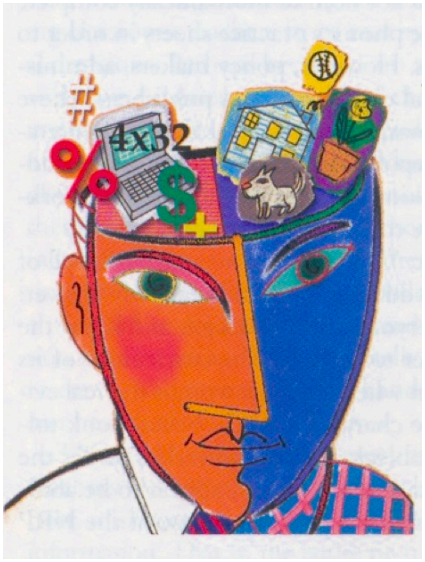
What Is Metacognition?



Teachers intuitively recognize the importance of metacognition but may not be aware of its many dimensions. Mr. Martinez explores the varieties of metacognitive skills and then offers suggestions for cultivating them in learners of all ages.

BY MICHAEL E. MARTINEZ

THE DISCOVERY and theoretical elaboration of metacognition constitute a major breakthrough in recent decades of cognitive research. While it is always best to begin with definitions, a concept as complex as metacognition demands that our initial definition be provisional. This definition will become more detailed and complete as our understanding grows. Many teachers would describe metacognition, quite acceptably, as "thinking about thinking." But I would propose a more precise definition: metacognition is the monitoring and control of thought. In this article, I seek to clarify the concept of metacognition and to present ideas about how metacognitive ability can be taught.

Metacognition serves many diverse functions, as does language. Consider what the Austrian philosopher Ludwig Wittgenstein had to say about language: "Think of the tools in a tool-box: There is a hammer, pliers, a saw, a screw-driver, a rule, a glue-pot, glue, nails, and screws. The functions of words are as diverse as the functions of these objects."[1] The toolbox is an equally apt metaphor for metacognition.

To give a sense of the breadth of metacognitive functioning, I have identified three major categories of metacognition: metamemory and metacomprehension, problem solving, and critical thinking. While this simple taxonomy does not exhaust the many types of metacognition, it does communicate the broad role of the process in important cognitive endeavors.

Metamemory and metacomprehension. I have grouped these two concepts together because both refer to an understanding of one's own knowledge state. To grasp metamemory, think about being asked if you are able to name the planets of our solar system in order of their distance from the sun. Now, you either can or cannot do so. But your answer to the question might be yes or no in either case. That is, you can be accurate or inaccurate in your appraisal of your own knowledge. Is this accuracy important? Yes, it is. Research has shown that this

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self-insight has predictive power for subsequent learning.[2]

Metacomprehension is a similar concept with similar importance to learning. Comprehension during reading or listening can be either good or poor. But independent of learners' true comprehension is whether they *realize* that their comprehension is good or poor. This appraisal can sometimes be very inaccurate. You can easily imagine a student reading a textbook page and not understanding it — and moreover not realizing that he does not understand it. Believing that one understands when one does not is a serious and common error. But even more serious is when students don't even consider whether they comprehend but simply take notes or read mechanically.

Problem solving. This almost exclusively human pursuit is a significant category of cognitive activity. Problem solving is exercised daily, often continuously, especially in a complex society where following established rules and procedures is not enough to succeed. Problem solving can be defined simply as the pursuit of a goal when the path to that goal is uncertain. In other words, it's what you do when you don't know what you're doing.

Scientific research is a form of problem solving; so is teaching. Neither of these enterprises is algorithmic. Both involve continuously generating possibilities, weighing those options, exploring subsets of options, and evaluating the results. Herbert Simon used the metaphor of finding your way through a maze to describe this process. Problem solving certainly involves cognition. But more is required: constantly stepping back mentally to appraise and rework plans by asking such questions as, What am I trying to accomplish? What are the most promising pathways? Is my strategy working?

Critical thinking. Like problem solving, critical thinking encompasses a lot of what human beings do — or at least potentially can do. While problem solving and critical thinking are distinct functions, they can be seen as complementary. Critical thinking may be a little harder to define, but here is a first approximation: critical thinking is evaluating ideas for their quality, especially judging whether or not they make sense. There are many metacognitive standards that apply to thinking critically. For example, when evaluating ideas or messages, we can ask:

- Is the idea stated clearly?
- Does one idea follow logically from another?
- Is the message logical, rational, and coherent? Or does it contradict itself or make unwarranted inferences or unsupportable generalizations?
- Are claims backed by evidence and analysis that are convincing and that conform to standards of inquiry (e.g., judging the probability of sampling error, establishing a control group, standardizing procedures, using reliable measurement)?

