**Lesson 2 : Understanding and Using Principles of Memory**

you should be able to remember and describe:

• Distinctions among encoding, storage, and retrieval

• Characteristics of sensory memory, working memory, and long-term memory

• Characteristics of procedural memory and declarative memory

• Methods of rehearsal for encoding: *repetition, auditory encoding, semantic encoding*

• Strategies for semantic encoding: *elaborative verbal rehearsal, self-reference, mental images*

• Organizing to encode

There are three main types of skills that lead to success in school:

• **Mental activity** that many people would judge as the basis for academic thought, things like memory, reasoning, problem solving, and critical thinking

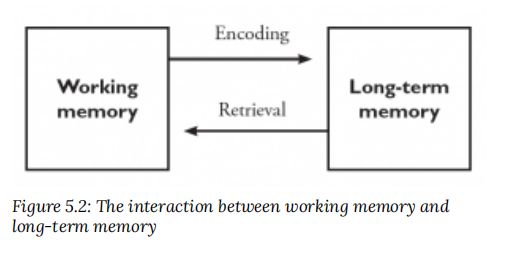
**• Interpersonal skills**, such as getting along with instructors and classmates and being able to work in groups—in short, the ability to “work and play well with others”

**• Intrapersonal skills**, which involve understanding and managing yourself—including being aware of your strengths and weaknesses and being able to maintain focus and motivation.

Mental processes of memory, learning, reasoning, problem solving, and critical thinking. All are major concerns of the sub-field of psychology known as **cognitive psychology,** the study of cognition. **Cognition** is the mental activity that deals with perception and with knowledge: what it is, and how people understand, communicate, and use it. Cognition is essentially “everyday thinking.”

**2.1 Memory**

We have two major memory systems that help to explain how memories are stored: working memory sometimes referred to as short-term memory, although the actual meaning is not identical and long-term memory. The process of creating a memory that you will remember for a test you will be taking next week and beyond involves both systems working together.



Memory plays a key role in many areas of our lives, not the least of which is school. To understand why we remember and forget, you need to consider the entire memory process. Here’s a very simple description: First, you have to get information into your memory systems; call this process **encoding.** When you need to get information out of memory

(for example, when you are taking an exam, or telling a story), you use the process called **retrieval.** In between encoding and retrieval we have, of course, memory **storage.**

Failure to remember information—that is, forgetting—can occur because of a breakdown at any of the three points (encoding, storage, retrieval). The typical culprits in the failure

to remember, however, are encoding and retrieval problems.

That’s why most of this module is devoted to encoding and retrieval. But first you need to understand the basic layout of memory, which is a key element of cognition.

We have two major memory systems that help to explain how memories are stored: working memory (sometimes referred to as short-term memory, although the actual meaning is not identical) and long-term memory. The process of creating a memory that you will remember for a test you will be taking next week and beyond involves both systems working together. Soon after information is first encountered, it enters the system called working memory. W**orking memory** is to think of it as the current contents of your consciousness—that is, whatever you are thinking about right now. So as you are sitting at your desk staring at a textbook, the words that you pay attention to enter into working memory. You hold information in working memory either because you are going to use it (for example, to solve some problem) or because you will be trying to transfer, or encode it, into long-term memory.

**Long-term memory** is the memory system that holds information for periods of time ranging from a few minutes to many years. If you do not use or transfer the information in working memory into long-term memory, it will be forgotten, probably in less than thirty seconds. One fact you should realize about working memory is that its capacity is limited. Psychologists had thought that people can generally hold about 7 pieces, or **chunks,** of information in working memory at one time. A chunk is a unit of meaningful information. For example, an individual letter might be a chunk. If the letters can be ordered to form words or abbreviations, then these are the chunks. More recently, however, researchers have proposed that memory capacity is a function of time, not quantity. Specifically, our working memory may hold the amount of information that we can process in about two seconds. A further type of memory is **Sensory memory** is an extremely accurate, very short duration system. It essentially stores the information taken in by the senses, vision and hearing, just long enough (about a second) to allow you to direct attention to it so you can get the information into working memory.

**Procedural memory** refers to skills and procedures. These are memories for things that you can do. **Declarative memory** refers to facts and episodes . Declarative memory is further subdivided into **semantic memory**—your general store of knowledge, such as facts and word meanings, and **episodic memory**— memory for events, or episodes from your life. So, if you remember that Bismarck is the capital of North Dakota, it is semantic memory, unless you remember the exact time that you learned this fact (in 5th-grade social studies, for example), in which case it would be episodic memory. So you see, as the details about when we first learned some piece of information fade, episodic memories can become semantic memory.

**2.2. Recode to Encode**

The basic strategy that people use to encode information from working memory into long-term memory is **rehearsal.** All of the encoding strategies in this module are kinds of rehearsal. The simplest kind of rehearsal is straight *repetition.*Although it may be one of the most common rehearsal strategies and is the one favored by many students, repetition is probably one of the least effective. Call this encoding without recoding. And the advice about it bears repeating: Encoding without recoding (in other words, straight repetition) is a poor way to encode information from working memory into long-term memory.

