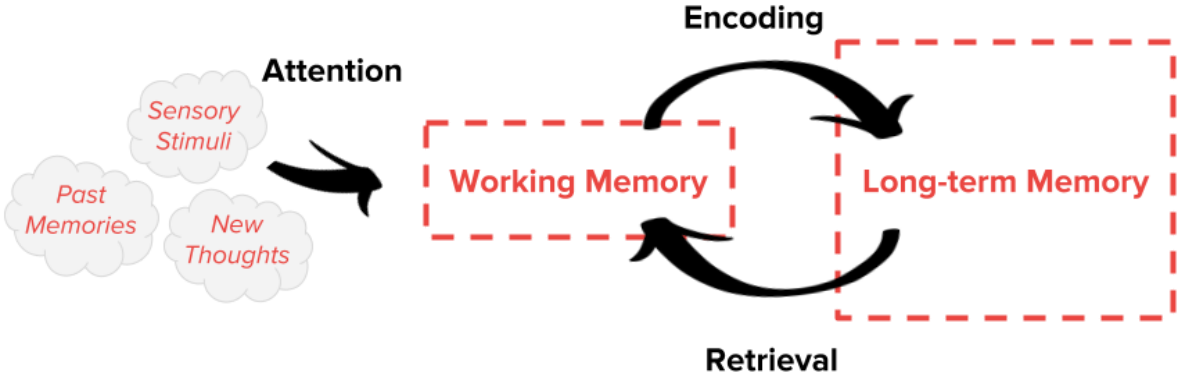
Part
1 | Cognition

Overview

Learning is hard work. It requires that individuals actively notice, grapple with, remember, apply and expand on new content and experiences. This involves complex cognitive processes like attention, encoding, and retrieval that occur through a relationship between working memory and long-term memory.



As the visual above shows, when learners consciously attend to something—whether it's new sensory stimuli, passing thoughts, or past memories—it is held in working memory. This is where learners grapple with ideas, make connections, generate understanding, and solve problems. These processes help learners encode information into long-term memory in ways that are meaningful and memorable. Then, by regularly engaging in practice, receiving high-quality feedback, and thinking about their own thinking, learning becomes even deeper and longer-lasting.

As designers, we can support this process by creating environments that honor the principles listed below.

Principle 1: Focused Attention	People learn best when they direct their focus toward the content and experiences most relevant to learning.

Principle 2: Manageable Cognitive Load	People learn best when they are challenged but are processing a manageable amount in their working memory.
Principle 3: Meaningful Encoding	People learn best when new learning is experienced in memorable ways and is related to prior knowledge.
Principle 4: Effective Practice	People learn best when they practice challenging-but-doable skills at frequent, focused intervals and across diverse contexts.
Principle 5: High-Quality Feedback	People learn best when they receive timely and targeted feedback to guide their improvement.
Principle 6: Metacognitive Thinking	People learn best when they are able to plan, observe, evaluate, and adjust their own learning processes.

Principle 1

Focused Attention

People learn best when they direct their focus toward the content and experiences most relevant to learning.

How It Works

Individuals are *always* learning. This may seem surprising at first, but it makes sense when we consider that the mind continually confronts **stimuli** from all kinds of different sources. These stimuli include sights, sounds, smells, tastes, or feelings stemming from new experiences. They also include spontaneous thoughts that are remembered ("Shoot, I needed to bring money for lunch today!") or that develop in the moment ("I think she's talking about me behind my back"). What learners attend to—or direct their focused **attention** toward—is held within **working memory** where it can be grappled with, made meaning of, or applied to accomplish a goal,[3] whereas *most* of what learners do not pay attention to is simply forgotten.[4]

Ideally, learners would attend to the stimuli most critical to learning. However, they may also attend to stimuli that are counterproductive to, or distract from learning. What learners attend to depends on many factors, including how salient information is to their goals and interests as well as to their physical and emotional needs.[5] [6] In addition, research suggests there is a hierarchy when it comes to how individuals process stimuli. Higher priority stimuli override lower priority stimuli.[7] This research indicates that the brain processes stimuli that pose a threat first ("I hear a siren getting closer"), followed by stimuli that generate strong emotions ("The character in this book reminds me of a terrible argument I had with my sister"), followed by goal-related stimuli ("I need to understand this concept to create a great experiment"). [8]

Implications for Learning Environments

We can't force learners to focus. However, we can remove or minimize distractions caused by physical or psychological threats, confusion, and competing sensory stimuli.