Critical thinking can take very specific forms. In fact, the methods of inquiry used in science and those used in other domains can be viewed as specialized tools developed over many years to focus a more basic and general orientation to critical thinking. Is metacognition a content-specific skill, or do metacognitive processes cross subject domains? On this question there are differences of opinion. Many researchers stress that the power of metacognitive skills is content-bound. But while it is easy to make a case that many metacognitive processes are content-focused, it seems unlikely that all important metacognitive functions are. The generality of some functions is stated plainly by Ann Brown in a seminal article on metacognition.

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> The skills of metacognition do appear to have recognizable counterparts in "real-world, everyday-life" situations. Checking the results of an operation against certain criteria of effectiveness, economy, and commonsense reality is a metacognitive skill applicable whether the task under consideration is solving a math problem, memorizing a prose passage, following a recipe, or assembling an automobile. Self-interrogation concerning the state of one's own knowledge during problem solving is an essential skill in a wide variety of situations, those of the laboratory, the school, or everyday life.[3]

METACOGNITION AND AUTOMATICITY

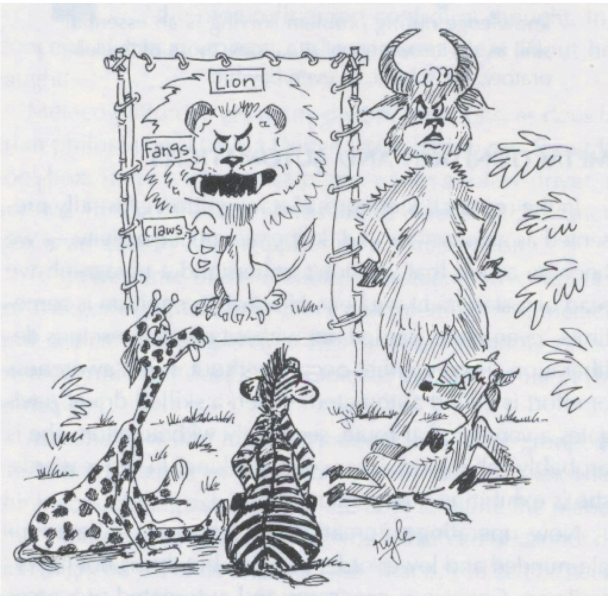
In the research literature, metacognition is usually presented as a conscious and deliberate mental activity — we become aware that we don't understand a paragraph we read or a statement we hear. However, cognition is sometimes, even often, carried out without much conscious deliberation. Thinking that occurs without much awareness or effort is called automated. When a skilled driver navigates a very familiar route, seemingly without effort, she is probably relying on automated thinking. In other words, she is exhibiting automaticity.

Now, operating automatically might seem to be a simple-minded and lower-order process, but this is not necessarily so. Conscious processes and automated processes often complement one another in complex cognition. Reading for comprehension relies, for example, on fluent decod-

ing skills that are automated, as well as on more deliberate cognition about themes and connections between ideas.

Automaticity, therefore, aids and is essential to higher-order thought. Higher-order and lower-order thought generally work together rather than compete because of the limited capacity of what is described as working memory. Working memory is the part of the mind that holds information temporarily for processing. A vital fact about working memory is that it is quite limited in capacity — we can hold only so much information in our conscious awareness at one time. If working memory is "filled" with information — say, from that needed to decode a text or to take notes on a lecture — there will be insufficient "room" in working memory to ask, Do I understand what I just read or heard? However, if reading skill and note-taking skills are automated and fluent, then their burden on working memory is reduced. Consequently, there is capacity left over for the monitoring functions of metacognition. In like manner, every complex mental task blends automated skills with critical, creative, and intelligent cognition.

Even metacognition can sometimes have the quality of automaticity. This became clear to me one day while I was teaching a class. A student noted a contradiction in something I said during a lecture and raised her hand almost reflexively — without any prior conscious thought, she said later. Perhaps this kind of automaticity is what we envision when we imagine a reflective person who has developed critical habits of mind. Metacognition can become so practiced, so normal, that as a mental habit it almost acquires the status of personality trait.



"You will appreciate this class when you get to the watering hole."

But surely, the desire to develop metacognition as a personal habit is not new. Socrates trained his students to develop habits of metacognition. We are all familiar with Socratic dialogue as a method of instruction, in which the teacher poses a series of questions and the student responds. But what was the point of those questions for Socrates? It was to reveal the gaps in understanding in the student as well as in himself. This self-insight — metamemory, if you will — was for Socrates a key aspect of wisdom. Folly, on the other hand, was the metacognitive error of believing one knows when, in fact, one does not. This misplaced confidence has been called the "illusion of knowing" and is a common phenomenon, even among college students.[4]

Metacognition can be related not only to the intellectual ideals of Socrates but also to those of modern scholars. Consider Bloom's Taxonomy, at the pinnacle of which is evaluation. Why should evaluation be given such high status? Because all ideas can be evaluated critically for their quality — i.e., for their accuracy, coherence, and completeness. Metacognition can be seen as evaluation turned inward, especially turned toward our own ideas.

