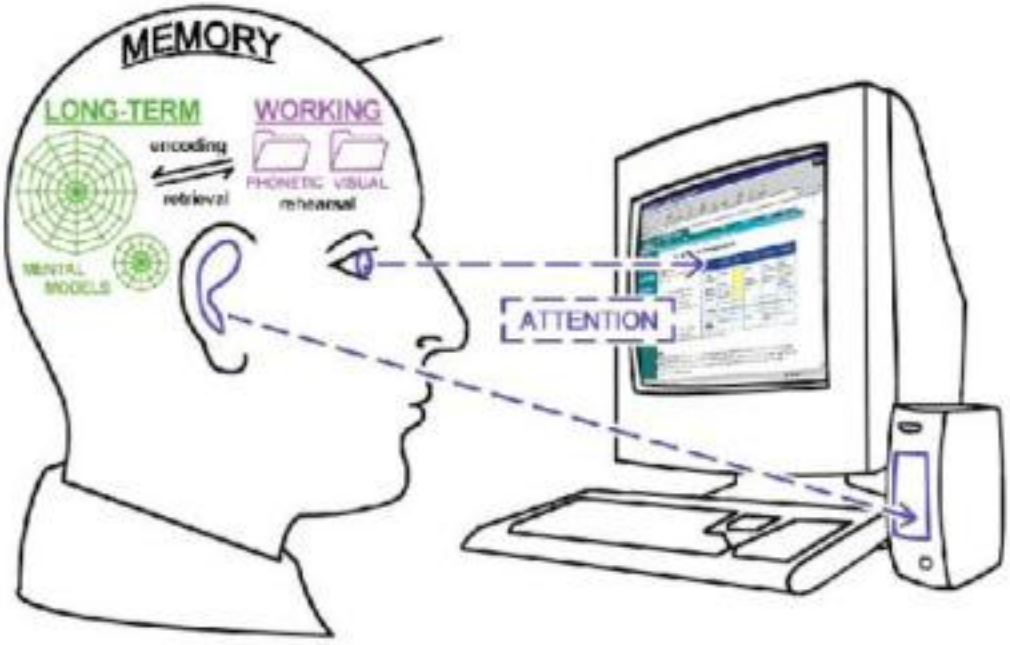

Cognitive Theory of Learning

MULTIMEDIA PRINCIPLES

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3. Cognitive Theory of Learning

3.0 INTRODUCTION

Most of the organizations are probably experiencing a demand for digitally delivered training. To save travel costs and instructional time, e-learning in both synchronous and asynchronous formats is increasingly supplementing or even replacing face-to-face classrooms.

However, all too often e-learning fails to live up to its potential, and as a result, learning suffers. Technologists ignore the unique instructional capabilities of e-learning by importing legacy materials from books or classroom manuals without employing engaging multimedia features. At the other end of the spectrum, technophiles who are enamored with technological features use all of them at once. Extraneous auditory and visual effects were added to the basic content to make it more interesting. The result is too much stimulus at once.

After hundreds of media comparison studies, it is learnt that it's not the delivery media that enables learning; it's how any given delivery technology supports human learning processes. If two lessons include all of the elements needed for learning, learning will occur whether the lesson is offered digitally or in a classroom. Alternatively, if a face-to-face classroom lesson is interactive, while a comparison digital lesson is not interactive, learning will be more easily achieved in the face-to-face version. And vice versa. No matter what mix of delivery media you use, it's imperative to accommodate the strengths and weaknesses of the human brain. In this unit you would learn in detail how the humans learn especially from e-lessons.

Learning Objectives:

The Learning objectives of this chapter are

- **State the three metaphors of learning**
- **Explain the three important cognitive processes in learning**
- **State the four principles of learning in cognitive science**
- **Elaborate on the processes of how instructional methods in e-learning can support and inhibit them.**

9.1 THREE METAPHORS FOR LEARNING

The learning psychologists have developed the three major metaphors during the past one hundred years as summarized in Table 9.1. In response – strengthening view of learning: the learner is a passive recipient of rewards or punishments and the teacher is a dispenser of rewards (which serve to strengthen a response) and punishments (which serve to weaken a response). This metaphor is not that it is incorrect but rather it is incomplete – it tells only part of the story because it does not explain meaningful learning.

