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Talking with Faculty about Cognitive Science and Learning

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Talking with Faculty About Cognitive Science & Learning

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When it comes to teaching, faculty at a research-intensive institution can be very much like our students in relation to their studies: very smart people whose primary interests lie elsewhere or, at least, whose expertise is not in this area. And we hear over and over again the common wisdom that faculty want research-based ideas on teaching. This implies that we can treat the teaching of teachers about research-supported aspects of learning in ways analogous to teaching students about other academic topics.

In introducing research-based ideas into the pedagogical discussion, it can be tough to find a balance between concepts drawn directly from "hard research" vs. ideas that are so digested for practitioners' use that the underlying research is completely obscured. If you rely too heavily on the former, the content becomes so specific and jargon-filled as to be impenetrable, while at the other extreme, you can end up with just another set of random-seeming "teaching tips" rather than a coherent and well-supported conceptual framework. And, surely, it is not surprising that having a coherent, comprehensible framework of ideas turns out to be of central importance for learning.

The Brain, Memory & Perception

It's tempting to think of the human brain purely as a wonderful thinking machine of almost unlimited ability; while this is true in many ways, there are limits to our cognitive capacities that can seem oddly restrictive to the academic and which can, in turn, produce bottlenecks in the learning process. One of the most limiting aspects is the capacity of *short-term memory* to hold multiple concepts in thought at one time, which is particularly inconvenient as short-term memory is the gateway to the brain's

ability to understand in the present and to long-term learning and retention.[i] Tests of humans' ability to recall information show that we can only hold up to around seven, perhaps eight, distinct concepts in active thought at one time.[ii] Any more than that and ideas simply get dropped — which provides a fundamental constraint on lesson design. Fortunately short-term memory seems to have two independent "channels", one for verbal/textual and one for visual/graphical information, which can double the number of concepts possible to think about at once if they're chosen with care.

If the teacher you're working with has a scientific bent, you may wish to discuss the limits of short-term memory pretty much as described in the previous paragraph, but even then you risk running afoul of another limitation of how the brain learns—that even if a person learns something "well", when that knowledge is completely disconnected from anything else that person already knows, then it's highly unlikely that the knowledge will ever be *activated* later on in that person's thinking; they'll "know" it but they'll never use that knowledge.[iii]

Getting to Learning & Teaching

You probably won't be surprised that the technique to connect new learning to prior knowledge is called *bridging*. For example, in discussing novice/expert differences you could talk with a scientist about how, for the novice learner, neurons fire across large swaths of the brain when thinking about a given concept whereas, for an expert in that field, thinking about the same concept, only very specific neural pathways are activated; thus, thinking is just plain easier for an expert. In short, the novice cannot attend to multiple ideas at once, while the expert can.[iv] But this line of reasoning might not serve as bridging for a teacher outside the natural sciences. For example, with a teacher in performance arts or another creative field you might invoke the idea of coaching students on a specific skill so that the students can attend to that aspect alone; in coaching it's possible -- even expected—that the student's overall performance may suffer temporarily (as their brains are preoccupied with learning the one skill to the exclusion of the whole) but once that is learned (and that neural pathway is well-established) then the student can work on integrating it into their overall knowledge.

The coaching model brings up the idea of *rehearsal*, namely that because concepts held in short-term memory fade or decay unless used, one needs to keep practicing them in order not to lose them. (An everyday example of

this is repeating an unfamiliar telephone number to oneself in order to remember it in the short term.) For the teacher this implies the importance of repetition of key ideas, so that students don't lose track of them during the lesson. Even better is to build in *redundancy* and opportunities for students' *reflection* — for example, foreshadowing, referral, comparisons with related concepts, and different methods of presentation both in order to address the need to keep key concepts alive in short-term memory and to take advantage of its dual-channel nature.[v]

