The Icing on the Cake: How Metacognition Enhances Learning

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Metacognition refers to reflection or thinking about one's cognition. Its importance as a tool for teaching and learning is well established in the educational research literature. Evidence indicates that metacognition is one of the most powerful things educators can incorporate into their teaching to improve learning outcomes.[1] Moreover, and perhaps more importantly than just outcome achievement, metacognition plays a critical role in how learners know how to adapt, apply, use, and refine knowledge and skills. Teaching metacognitive strategies is critical to Next Level Learning. It prepares students to apply and use their learning in real-world contexts, even when those contexts are complex, dynamic, and uncertain.

Findings about the importance of metacognition are referenced in other articles on this site (such as Williams (2007) and Webb (2021)) and in our own introductory article for this series. In fact, we see metacognition as being at the very heart of Next Level Learning. As we have discussed in earlier articles, Next Level Learners can apply strategies for more effective learning based on an informed sense of how their own minds work. This helps them to understand their individual minds as well as how human minds, in general, work. For instance, knowledge about how human minds generally work might inspire reshaping one's study patterns, such as opting to plan several study sessions over the course of a week rather than cramming the night before. Knowing specifics about one's own mind might lead a learner to choose to study during the time of the day when s/he is most productive or to minimize stimuli that s/he finds distracting, and so on.

Unfortunately, attempts to use metacognition in the classroom sometimes fail to uphold the promise described in the research literature. Teachers are rightfully frustrated when the reflection activity that they have put time and effort into designing seems to have little impact on learning or performance. Likewise, students are often unclear about the purpose of metacognitive activities and may treat them like "busy work." There are at least three reasons why incorporating metacognition into instruction can fall short: 1) The activity is actually just cognitive and is missing the meta-level aspects, 2) What is being reflected upon is narrowly construed, and 3) The focus on cognition and metacognition are collapsed in a kind of time sharing so that learners are unable to attend to each. We consider these challenges in turn, suggesting ways to address them and describing how they lead to a conception of metacognition that supports Next Level Learning.

Focus on the "Meta" in Metacognition

What does it mean to focus on the meta level? Compare it to the icing on a cake. In baking a cake, we add all of the essential ingredients into the mixing bowl–flour, sugar, eggs and so on–mix them up and bake them. The ingredients for basic learning are like the ingredients in the cake. These represent the conceptual ideas, skills, etc. that we want our learners to learn. Metacognition sits above all of these

ingredients. Much as icing gets spread over the cake to enhance its flavor, metacognition is a process that is layered on top of our learning activities to enhance the outcomes. It is commonly assumed that thinking routines and strategies are inherently metacognitive, when in fact these are really the ingredients of cognitive processes – important ones! – to which the icing layer or "meta" level of reflection can be applied. Metacognition involves not just being aware of our thinking, but also describing, evaluating, managing it, and planning for what we might do similarly or differently in the future.

Evaluative and planful aspects of metacognition are critical for Next Level Learning because they empower students with a sense of agency to take charge of their own learning. Next Level Learners set goals and develop learning paths toward new understandings and abilities. This process involves being aware of one's interests and desired outcomes and understanding the steps required to pursue those paths. It also entails identifying gaps in one's knowledge and figuring out how to access relevant information and resources to move forward. To support Next Level Learning, metacognitive activities should encourage students to reflect on what they have learned, what they want to learn in the future, and how they will best learn it.

For example, a learner might realize that when reading an assignment, she adopts a passive stance and loses track of what she is reading. Pausing to reflect, she might realize that she is unclear on what the text says. By becoming aware of her lack of clarity and describing her reading process, she can then decide to learn and adopt more active reading processes and plan to apply them to future readings. For instance, she might stop and explain to herself what she just read, try to retrieve it without looking, or create her own response to the author about why she agrees or disagrees.

Additionally, focusing on the "meta" helps learners become aware of connections between pieces of knowledge. In our introductory article on Next Level Learning, we described a tension between deep understanding and flexible thinking: while deep understanding is a crucial part of learning, it can also lead the learner to feel "stuck" within the original domain or context in which the information was presented. Metacognitive exercises can help learners zoom out and see the bigger picture, recognizing structures and patterns that are similar between contexts and understanding how knowledge or skills that are learned in one context might transfer to another.

For instance, imagine students who are struggling to understand the concept of symbiosis in biology (e.g., the mutually beneficial effects of a bee pollinating a flower). A useful reflection activity could involve having the students list out the things that they understand so far about symbiosis, as well as the places where they are feeling confused. A student could then ask questions like, "Have I encountered any of these ideas before? How can these prior ideas help me to understand this new topic?" This might lead the student to recall a social studies lesson about the idea of "win-win situations," such as a negotiation that ends in a satisfactory outcome for both parties. Looking for similarities or analogous features across the ideas, as well as places where the analogy doesn't work, can help them to reach a deeper understanding of symbiosis.