In fact, this characterization is compatible with the teachings of the Soviet psychologist Lev Vygotsky, who is best known for the concept of the zone of proximal development. Equally important, though, is his theory of higher-order thought. Vygotsky taught us that higher-order thinking begins as social discourse and that these discourse patterns are internalized over time and experience. We can imagine, for example, a debate between two parents who are trying to make a decision together — "We should do this because . . ." countered by "No we shouldn't because. . . ." When children eavesdrop on this kind of debate, ideally they will internalize the structure of an argument that weighs options and selects good ones. Later, when the child faces a complex decision alone, this same kind of internalized psychological debate can be put to good use.

METACOGNITION IN THE CLASSROOM

The pedagogical implication of Vygotsky's theories is that student interaction can contribute to high-quality thinking. Why is it that collaborative forms of learning are recognized as having great potential to benefit students? It is probably because of a vaguely realized sense that the capacity for higher-order thought is often cultivated by first engaging in it in a social setting, just as Vygotsky claimed. I have suggested that metacognition is implicit in many conceptions of the educated mind, going back as far as Socrates. It also resonates with the intuitions of many teachers, who often

recognize the importance of metacognitive skills and take steps to cultivate them in their students.

Just as the idea of metacognition has been understood implicitly, so has it been practiced implicitly for millennia in the form of apprenticeship in the crafts and trades. More recently within the professions, such apprenticeships as medical residencies have provided the social environment for the acquisition of patterns and standards of reasoning. In science laboratories, metacognitive criteria are crucial to the interpretation of data. For example, an anomalous result could signal either an error or the possibility of a discovery.

Metacognition is important and consequential for learners of all ages. This leads to the all-important question of how metacognitive skills and habits can be developed in the classroom, whether elementary, secondary, undergraduate, or graduate. First, and most obviously, students must have the opportunity to practice and so must be placed in situations that require metacognition. Students should know the meaning and importance of metacognition, and the development of the capacity for it ought to be an explicit goal for both teacher and student. This goal must have a credible and enduring presence in the established curriculum and in assessments.

Second — and this connects to Vygotsky's teachings — metacognition can and should be modeled. When a teacher "thinks aloud," particularly during problem solving, his or her verbalizations can be a powerful source of cognitive processing that can be internalized by students. This has been called cognitive modeling, or what I like to think of as "making thinking audible."

Third, just as teachers should model metacognition, social interaction among students should be used to cultivate their metacognitive capacity. If students are encouraged and guided to think critically together, then their spoken reasoning will ideally make their cognitive tools available to one another.

I do not want to leave the topic of metacognition having stressed only its coolly rational elements. Metacognition also involves emotional and motivational considerations. Because metacognition is required in demanding situations, it entails the management of emotions that often accompany difficulty, uncertainty, and the possibility of mistakes and failure. Metacognition might also involve learning positive emotions associated with accomplishment, focus, overcoming obstacles, and the possibility of creative solutions.

On the self-regulatory side, persistence in the face of difficulty can be crucial. Metacognitive thought can support persistence and focus. Students can learn to coach themselves: "Stay on track." "Don't give up." "Concentrate." Related to persistence are belief systems that emphasize the role of effort, rather than fixed ability, in ultimate success. The corresponding thought is: "With enough effort I can learn this."

CONCLUSION

Although the term metacognition is a relatively recent invention, its practice is as old as rational thought. As long as people have evaluated ideas for their quality and sought to improve those ideas, they have performed metacognitive operations. Yet something is to be gained by giving this practice a name and being clear about its meaning. Fortunately, metacognition can be defined simply, and it is also fairly easy to identify teaching methods that will encourage metacognition.

Metacognitive ability is central to conceptions of what it means to be educated. The world is becoming more complex, more information-rich, more full of options, and more demanding of fresh thinking. With these changes, the importance of metacognitive ability as an educational outcome can only grow.

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1. Ludwig Wittgenstein, *Philosophical Investigations,* 3rd ed., trans. G. E. M. Anscombe (Englewood Cliffs, N.J.: Prentice-Hall, 1958), p. 6.

2. Sigmund Tobias and Howard T. Everson, *Assessing Metacognitive Knowledge Monitoring* (New York: College Board, Report No. 96-1, 1996).

3. Ann L. Brown, "Knowing When, Where, and How to Remember: A Problem of Metacognition," in Robert Glaser, ed., *Advances in Instructional Psychology,* vol. 1 (Hillsdale, N.J.: Erlbaum, 1978), p. 80.

4. Arthur M. Glenberg and William Epstein, "Calibration of Comprehension," *Journal of Experimental Psychology: Learning, Memory, and Cognition,* October 1985, pp. 702-18.