Metacognitive Skills – why bother (and how)?

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I. What is metacognition?

"Thinking about thinking" involves both explicit higher order cognitive skills (e.g., to measure of self-efficacy) and, operating on lower order, largely subconscious and automatic mental operations (e.g., memory, problem solving, text comprehension, or perception).

Types of knowledge

We commonly divide our knowledge into two types: declarative ("know that": facts, events, stories, theories) and procedural ("know how": abilities, skills). Declarative knowledge, unlike the procedural type, is in principle accessible to introspection and articulation and can be mastered in one exposure, while procedural knowledge requires practice to be maintained. Metacognitive knowledge is, by all accounts, procedural.

The literature divides metacognitive knowledge into three clusters, normally performed sequentially:

Metacognitive knowledge consists of awareness of

- Existing declarative and procedural knowledge
- Resources (time, attention, effort, assistance) required
- The action engaged in: calculation, analogies, summary, proof
- Degree of motivation, goals, intrinsic/extrinsic awards
- Compatibility of learning style with teaching style
- Level of understanding (comprehension, analysis, synthesis)

Metacognitive monitoring includes awareness of

- Text comprehension, detect errors/contradictions
- Information incompatible with intuition

- Critical features of a problem, create mental map
- Assess ability to make inferences from text
- Predict long-term recall/task completion

Metacognitive control involves actions such as

- Replace mistaken/incomplete beliefs
- Inhibit/suppress irrelevant activations, biases, wrong heuristics
- Change context of study (time, space, noise level, research resource, company)
- Modify problem-solving strategies: terminate/continue studying; adjust standards, revise level of engagement or pace, regulate; seek help, engage other resources; transfer strategies.

Sources of knowledge

Knowledge can be acquired innately (e.g., how to suck, walk, recognize mother's face), or "automatically" (like a first language), or deliberately from books, teachers, and other external sources.

To summarize:

Knowledge

Types	**Sources**
T1. Declarative Knowledge	S1. Innate
T2. Procedural Knowledge	S2. Automatic
T3. Conditional knowledge	S3. Deliberate

A major implicit misconception in education assigns metacognitive skills to the "automatic" domain. Many believe that if you only supply your students rigorously with content and academic skills, metacognitive skills will "emerge" naturally as part and parcel of intellectual maturity. Alas, the ability to examine oneself as a cognitive agent will develop naturally only to a pitiful rudimentary level. Therefore, we believe that our job as educators involves instilling motivation, significant amounts of critical reasoning, ***and*** metacognitive skills, and we should do that in every subject (including teaching racket-ball or music theory), and in almost every class.

II. What are the benefits of metacognitive skills?

Cognitive ability together with effort are considered predictors of strong academic performance. Mastery of metacognitive skills, however, contributes greatly to developing a “hungry mind,” the drive to pursue and engage in learning opportunities, which proves to be a third important such predictor.

Research shows that explicitly teaching study strategies in content courses improves learning (Commander & Valeri-Gold, 2001; Ramp & Guffey, 1999; Chiang, 1998; El-Hindi, 1997; McKeachie, 1988). Research also shows that few instructors explicitly teach study strategies; they seem to assume that students have already learned them in high school—but they haven’t. (McKeachie, 1988). Rote memorization is the usual learning strategy—and often the only strategy—employed by high school students when they go to college (Nist, 1993). They place blind faith in memorizing and end up insisting their inaccurate answers were correct because their memory can't have been wrong.

James Lang (2012) asserts that students’ inability to assess themselves leads to a mistaken sense of confidence about their knowledge and understanding, that is often shallow, fragmented, infested with misconceptions. Metacognitive skills can encompass many different learning strategies. The literature presents a variety of information on metacognitive skills and an increase in learning, however, often the causality for the learning is not well-established. Causal studies conducted on specific learning outcomes, such as Kramarski and Ritkof’s (2002) research, are more useful. The authors found that students instructed in metacognitive strategies performed better in constructing and interpreting graphs. Prins, Veenman and Elshout (2006) concluded that the effect of metacognition on learning physics is significant for moderately difficult tasks. In an important study, Trainin and Swanson (2005) compared GPA, reading comprehension, and vocabulary scores of college students with learning disabilities to those of students without learning disabilities. They found that using metacognitive strategies allowed students to compensate for their disabilities and achieve scores at least as high as students without disabilities.

The goal of education is also to prepare students to adapt flexibly and efficiently to new situations and transfer their acquired procedural knowledge to solving novel problems. Techniques that instill metacognition allow students a sense of control over their own learning, alleviate anxiety, enhance motivation, reduce incompetence and unwarranted confidence, and hopefully generate life-long learners. More specifically, metacognitive skills allow:

- Awareness of the effectiveness of one’s approach to problem solving, of methods for monitoring the process of problem solving, and the knowledge required to revise unsuccessful strategies when necessary.
- Familiarity with one’s own learning styles in relation to modes of presentation and types of problems (e.g., serialistic to holistic).
- Flexible and efficient adaptation to new situations, and transfer of procedural knowledge to novel settings.

