

The 4 T's. Applying cognitive science to Improve EM education.

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**The 4 Ts are:**

**Time (how to utilize it for effective learning),**

**Technical elements,**

**Tell a story**

**Tie it together**

## Learning theory

**Working memory** – is the learning processing system.

The brain has to integrate new information, discard unnecessary information, and organize it in such a way that it can be moved into long term memory. Standard education theory suggests that we can process 7 +/- 2 new pieces of information, though this is now somewhat controversial. However, we know working memory is limited, and affected by sleep, emotions, stress, and cognitive load.

### Cognitive Load Theory

The processing loads in the working memory are intrinsic load, germane load and extraneous load. Since working memory is finite, the cognitive loads are additive.

**Intrinsic load** – Difficulty of the material. This is impacted by:

Learners: Novice vs. expert, background education, life experiences.

Material complexity in the given time: Relatively simple concepts can be difficult if presented too quickly or if too many are presented.

Example: Management of a patient with flash pulmonary edema by a July intern versus a June PGY-3.

**Germane Load** – A function of how an individual learner processes and retains information.

Some believe germane load is part of intrinsic load; some believe it is a separate part of learning. It is the manner in which information by the learner is moved from working memory into long term memory. Over time, learners develop their own strategies.

Impacted by learner processing ability, motivation, task characteristics, personality, and individual choice of learning strategies.

**Extraneous load** – Placed on the learner by how well or how poorly the material is taught or explained. It consists of extra information, facts that are unimportant, or any material that unnecessarily draws attention away from the main teaching point. Examples of extraneous load: inappropriate lecture format, busy slides, ineffective instruction, interruptions, and reading from

slides. Information that detracts from the key messages is a part of extraneous load. Ultimately, extraneous load makes material harder to process, comprehend, and recall in the long run.

Using cognitive load theory while preparing for an educational session, be it a power point, small group, or case-based discussion, begins with thinking about the cognitive load and working memory. Consider building your presentation “backward”: start with the take home points/educational goals for the session, keeping in mind that the 3 cognitive loads are largely cumulative and, since working memory is finite, any increase in a particular load detracts from the others. What are the key take home points? How difficult are they? Where are your learners in their education? How does the rest of the conference day look? Traditional presentation methods overwhelm the learner with information that isn’t retained: take home points aren’t taken home. Then, as preparation for the learning session continues, the 4 Ts are a useful reminder on how to use the cognitive load theory/working memory in developing a truly educational and engaging session.

## The 4 T’s

### Time

After 18 – 25 minutes, learning decreases and cognitive backlog occurs. The working memory can become overwhelmed. The sea of blank stares....

The EM RRC requires 5 hours of education per week. Strategize how to break up the lecture day. Small groups can self-regulate somewhat by taking natural breaks. The learners can discuss the information, look something up, stand up and stretch. Are there hands-on topics? Can they debate and approach? Practice on a BiPap machine? These are strategies to break up the day and encourage learning.

Consider the 3-second pause. After discussing a topic, giving the audience 3 seconds to process the information, to answer a question or to come up with a question. It’s uncomfortable but often effective.

### Technical elements – avoiding extraneous load

The working memory’s processing is subdivided into independent systems for auditory and visual inputs. The auditory system processes spoken language while the visual system is dedicated to images. The two systems process inputs simultaneously – this is sometimes referred to as dual-coding theory. Working memory can be overloaded when the information presented is discordant between the two channels; when the words on the screen don’t match what is being spoken.

Understanding dual coding theory leads to some general recommendations for slides

Size – no less than 36 font – learners shouldn’t have to work to read – they will not be able to focus on what is being said.

Distractions – extraneous “stuff” on your slide – bullets, logos, too many pictures, animations/transitions

Contrast – distracting colors. For example, X-ray slides should take up the whole slide and have a black background. No loud colors that “shout”.

Words – no more than 6 words per line. Learners can read or listen but not both.

### **Tell a story**

Stories enrich data-heavy topics, tap into pre-existing emotions and help to build long-term memories. In medicine, this is often a case-based scenario. Stories increase attention and retention. Learning about BiPap is easier in the context of someone in flash pulmonary edema compared to a lecture on mechanics and settings. Emotions and connection spark attention which affects the germane load and the movement from working memory to long-term memory.

### **Tie it together**

The connection of disparate pieces of information, or the “aha” moment stimulates the reward center in the brain and dopamine release. This can improve recall, and stimulate the desire to learn more. Curbing redundant information and innovating new methods of information delivery are also known to stimulate dopamine. Synthesis of information – the flash of insight promotes long term retention.

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