IN THE SCIENCE CLASSROOM	
Principle	**Example**
1. Gain the students' attention.	•Use cues to signal when you are ready to begin. •Move around t he room and use voice inflections.
2. Bring to mind relevant prior learning.	•Review previous day's lesson. •Have a discussion about previously covered content.
3. Point out important information.	•Provide handouts. •W rite on the board or use transparencies.
4. Present information in an organized manner.	•Show a logical sequence to concepts and skills. •Go from simple to complex when presenting new material.
5. Show students how to categorize (chunk) related information.	•Present information in categories. •Teach inductive reasoning.

Application of Information Processing Model in Science T&L

6. Provide opportunities for students to elaborate on new information.	•Connect new information to something already known. •Look for similarities and differences among concepts.
7. Show students how to use coding when memorizing lists.	•Make up silly sentence with first letter of each word in the list. •Use mental imagery techniques such as the keyword method.
8. Provide for repetition of learning.	•State important principles several times in different ways during presentation of information (STM). •Have items on each day's lesson from previous lesson (LTM). •Schedule periodic reviews of previously learned concepts and skills (LTM).
9. Provide opportunities for overlearning of fundamental concepts and skills.	•Use daily drills for arithmetic facts. •Play form of trivial pursuit with content related to class.