Learning environments should be designed to tend to any feelings of physical or psychological threat, inside or outside of school, because *a*

To support Focused Attention, learning environments should:

- ❑ Help learners feel physically and psychologically safe and healthy
- ❑ Ensure learning objectives and activities are clear
- ❑ Minimize sensory distractions

[3] Sousa, 2016
[4] Ibid.
[5] Ibid.
[6] Katsuki & Constantindis, 2013
[7] Sousa, 2016
[8] Ibid.

learner's cognition will attend to these first. These threats produce negative emotions that hijack a learner's attention. However, emotional distractors are sometimes given less priority within learning environments than distractors like noise. This should not be the case. We can intentionally design against emotional distractors by developing policies and routines that ensure our facilities are warm and secure. Example routines could include having adults check for a learner's emotional state at the door each morning or having a calming breakfast among peers to diffuse negative emotions versus a large group breakfast in a busy cafeteria. In addition, our curriculum could integrate contemplative practices to help learners manage stress. We could also develop additional adult roles or create partnerships with community organizations to ensure learners have access to health and wellness resources inside or outside the learning environment. We can also ensure educators and administrators are well-equipped to identify a learner's emotional state and help manage it.

Next, we must design against distractions resulting from confusing and overly complex learning objectives or learning activities. When this happens, learners are unsure where to direct their focus and may attend to the wrong content or engage in a task in the wrong way. To prevent this, we can ensure that curricula and other instructional materials are clear and organized. We can also ensure that adults have the knowledge and skills to communicate ideas to learners clearly and to design logical learning experiences.

Finally, we can address sensory distractions like excess noise, poor lighting, or even uncomfortable temperatures by designing physical spaces and facilities with good acoustics, considering the quality and brightness of lights, and ensuring rooms have temperature control whenever possible. We can also create community-wide routines and policies that foster a sufficiently calm environment without being overly restrictive, and grant flexibility with these routines and policies when needed.

Additional Resources

- **Focus: The Hidden Driver of Excellence** | Daniel Goleman
- **Strategies for Getting and Keeping the Brain's Attention** | Edutopia

Principle 2

Manageable Cognitive Load

People learn best when they are challenged but are processing a manageable amount in their working memory.

How It Works

Working memory is used to temporarily hold content and experiences important to learning. It's also where conscious thinking happens. Unfortunately, working memory is fragile and easily overwhelmed. In adults, working memory can only hold approximately three to five pieces of information at once and can only retain the information for seconds or minutes. In children and adolescents, this number is more like three or four chunks of information. In toddlers, working memory's capacity is even more limited; it can only hold approximately one or two chunks of information at once.[9] When **cognitive load**—the amount being held and grappled with in working memory at any one time—is too large, learners lose the ability to process new information. In fact, it's actually surprisingly easy for learners (especially those who are novices) to experience cognitive *overload*. This can occur when learners have to hold or process too many *new* things at once. It can also happen when working memory is forced to do extraneous processing that does not support the instructional objectives—factors such as hunger, stress, threats to identity, strong emotions, or lingering thoughts from past situations.

What is manageable for working memory varies across individuals and across contexts.[10] In other words, what is manageable for one learner may overwhelm another, even if they are similar ages and in the same learning environment. This is not *typically* because working memory itself is weaker or stronger across individuals—although neurodevelopmental differences like ADHD can diminish working memory—but because of learners' different emotional and physical states, as well as the relevant knowledge and expertise they already hold. In some cases, emotional and physical states may lead learners to have competing thoughts ("I feel like I don't fit in here" or "I'm incredibly hungry"). In other cases, a learner's lack of prior knowledge may increase cognitive load by forcing the learner to grapple with additional ideas that are beyond the scope of the learning objectives but are not yet held in long-term memory.

