The Academy for Teaching and Learning Excellence (ATLE)
"Office hours for faculty"
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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
        i. Syllabus policy: disallow devices (or put into one corner of the room only?)
    b. The brain is plastic and rewires itself, but ONLY if attention is paid
        i. Lectures: require attention, but also encourage it via interesting slides that don't give away too much (aren't boring; saying what you do out loud)
    c. Primacy-recency effect: use the first and last part of your class for high impact
        i. Lecture: Put important reminders and summaries at the first ten minutes, and the last.
2. Memory is the residue of thought
    a. There is no learning without memory
        i. Lecture: maybe use some class time to help them memorize things?
    b. Learning is effortful (makes it deeper/durable; challenging is better)
        i. Lecture: explain the principle of learning to them out loud (metacognition)
    c. Laptop notes discourage thought
        i. Syllabus: ban devices (handwritten is better)
    d. Proficiency requires practice
        i. Syllabus: build additional practice that is worth points
    e. Learning styles are not supported by the literature
    f. Factual knowledge precedes skill
        i. Syllabus: flip classroom when possible to spend class time on skills
    g. Chunking creates patterns, patterns are easier to remember – chunking increases cognitive load
        i. Lecture: spend time thinking of useful ways to chunk material into patterns for students (acronyms?)
    h. STM stays in hippocampus; without encoding it doesn't leave to larger lobes
        i. Lecture: tell students importance of hydration, sleep, and reviewing notes right before bed (best chance of encoding)
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
        i. Syllabus: rewrite my tests to make them cumulative all semester long, and warn students that will happen
    b. Massed practice (including cramming) is poorly productive for LTM
        i. Syllabus: re-test after a while, and unannounced, to reward LTM only (and tell students you will do this)

c. Distributed practice yields best results
    i. Syllabus: fold distributed practice into the assignments and assessments
d. Mixed practice (interleaving) brings positive benefits
    i. Syllabus: craft assignments and tests that interleave
    ii. Lecture: use F2F time for interleaving
e. Reflection is a form of retrieval practice
    i. Lecture: create time for reflection and follow-up to make the activity worth while
f. Retrieval practice interrupts the forgetting process
    i. Lecture: call on them to recall/retrieve during F2F time, individually and in groups
    ii. Syllabus: create activities that force them to retrieve info, even if already "practiced" one time (maybe change format, such as Disc Board?)
g. Wait time is crucial to allow for student recall to occur
    i. Lecture: ask questions and let the silence hang; don't provide the answer

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
        i. Syllabus: do not reward STM; find ways to punish those who only cram
    b. Cortisol (stress) is bad for the hippocampus's optimal functioning
        i. Lecture: tell this to students (metacognition)
    c. "Affective filter" can impact perception of teacher AND subject matter
        i. Lecture: classroom interactions, demeanor, relatability, approachability, etc need to be properly calibrated. Be "more of a human" in your PPT introduction of yourself.
    d. Memory is associative (more like a reconstruction than a true recall). "Fire together, wire together"
        i. Lecture: pictures on screen can aid the association. The more outlandish/memorable, the better
        ii. Lecture: Use F2F activities to create associations with the learning object (rather than just a piece of knowledge gleaned from a reading)
    e. The brain is an organ: nutrition, hydration, sleep, exercise matter (the brain uses up to 25% of the body's energy)
        i. Lecture: like a muscle, it gets tired. Give a break of 30-60 seconds even in a one hour class. Stand, stretch. Check your devices!
    f. Memories are made during sleep – the cleaning out of toxins
        i. Lecture: tell students so they can get enough sleep (metacognition)
    g. Read notes JUST before sleep to aid consolidation
        i. Lecture: tell students (metacognition)
5. Meaning helps retention
    a. Memory systems: explicit (declarative) are episodic (autobiographical) or semantic ("academic learning"), or implicit (nondeclarative) such as procedural (motor skills) and conditioning
        i. Lecture: all learning starts as episodic. Make them *experience* something to get best chance at turning semantic
    b. Putting knowledge into larger context helps learning
    c. We understand new things in context of things we already know
        i. Lecture: focus on the context, not the new learning concept
    d. High perceived utility increases retention and motivation
        i. Lecture: stress the utility and do not assume inherent motivation
    e. Cognition is fundamentally different early and late in training
        i. Syllabus: If the learners are novices to this discipline, they need more step by step practice. If they are not, create more synthesis activities
    f. We solve new problems better when we understand the underlying principles or 'rules'

   i. Do not skip or give short shrift to the underlying principles (in fact, make summarizing them part of the students' job)
- g. Elaboration connects to contexts and builds on underlying principles
   i. Lecture and Syllabus: create activities that encourage or require elaboration
- h. Transference (use it in a new application) demonstrates real learning
   i. Lecture and Syllabus: After the first "practice," make the students do another activity which practices it in a new context and might even look different.
- i. Predicting-and-failing is better than watching a presentation. Make them guess!
   i. Lecture: avoid a pattern of "explain-practice". Instead, "practice-explain-practice again"
- 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
      i. Lecture: tell students this is why devices have to be off; they cannot be easily resisted
   b. The attention "muscle" wears down over time and needs breaks
      i. Lecture: take breaks, even unrelated ones to your content
   c. Novelty increases motivation and interest
      i. Lecture: Your approach should be novel ("wacky professor"?) compared to other teachers. Your slides should be different
   d. Practice should be varied
      i. Lecture: even a novel activity gets old quickly. Constantly vary them. (interactive techniques list)
   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
      i. Lecture: in addition to HEARING the concept, they should write it. And then they should EXPLAIN it verbally to their neighbor.
   h. Images and imagining promote novelty and increase retention
      i. Lecture: how about a PPT with nothing but images?
   i. Mystery drives novelty (and the corollary: visible lecture notes decrease novelty)
      i. Lecture: remove bullets from visible slide (move to "notes" section?)
      ii. Lecture: structure the hour to add mystery, such as a "driving question" for the hour that only later will be answered.
   j. Implicit learning ("Wo ist Gudrun?") can add fun and novelty
      i. Lecture: make rote learning something amusing
   k. All learning is initially episodic – this provides context clues to make the recall easier once it (later) becomes semantic. Thus, wackiness stands out

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