Table 9.1: Three Metaphors of Learning

Metaphor of Learning	Learning is	Learner is	Instructor is
Response Strengthening	Strengthening or weakening of associations	Passive recipient of rewards and punishments	Dispenser of rewards and punishments
Information Acquisition	Adding information to memory	Passive recipient of information	Dispenser of information
Knowledge Construction	Building a mental representation	Active sense maker	Cognitive guide

In information- acquisition view of learning, the learner's job is to receive information and the instructor's job is to present it. A typical instructional method is a textbook or power point presentation in which the instructor conveys information to the learner. This approach sometimes called the empty vessel or sponge view of learning because the learner's mind is an empty vessel into which the instruction pours information.

The third metaphor can be called knowledge acquisition. According to the knowledge construction view, people are not passive recipients of information, but rather are active sense makers. They engage in active cognitive processing during learning including attending to the relevant information, mentally organizing it into a coherent structure and integrating it with what they already know.

Although there are some merits in each of the metaphors of learning we focus most strongly on the third one. In short, the goal of effective instruction is not only to present information but also to encourage the learner to engage in appropriate cognition processing during learning.

9.2 PRINCIPLES AND PROCESSES OF LEARNING

Figure 9.2 presents model of how people learn from multimedia lessons. In the left column, a lesson may contain graphics and words (in printed or spoken form). In the second column, the graphics and printed works enter the learner's cognitive processing system through the eyes, and spoken words enter through the ears. If the learner pays attention, some of the material is selected for further processing in the learners working memory - where you can hold and manipulate just a few pieces of information at time one time in each channel. In working memory, the learner can mentally organize some of the selected images into a pictorial model and some of the selected words into a verbal model. Final, as indicated by the "integrating arrow", the learner can connect the incoming material with existing knowledge from long – term memory - the learners' storehouse of knowledge.

There are three important cognitive processes indicated by the arrows in the arrows in the figure 9.2:

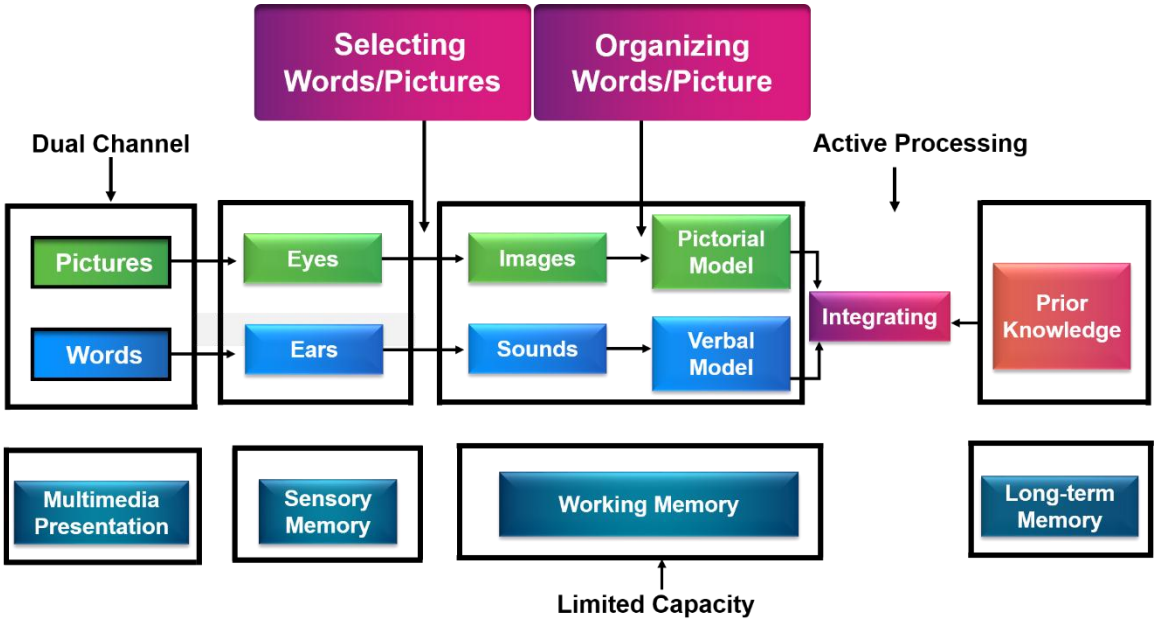

Fig 9.2: Cognitive Theory of Multimedia Learning

1. Selecting words and images – the first step is to pay attention to relevant words and images in the presented material;

2. Organizing words and images – the second step is to mentally organize the selected material in coherent verbal and pictorial representations; and

3. Integrating – the final step is to integrate incoming verbal and pictorial representations with each other and with existing knowledge.