Should one bring up ideas like "rehearsal" and "redundancy" with a teacher and let them stand on their own merits with only "it comes from cog-sci research" as a supporting basis? Possibly not, unless you can link those ideas to practices in the teacher's field of study (or everyday life) you risk not providing the bridging needed for the teacher to activate and use that knowledge later when they're actually teaching. Fortunately if they're interested enough to be discussing these matters in the first place, they may be familiar with something like the classical learning cycle; even better, much of what we can glean from cognitive science maps nicely onto a learning cycle framework.[vi] Undertaking a complete mapping of the learning cycle onto our understanding of cognition would require a separate essay but it is worth noting that in presenting such a mapping (in whole or in part) to a teacher already familiar with the learning cycle you yourself are performing the same sort of "chunking" of low-level information into higher-level organizational units that you might suggest a teaching do for his or her students. This allows the learner (whether your teacher-client, or that teacher's student) to use up fewer "slots" in their short-term memory in thinking about it, since the unfamiliarity with the low-level information gets subsumed by the more familiar higher-level units. Also this mapping creates 'bridging' between current knowledge and new ideas so s/he can access it more easily later.

Back to the Brain

There's one more cognitive factor that comes into play in the learning cycle: it turns out that the creation of robust neural connections is strongly fostered by the presence of neurochemicals associated with feeling an emotional connection to whatever is being thought about. In other words, learning for long-term retention is more likely when the learner feels an emotional attachment to the material.[vii] (This should come as know surprise, since our strongest memories tend to be of our most emotional experiences.)

Reflection, in general, is both an intellectual and an emotional process. I tend to think of it as the learning cycle being bathed in a nutritive bath of emotive neurochemicals, but you can use whatever metaphor works best for the teacher you're working with. So in the end, the idea that making your students care about the material isn't just fluffy "ed school talk" but has a strong scientific rationale behind it.[viii]

There are other ways you can **use** cognitive concepts in working with faculty, but may want to be careful how and when you choose to do so. For example, if a given teacher's lesson plans implicitly seeks either simple stimulus-response patterns (e.g. asking students only factoid-type questions requiring no thinking) or raw information transfer from teacher to student (e.g., cramming in maximal content with little context or redundancy), but the teacher's assignments look for a high level of analysis or synthesis on the students' part, simply pointing out the contradiction is a form of cognitive conflict that at least has a chance of making an impression — i.e., of breaking the teacher out of a familiar but undesirable cognitive-behavior pattern. No teacher wants to create parrots or automatons out of their students!

The above may be an extreme example that you use with caution, but those times when you come across lower-stakes examples of cognitive conflict within a teacher's practices can be prime opportunities to bring up **why** breaking a student out of a prior misconception or misapplied skill by using cognitive conflict often makes for a powerful learning moment. Hopefully this essay has brought to mind for you other ways in which you can use the content of your discussions with teachers to illuminate for them.

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[i] Even though I use it here, *short-term memory* is no longer a favored term among researchers, who now refer to the brain's buffer of currently in-use information as *working memory*, or as a combination of *sensory memory* + *working memory* [see for example Mayer & Moreno, 2003. *Educational Psychologist*, 38(1), 43-52.]

[ii] E. F. Redish, 2003. *"Teaching Physics with the Physics Suite."* (Wiley)

[iii] *ibid*.

[iv] In fact, the ultimate novices – newborn babies – grow new neurons only for the first year or so of life; from that point on learning seems to consist mostly of creating new, efficient neural pathways using existing neurons. The more one learns something, the *fewer* neurons need to fire in order to think about it effectively. [cf. J. Zull, 2002. "*The Art of Changing the Brain*." (Stylus)]

[v] A nice side-benefit of bringing up students' learning practices (such as self-reflection) specifically in relation to a teacher's pedagogical practice is that they can be seen as leading directly to the idea of "active learning"— in that the students are engaged cognitively,

intellectually and personally with the material —while bypassing any debates as to the specific definition of active learning and of what particular activities students need to be performing for a given lesson or activity to "count" as active learning per se. To the extent that the teacher fosters students' *intentional* self-reflection, you may see that as a jumping-off point to discuss such student metacognitive practices in general – but that would also be a topic for another essay.

[vi] To see examples of such mappings, search online for "learning cycle Zull Kolb".
[vii] *ibid*.
[viii] I'm not disparaging "ed school talk" in any way, other than noting that teachers in the so-called academic disciplines can be wary of it, and so the research result can provide a counter if you do encounter such resistance. Note that in principle the students' emotional connection needn't be specifically positive or negative; what matters is the perception of emotional *importance*.

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