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Can students get better at thinking about how they think?

How often do you consider your own thinking?

Example 1: when examining your research data, how often do you say – "*I thought those trends suggested x.y.z., but now I think they should be tested further.*" This is you the expert geoscientist thinking hard about how your thinking is working, and whether it's on track.

Example 2: when reading about a new potentially important method, how do you take notes? How to you "chunk the information" so that you will most efficiently learn the new ideas? Or, how often do you say to yourself – *"hey, wait a minute, that doesn't make sense …".* This is you the expert learner keeping track of how your thinking is working, and constantly deciding how to adjust your mental analysis as you move towards understanding.

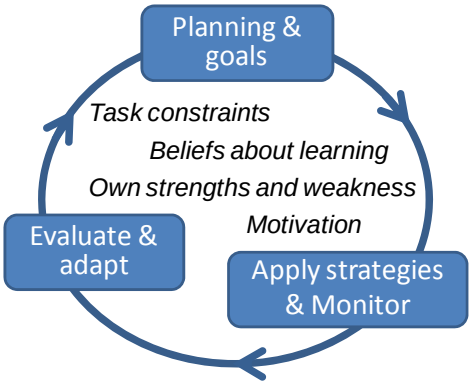
Are students expert learners (yet)? Are they expert geoscientists (yet)? Can we help them get better?

Metacognition, or thinking about your own thinking, is an integral part of "self regulated learning".

Metacognition is a broadly used term encompassing many related aspects of both learning and functioning as an expert. Descriptions of metacognition in two commonly cited books illustrate the breadth of the issue:

1. Bransford etal (2000) describe metacognitive abilities as those that focus on sense-making, self-assessment, and reflection. Highly developed metacognitive skills are noted as **an important part of distinguishing experts from novices**. The authors suggest that characteristics of pedagogies which address metacognition include: (i) explicit support for developing relevant frameworks; (ii) encouragement of abstraction; (iii) conscious evaluation of progress; (iv) learning specific content in some depth; and (v) persistent awareness and use of the available foundational knowledge.
2. Handelsman etal (2006) refers to metacognition **in the context of learning** as "the internal dialogue about what is being learned", and state that it includes "the process of setting challenging goals, identifying strategies to meet them, and monitoring progress toward them". The latter two aspects, in addition to addressing student's beliefs about learning, are also the focus of Lovett's approaches to **teaching** metacognition (Lovett, 2008).

If thinking can be loosely described using the figure to the right (Lovett, 2008) then pedagogies supporting development of metacognition will include explicit support during one or more parts of the cycle, and may withdraw that support as learning progresses.
One common thread among pedagogies that actively help improve metacognitive skills is that they are **rich in feedback.** For example, focused social settings such as discussions, team or group work, tutorials & recitations, or individual tutoring, are situations which can provide feedback which is highly responsive to both the context and the individuals.



Specific examples in EOSC courses of situations that target improvement of metacognitive skill

EOSC350, Applied Geophysics (mainly 3rd or 4th year geology or geo-eng students)

In this course, several classes are spent on carefully designed team exercises. These require teams to make complex, multi-faceted decisions, report in very simple forms, then justify and discuss choices as a whole class. The whole process provides rich opportunities for team members to debate, think, and rethink as individuals, in the focused social setting of teams, and as a whole class, all under the guidance of an "expert" instructor. For

details about this and other important aspects of how Team Based Learning works, see the UBC Applied Science TBL website at http://teambasedlearning.apsc.ubc.ca/ .

EOSC114, Natural Disasters (a service course for all UBC students)

Clicker questions used in class can help students think about their thinking. For example, students can be asked to respond to a carefully designed concept-based clicker question first individually, then (after seeing results) again after discussing options with peers. Results of the second try can be followed up by the instructor either directly or by soliciting further discussion from students. Instant feedback, discussions with peers, and guided discussion with the instructor all force students to think hard about how they are thinking. This is vastly more "metacognitive" than sitting listening to one person deliver a story (ie lecturing).

EOSC332 Tectonic History of North America (3rd or 4th year geology students)

Strong writing & editing skills are highly metacognitive. In our final written assignment, students are required to produce a draft of their paper which is then edited and evaluated by at least two peers. Comments are returned to the author who then has a week to complete their final draft. This feedback encourages thinking about other peoples' work and consideration of strengths and weakness of one's own work. In addition, the rationale for the process is explained frequently to the students so that they explicitly recognize the importance and benefits of careful thinking about their own thinking.

ENVR200, Environmental Science I

A few examples of students demonstrating *thinking about their thinking*, obtained from various opportunities they are given to reflect on what's helping learning, and where challenges are (details in Jones, Harris, & Steyn).

- About CIQ's: *"…good to know what peers have written … so many thoughts in common ..."*
- About the individual's learning: *"… most engaged while explaining my group's poster to others*…"
- About logistics: "… *surprised by the lack of time provided to discuss group projects* …"
- About interactions with others: " …*distanced when some peers dominated discussions* …"
- Other: *"… I became a little frightened … don't think I've been committed enough* ..."

Some references related to metacognition:

1. This edition of EOS-SEI times is based partly on an essay written by Francis Jones (http://serc.carleton.edu/28574) for the workshop entitled "The Role of Metacognition in Teaching Geoscience" (http://serc.carleton.edu/25697), Nov. 2008.
2. Birmingham, C. and M. McCord; *Group Process Research: Implications for Using Learning Groups*, in Team-based learning: a transformative use of small groups, Michaelsen, L. K., A.B. Knight , L. D. Fink editors, Sterling, Va. Stylus Pub., 2004.
3. Bransford, J. D., Brown, A. L. & Cocking, A. R., editors (2000). *How people learn: Brain, mind, experience, and school.* National Research Council, National Academy Press, Washington, DC,
4. Handelsman, J., S. Miller, and C. Pfund; *Scientific Teaching,* W.H. Freeman & Company, and Roberts & Company Publishers (2006).
5. Lovett, M.C., 2008, Teaching Metacognition: Presentation to the Educause Learning Initiative Annual Meeting, 29 January 2008, retrieved from: http://net.educause.edu/upload/presentations/ELI081/FS03/Metacognition-ELI.pdf.
6. Michaelsen, L. K., A.B. Knight , L. D. Fink; *Team-Based Learning - A Transformative Use of Small Groups in College Teaching,* Sterling, Va. Stylus Pub., 2004.
7. Torp. L. and S. Sage, 2002, *From Problems as Possibilities: Problem-Based Learning for K–16 Education, 2nd Edition*, Alexandria, VA: Association of Supervision and Curriculum Development.

Contact EOS-SEI: You are encouraged to talk about your course(s) or teaching and learning in general by dropping by EOS-South 361 or contacting Francis Jones (fjones@eos.ubc.ca), Brett Gilley (bgilley@eos.ubc.ca), Josh Caulkins (jcaulkins@eos.ubc.ca), Erin Lane (elane@eos.ubc.ca) or Sara Harris (sharris@eos.ubc.ca).

For more faculty resources and information, see http://www.eos.ubc.ca/research/cwsei/.
Also, please watch for Brown Bag discussion sessions roughly once a month in the Tuesday 12:30-1:30 time slot.