9.3 FOUR PRINCIPLES OF LEARNING IN COGNITIVE SCIENCE

Meaningful learning occurs when the learner appropriately engages in all of these processes. Thus learning model reflects four principles from research in cognitive science:

1. Dual channels – people have separate channels for processing visual/pictorial material and auditory /verbal material;

2. Limited capacity – people can actively process only a few pieces of information in each channel at one time;

3. Active processing – learning occurs when people engage in appropriate cognitive processing during learning, such as attending to relevant material, organizing the material into a coherent structure, and integrating it with what they already know; and

4. Transfer – new knowledge and skills must be retrieved from long – term memory during performance

9.4 HOW DO LESSONS AFFECT HUMAN LEARNING?

Cognitive learning theory explains how mental processes transform information received by the eyes and ears into knowledge and skills in human memory (Refer Figure 9.3)

Instructional methods in the e-lessons must guide the learners' transformation of words and pictures in the lesson through working memory so that they are incorporated into the existing knowledge in long-term memory. These events rely on the following process:

1. Selection of the important information in the lesion;

2. Management of the limited capacity in working memory to allow the rehearsal needed for learning;

3. Integration of auditory and visual sensory information in working memory with existing knowledge in long-term memory by way of rehearsal in working memory; and

4. Retrieval of new knowledge and skills from long –term memory into working memory when needed later.

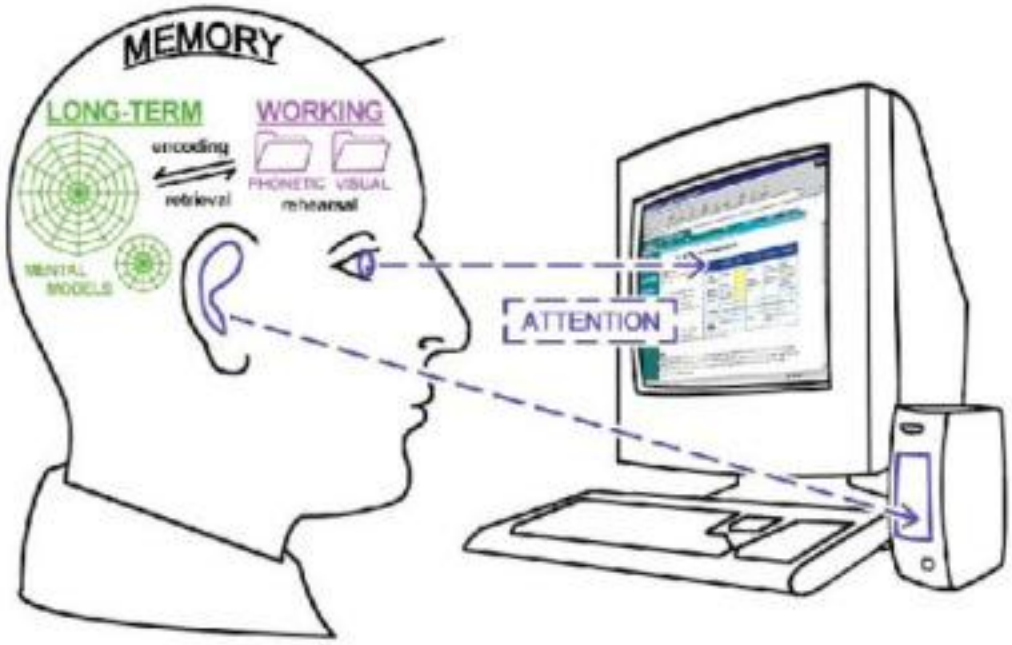

Figure 9.3: Cognitive processing of learning

In the following sections, we elaborate on these processes and provide examples of how instructional methods in e-learning can support or inhibit them.