One specific situation in which many people have difficulty encoding is when they read textbooks. Have you ever read a paragraph, realized that you have immediately forgotten it, and as a consequence decided to re-read it? Often, the problem is that you are merely reading the words over in your head, making sure you can “hear” yourself silently saying the words. In this case, you are **recoding**: transforming the information from one form into another. But the transformation, in this case, is minor and not very useful. Psychologists call it **auditory encoding** or **acoustic encoding**. Auditory encoding is ok. Many students rely on it, and with enough effort, they do fairly well at school. In order to remember better, however, there is no question that you should try to move to the next level of recoding, in which you transform the information into something meaningful. For example, Craik and Tulving (1975) developed the idea of **semantic encoding.** Semantic means “meaning,” so semantic encoding refers to mentally processing the meaning of information. For example, you should pay attention to patterns and relationships and their significance, rather than just the words or numbers themselves.

**2.3. Creating Memories in the Brain**

You may already know that the brain is made up of billions of cells called **neurons.** For now, you can think of the brain as simply a very large collection of neurons. The neurons are all connected to each other in an extraordinarily complex pattern (one neuron can be simultaneously connected to many other neurons, all of which can be connected to many

other neurons, and so on down the line). Neurons are connected to each other by **axons,** which look like single long branches extending from the cell body, which is the round part of the neuron, and by **dendrites,** which are smaller branches splitting off from the cell body. (Each neuron has a single axon but many dendrites.) Electrical and chemical activity that takes place through pathways created by these interconnected neurons determines everything we say,

think, feel, or do . The neurons are involved in two significant ways when you encode information:

***2.3.1. Activation*** *w*hen you encode information and move it into memory, many neurons throughout the brain become active. The neural activity is pulses of electricity that are caused by chemicals called ions (electrically charged particles) briefly changing locations in your brain. The ions (sodium, which is abbreviated Na+) rush into the axon of a neuron. This movement of ions produces a brief electrical charge inside the neuron, which is then transmitted to many other neurons branches splitting off from the cell body.

***2.3.2.Synaptic plasticity i***n order to store information for a long time, the brain has to change its very structure—that is, the neurons themselves must change. Brain researchers currently believe that the change in structure can occur either within the individual neurons or through the connections among the billions of neurons in your brain.

**2.4.** **Storing Memories Across the Brain: Neural Networks**

Neurons are connected to each other in massive three-dimensional, dynamic, organic versions of the concept map. We call these many interconnected neurons **neural networks.** Many neuroscientists believe that most memories are not stored in a specific area of the brain but are spread out in interconnected neural networks across many areas of the brain. In other words, brain activation and synaptic plasticity for memories travel throughout the brain.

**2.5. Memory Retrieval**

**Memory retrieval** (withdrawing information from long-term memory for use in working memory) is largely a matter of coming up with and using effective retrieval cues. In familiar terms, **retrieval cues** are reminders, any information that automatically leads you to remember something. More scientifically, you can think of retrieval cues as entry points into the neural network associated with a particular memory. The more cues you create through this recoding and the better they are, the better your chances of being able to “grab onto one” when you need it. Now you might begin to understand why straight repetition is only a mediocre study strategy. To be sure, the repetition of a concept and its definition provide you with a possible retrieval cue. A formerly meaningless term and definition, completely disconnected from the rest of the knowledge in your head, is not the world’s greatest hook, however. In contrast, consider a retrieval cue that is based on memories from your own life. For example, suppose when trying to encode the concept *procedural memory* into your long-term memory, you remembered the time you helped your little sister learn how to tie her shoes. The formerly meaningless concept, procedural memory, now becomes part of your memory for this event.

**2.6. Retrieval practice**

One of the most important things you should do is to PRACTICE RETRIEVING THAT INFORMATION . And not just once. You should practice retrieval over time, spacing out your practice sessions as much as you can. Many students believe that it is more efficient to do all of their studying at one time, but the **spacing effect** shows that the very opposite is true.

So, to summarize, allow us to present a guide to studying that is based on some of the best principles of memory that psychologists have to offer.

1. Spend some time surveying the material before you start reading it. Figure out how it is organized by reading previews and summaries, and paying attention to outlines.

2. Recode for meaning while you read: periodically pause and reflect on what you have just read. Rephrase material and come up with examples from your own life (elaborative verbal rehearsal with self-reference). Note relationships between different concepts. Pay attention to how the current information fits into what you have already learned.

3. Practice retrieving while you are reading. During some of your periodic pauses, cover up what you just read. Try to retrieve the definitions of key terms. Try to generate your elaborative verbal rehearsals without looking at the text.

4. Practice retrieval after reading. Use practice quizzes, flash cards, quizlet, etc. It is far more effective if you have to come up with the answers yourself rather than just recognizing the answer (like in a multiple-choice question).

5. Come up with a schedule that allows you to take advantage of the spacing effect.