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STS-02: The Science of Learning
Cognitive Principles

1. **Memory formation requires focused attention**
    a. Multitasking yields up to 50% errors
    b. The brain is plastic and rewires itself, but ONLY if attention is paid
    c. Primacy-recency effect: use the first and last part of your class for high impact
2. **Memory is the residue of thought**
    a. There is no learning without memory
    b. Learning is effortful (makes it deeper/durable; challenging is better)
    c. Laptop notes discourage thought
    d. Proficiency requires practice
    e. Learning styles are not supported by the literature
    f. Factual knowledge precedes skill
    g. Chunking creates patterns, patterns are easier to remember – chunking increases cognitive load
    h. STM stays in hippocampus; without encoding it doesn't leave to larger lobes
3. **Do not mass retrieval practice**
    a. What works best for SHORT term memory doesn't work for LONG (and vice versa) – this is why students study all wrong
    b. Massed practice (including cramming) is poorly productive for LTM
    c. Distributed practice yields best results
    d. Mixed practice (interleaving) brings positive benefits
    e. Reflection is a form of retrieval practice
    f. Retrieval practice interrupts the forgetting process
    g. Wait time is crucial to allow for student recall to occur

4. **Memory formation involves the limbic system, which is also associated with emotions**
    a. Short term memory begins in hippocampus. Brain is not changed until encoding to LTM
    b. Cortisol (stress) is bad for the hippocampus's optimal functioning
    c. "Affective filter" can impact perception of teacher AND subject matter
    d. Memory is associative (more like a reconstruction than a true recall). "Fire together, wire together"
    e. The brain is an organ: nutrition, hydration, sleep, exercise matter (the brain uses up to 25% of the body's energy)
    f. Memories are made during sleep – the cleaning out of toxins
    g. Read notes JUST before sleep to aid consolidation
5. **Meaning helps retention**
    a. Memory systems: explicit (declarative) are episodic or semantic ("academic learning"), implicit (nondeclarative) such as procedural and conditioning
    b. Putting knowledge into larger context helps learning
    c. We understand new things in context of things we already know
    d. High perceived utility increases retention and motivation
    e. Cognition is fundamentally different early and late in training
    f. We solve new problems better when we understand the underlying principles or 'rules'
    g. Elaboration connects to contexts and builds on underlying principles
    h. Transference (use it in a new application) demonstrates real learning
    i. Predicting-and-failing is better than watching a presentation. Make them guess!
    j. Metamemory (teaching students about memory and learning) improves memory and recall
6. **The brain is attracted to novelty**
    a. Brain seeks stimuli and has built-in curiosity
    b. The attention "muscle" wears down over time and needs breaks
    c. Novelty increases motivation and interest
    d. Practice should be varied
    e. Need to take breaks and reset (nature videos?)
    f. Multisensory input is better than unisensory
    g. Dual encoding (asks students to visualize a concept heard verbally, or verbalize something only seen) creates additional hippocampus pathways and increases chance of survival
    h. Images and imagining promote novelty and increase retention
    i. Mystery drives novelty (and the corollary: visible lecture notes decrease novelty)
    j. Implicit learning ("Wo ist Gudrun?") can add fun and novelty
    k. All learning is initially episodic – this provides context clues to make the recall easier once it (later) becomes semantic. Thus, wackiness stands out