9.4.1 Methods for Directing Selection of Important Information

Our cognitive systems have limited capacity. Since there are too many sources of information competing for this limited capacity, the learner must select those that best match his or her goals. We know this selection process can be guided by instructional methods that direct the learner's attention. For example, multimedia designers may use an arrow or color to draw the eye to important text or visual information.

9.4.2 Methods for managing Limited Capacity in Working Memory

Working memory must be free to rehearse the new information provided in the lesson. When the limited capacity of working memory becomes filled processing becomes inefficient. Learning slows, and frustration grows. For example, most of us find multiplying numbers like 968 by 89 in our heads to be a challenging task This is because we need to hold the intermediate products of our calculations in working memory storage and continue to multiply the next set of numbers in the working memory processor. It is very difficult for working memory to hold even limited amounts of information and process effectively at the same time.

Therefore, instructional methods that overload working memory make learning more difficult. The burden imposed on working memory in the form of information that must be held plus information that must be processed is referred to as ***cognitive load.***

Methods that reduce cognitive load foster learning by freeing working memory capacity for learning. In the past ten years, research was carried out to reduce cognitive load in instructional materials. Many of the guidelines you see in next chapter are effective because they reduce or manage load. For example, the coherence principle described in next chapter states that better learning results when e-lessons minimize irrelevant visuals, omit background music and environmental sounds, and use succinct text. In other words, less is more. This is because by using a minimalist approach that avoids overloading working memory, greater capacity can be devoted to rehearsal processes, leading to learning.

9.4.3 Methods for integration

Working memory integrates the words and pictures in a lesson into a unified structure and further integrates these ideas with existing knowledge in long-term memory. The integration of words and pictures is made easier by lessons that present the verbal and visual information together rather than separated. Once the words and pictures are consolidated into a coherent structure in working memory, they must be further integrated into existing knowledge structures in long term memory. This requires active processing in working memory. E-Lessons that include practice exercises and worked examples stimulate the integration of new knowledge into prior knowledge. For example, a practice assignment asks sales representations to review new product features and describe ways that their current clients might best take advantage of a product upgrade. This assignment requires active processing of new product feature information in a way that links it with prior knowledge about their clients.

9.4.4 Methods for Retrieval and Transfer

It is not sufficient to simply add new knowledge to long-term memory. For success in training, those new knowledge structures must be encoded into long-term memory in a way that allows them to be easily retrieved when needed on the job. Retrieval of new skills is essential for transfer of training. Without retrieval, all the other psychological processes are meaningless, since it does us little good to have knowledge stored in long-term memory that cannot be applied later.

For successful transfer, e-lessons must incorporate the content of the job in the example and practice exercises, so the new knowledge stored in long-term memory contains good retrieval hooks. For example, one multimedia exercise asks technicians to play a Jeopardy game in which they recall facts about a new software system. A better alternative exercise gives an equipment failure scenario and asks technicians to select a trouble shooting action based on facts about a new software system. The Jeopardy game exercise might be perceived as fun, but it risks storing facts in memory without a job context. These facts, lacking the contextual hooks needed for retrieval, often fail to transfer. In contrast, the troubleshooting exercise asks technicians to apply the new facts to a job-realistic situation.

9.5 SUMMARY OF LEARNING PROCESSES

In summary, learning from e-lessons relies on four key processes:

- First, the learner must focus on key graphics and words in the lesson to select what will be processed.
- Second, the learner must rehearse this information in working memory to organize and integrate it with existing knowledge in long-term memory.
- Third, in order to do the integration work, limited working memory capacity must be overloaded. Lessons should apply cognitive load reduction techniques, especially when learners are novices to the new knowledge and skills.
- Fourth, new knowledge stored in long-term memory must be retrieved back on the job. We call this process as transfer of learning. To support transfer, e-lessons must provide a job context during learning that will create new memories containing job-relevant retrieval hooks.

All these processes require an active learner – one who selects and processes new information effectively to achieve the learning goals. The design of the e-lesson can support active processing or it can inhibit it, depending on what kinds of instructional methods are used.

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