Table: Metacognition in Action

Ways to reflect on your thinking (or feelings, actions, motivations, knowledge, etc...)	**What it might sound like**
Becoming aware	"This big history project made me feel confused and anxious. I had never written a research paper before, and it was overwhelming."
Describing	"I wasn't sure how to get started on my thinking. That made me anxious and so I just kept putting it off all week. Every time I thought about it, I got a little bit of a stomachache. When I did make time to think and dug in, I felt better at those moments. I didn't make enough time to dig into the project, so my thinking was still kind of surface level."
Evaluating	"Procrastinating wasn't a good idea – I didn't leave myself enough time to do the assignment properly. I just ended up having to rush to complete it on the night before it was due, and my teacher wasn't available to answer my questions because it was so last-minute."
Managing and planning for the future	"Next time I have a big project like this, I'll get started sooner so that I have time to break the assignment into chunks and get help along the way. I can also pay attention to my body and how I'm feeling. This will help me recognize if I am worried about an assignment, and I can stop and figure out what's making me feel that way."
Considering the environment	"I can try asking my teacher to give me some interim deadlines or check-in points. This will encourage me to get started sooner and catch any places where I am feeling stuck while I still have time to ask for help. I also know that fresh air and movement can help when I'm feeling anxious. If I'm having a hard time with an assignment, I can take a walk with my mom and talk my project ideas out with her."

Expand What We Can Be "Meta" About

The promise of metacognition can also fail when the focus of metacognition is too narrowly construed. Returning to the cake analogy, just as icing can enhance many different kinds of cakes, metacognition can enhance many aspects of learning. People often take metacognition to mean reflection on simply the cold, "rational" aspects of cognition, but reflecting on our emotions, our social contexts, our

motivation, our ideas, even the nature of knowledge itself can do a lot to enhance learning and performance.

A broad construal of the targets for metacognition is especially important for Next Level Learners. As described in earlier articles, Next Level Learners reflect upon and modify their own behaviors as well as the learning contexts to support their best performance. Understanding the relationship between the individual and the context is critical to doing so. Metacognitive strategies help learners to recognize interactions between their own learning strengths and challenges and the features of the learning environment in which they find themselves. Based on the interactions they've identified, learners can then begin to think about modifications that they might make to their actions and/or their environment to learn more effectively in the future. For instance, a student who knows that she is easily distracted by friends talking nearby, and who recognizes that the classroom is especially boisterous during the last period of the day, might seek to modify her learning environment by creating a quiet workspace in the corner of the room with noise-canceling headphones and a cardboard partition.

Metacognition is also critical for monitoring and managing our emotional states during learning, and it can help us to identify the kinds of conditions that tend to heighten certain emotions so that we are more prepared in the future. Earlier articles in this series considered the value in being attuned to one's "gut instincts" and to recognizing the emotional and physiological responses that a learning or performance context may elicit. This increased awareness empowers the learner to act more strategically. For instance, a learner may draw upon relaxation practices if they recognize that they are feeling threatened or anxious, or they may leverage epistemic emotions to pursue a line of inquiry that has instilled a sense of curiosity or wonder.

In addition to reflecting on one's internal affective state, Next Level Learners attend to external environmental contexts and modify their behavior based on this awareness. This includes recognizing the possible social consequences of an action, like "self-editing" before we blurt out a statement that might hurt the feelings of someone in the room. It also entails a broader awareness of the cultural assumptions we bring to the table (as shaped by our heritage and family upbringing, school experiences, and so on) and the ways that these assumptions may or may not align with the context in which we currently find ourselves. Metacognition can support the process of holding onto one's own cultural identity while adjusting to, and navigating within, new contexts by encouraging the learner to reflect on their personal commitments and the areas in which they are willing to be flexible or adapt. For instance, learning to isolate and control for variables in science is a central concept of Westernized science. Learners from cultures that stress relationships and connectedness might reflect upon the divergence from their own beliefs and choose to learn about, but not to adopt the epistemic commitments in isolating and controlling variables.[2]

Cognition and Metacognition Cannot Timeshare: Devote Time to Each

Finally, just as we wouldn't try to ice a cake while it is baking, we should not expect cognition and metacognition to happen concurrently. Engaging in metacognition requires holding information about our thinking in working memory and focusing on it to understand it and to make plans about how to

improve it. It involves a lot of what researchers call “cognitive load.” Rather than expecting students to engage in metacognition while they are working on developing a new understanding, we should dedicate time specifically for reflection. This doesn’t mean that it must wait until the learning is over; often the most effective times for metacognition are during the process of learning, but it does require taking a metacognitive pause to dedicate time to reflect upon the learning. This might happen several times throughout the course of a learning experience. One might think of it as icing a multi-layered cake as one stops every now and then to reflect upon and find ways to improve their learning process before moving on to the next layer.

In summary, we believe that these three moves – to focus on the meta, expand what we can be meta about, and to give unshared, dedicated time to cognition and to metacognition – can make a powerful contribution to learning. Far too often, teachers must scramble to cover a vast amount of material in the limited amount of time they have with their students, a challenge that has been exacerbated during the Covid-19 pandemic. When time is scarce, reflection activities that feel like “extras” are often the first to fall by the wayside. We would argue, however, that prioritizing metacognition is not only integral to the process of achieving deep understanding but a valuable investment toward students’ future learning. Students who are taught to reflect on their thinking in the ways that we have described above will be better prepared to incorporate feedback, navigate complexity, and chart paths forward, all things that will make them more effective and efficient learners in the long term. We encourage you to consider how making time for metacognition might help all of your students bring their learning to the next level.

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and innovating in the space of technology and learning to develop new visions for what is possible in developing human potential.

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[1] Yarnall, L., Freed, M., & Malone, N. (2019). Self-regulated learning. *Modernizing Learning: Building the future learning ecosystem*, 285-297.

[2] e.g., Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education,* 94(6), 1008-1026.