- Sensitivity to external constraints (time, resources, help) and internal obstacles (level of expertise, motivation, effort required, affect).
- Understanding the different levels of understanding, e.g., as demarcated by the abilities to summarize, criticize, analyze, synthesize, etc.
- Reduction of well-embedded misconceptions that normally inhibit the acquisition of the academically accepted theories and explanations.
- Development of mechanisms to utilize cognitive heuristics and overcome biases related to material and tasks.
- Enhanced motivation stemming from the empowerment felt in gaining control of the learning process, and self-regulating problem solving.

III. Some cheap instructional tricks

The culture of disconnection that undermines teaching and learning, says Parker Palmer in "The Courage to Teach," is driven in part by our Western commitment to think in polarities. The distinction between the teacher (the sage on stage with all the answers) and the student (the obedient recipient of knowledge) may be beneficial in some domains such as driving and open heart surgery, but it fails to be effective in academic settings, where the goal is to turn students into thinkers and not merely containers of information. Effective learning calls for active participation of the learner in the process. As Leamnson states, "Learning takes place only when the synapses that enable understanding are used repeatedly until they stabilize" (2000, p.37). He warns, "Simply getting students active or talking in groups or having fun will not alone produce learning" (2000, p. 40). Students must become inspired to actively engage in the material, both in and out the classroom. Some of the following simple and time-efficient techniques we have found beneficial are:

(i) Ask students to estimate their grades on tests, assignments, or projects. If they continuously deviate by 15% or more, they should account for the discrepancy by explaining how exactly they completed the task, in what environment, and what resources (effort, time, help) they have relied on.

(ii) Establish a communication device (a primitive form of "clickers") where students show their level of understanding or ability to apply the concept quantitatively (with their fingers, palm facing the teacher).

(iii) Use attribution theory-- Luck, Ability, Task, Effort--to generate self-reflection. Students' reaction to their success or failure depends on what they attribute it to. Explaining a failure on a math test by citing inability to deal with abstract concepts, for instance, is likely to raise the probability of continuing failure. Attributing a good grade on a test to having studied the questions that luckily appeared on the test re-enforces low self-confidence. A change in self-attribution can be enhanced by exposing students to their natural tendencies, and explaining the relationship between emotional maturity, academic maturity, and the attribution one makes for achievements. Our normal attributions are:

Luck: performance is purported to depend on the whimsical or random nature of daily events. Examples: "I was sick the day we covered the stuff," "I didn't study the right material," or "The dog ate my homework."

Ability: performance is assumed to depend on genetically endowed skills. Examples: "I'm not good at math/logic/thinking/music/writing," "I can't understand lectures, only one-to-one tutoring," etc.

Task: failure and success is attributed to the task, the teacher, or the grader, For instance: "The instructor is lousy," "The test was unfair / too difficult / boring / ambiguous / irrelevant," "The grader is too tough," "Grading is completely arbitrary: my girlfriend copied from me and got a better grade."

Effort: Attribution of performance causes is correlated with hard work, so success is within control. Examples: "I didn't study enough," "I realized why I failed the last time, and prepared properly for this test."

Decentralized instructional methods

Perhaps the ultimate in the "super active learning" required for real learning takes place when the student plays the role of a teacher outside the classroom. In particular, we recommend the following two techniques:

TEACHER	STUDENT	METHOD
1. Expert	Novice	Teach the beginner
2. Insider	Outsider	Teach the lay-person

EXPERT-NOVICE TUTORING is a remarkably successful device, in which everyone wins. Lower class (e.g., introductory class in your field) students can ask for a free tutor by handing the teacher a note with their e-mail address; the notes are then distributed among the upper class volunteer students, who provide three tutoring units (60-90 minutes each) for extra credit points.

The Expert-Novice project involves students on a voluntary basis, while both groups work hard and benefit greatly from the experience. The novices need to come prepared for their tutoring sessions; they are expected to complete all assignments given to them by the expert (on top of their regular class work), and to know exactly what they need help with. The experts prepare carefully by completing all the work given in the novices' classes, make sure they do not participate unknowingly in directly helping with assignments to be handed in for a grade, anticipate difficulties, and develop their own exercises and homework for their students. Pairs should be invited to come together to consult with the instructor when they encounter academic or social difficulties, and toward the end of the semester they should fill out a report detailing when they met and what material was covered. The self-selected experts are often not the fastest students, who may have no need for extra credit points, but rather the B and C students who gain an A status as a result of having to teach the material they may struggle with. The reports from "experts" and "novices" show an outstanding effect on both. The sense that develops very quickly is that of accountability for the novices' progress during the semester, a sense shared by both parties. Most pairs continue working together well beyond the extra-credit reward limits, rewarding both the novice and the expert with knowledge, deep understanding, and intellectual satisfaction.

TEACH THE LAY PERSON takes place when a difficult concept or distinction is conveyed in class, or when an explanation for a theory or a phenomenon tends to contradict "common wisdom," creating a contrast with commonly held naïve misconceptions. In this active learning strategy, each student is assigned the task of teaching that material to someone outside of class (parent, sibling, friend, room-mate), who is probably confused about this concept or rule, and the task of gently "setting them straight." The students submit a detailed report about their teaching assignment: who the student was, how they detected his confusion about the topic at hand, what methods they used for explaining the difficult point, and how they tested the student for comprehension. Of all of the above-mentioned methods for reducing the effect of prior false beliefs and of incorrect approaches on learning, "teach the lay person" seems to be the most effective.

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