The latter example highlights the importance of **prior knowledge** to future learning—a finding backed by extensive research.[11] [12] Having prior knowledge or relevant existing expertise allows a learner to manage the concepts and tasks at hand more quickly and effortlessly and to grapple with new learning. This is because some automated processing can be done by

[9] Ibid.
[10] Willingham, 2008
[11] Tobias, 1984
[12] Lui ,Grady & Moscovitch, 2016

long-term memory.[13] For example, a reader who is automatically able to decode words and read with fluency has more capacity in working memory to focus on comprehension.

Implications for Learning Environments

If learners are grappling with more than their working memory can manage, they are unlikely to learn effectively. To prevent this, learning environments must continue managing distractions, organize learning objectives and activities thoughtfully, and support each learner to achieve competency in tailored ways.

To support Manageable Cognitive Load, learning environments should:

- ❑ Minimize cognitive and emotional distractors
- ❑ Break learning into manageable, logically sequenced increments
- ❑ Represent content and experiences clearly
- ❑ Respond to individual learner readiness with tailored supports and pacing
- ❑ Ensure individual learners achieve competency with prerequisite objectives before they move on

While focus helps individuals *attend* to the content and experiences essential to learning, ensuring a manageable cognitive load helps them *process* the content and experiences. In both cases, minimizing distractions is critical. This is because distractors can compete for limited working memory capacity even if a learner is attempting to focus. This again reinforces how important it is to help learners feel physically and emotionally safe by designing secure facilities, ensuring learners are supported by caring adults, and creating ways for learners to practice self-management as well as to access additional resources and supports when needed.

Preventing cognitive overload also has implications for how content and experiences are organized.[14] First, learning should be broken into manageable chunks and logically sequenced to support future learning. In addition, experiences should minimize confusion and extraneous processing. For example, when multiple modalities—such as visuals, text, and sound—are all used at once, these modalities should complement each other instead of competing with each other since processing competing information can unnecessarily occupy a learner's limited working-memory capacity.[15] [16] [17] To accomplish this, we can hire and train educators who have the knowledge and skills needed to design clear and organized curricula, learning activities, and materials. Alternatively, pre-designed curricula can free educators up to spend more time working with learners. Either way, as these resources are developed, we'll need to ask tough questions like: How many standards can we really expect a learner to "master"? And how much time do learners realistically need to reach mastery? Minimizing distractions should also push us

[13] Sweller, 2011
[14] Ibid
[15] Clark & Mayer, 2011
[16] Tabbers, Martens & van Merrienboer, 2004
[17] Tindall-Ford, Chandler & Sweller, 1997

to reflect on other parts of our designs too. For example, we should consider how much thinking our physical spaces require learners to do, and whether that thinking supports learning or is a distraction. In many cases it may be helpful to develop some routine learning activities—such as using the same Socratic seminar format every Friday—to prevent learners from having to build understanding of new processes over and over.

Our designs should also empower educators and learners to adjust fluidly in response to individual readiness and should ensure each learner achieves competency with critical prerequisites before moving on. A competency-based and customized approach like this is very different from what schools traditionally do and thus requires new design choices. For example, this approach calls for a more robust and flexible curriculum than is typically the case today. This curriculum should allow learners to move through content in different ways and should have scaffolds embedded within it to support different learners, such as different representations of information, graphic organizers, worked examples, or adult or peer support.[18] [19] Assessment practices will also need to shift from being primarily whole group activities that occur at single, fixed intervals, to being available on-demand to individual learners as they work through learning objectives *and* until they achieve competency with those objectives. Lastly, because learning requires ongoing retrieval, curriculum and assessments must consider how best to spiral and revisit content over time.

Additional Resources

- **Combating Cognitive Load** | Sanford Inspire
- **Cognitive Load Theory** | MindTools
- **Information and Cognitive Overload, How Much is Too Much?** | Richard L. Byyny

[18] Deans for Impact, 2015
[19] Vygotsky, 1978

Principle 3

Meaningful Encoding

People learn best when new learning is experienced in memorable ways and is related to prior knowledge.

How It Works

The limited processing capacity of working memory means **long-term memory** is critical for *lasting* learning. Long-term memory is the mind's deep storage space. The knowledge, skills, and mindsets in long-term memory are retrieved and get applied to material in working memory to guide decisions and actions. When complex tasks such as driving or reading are practiced sufficiently, they become automated by long-term memory. The knowledge and skills stored in long-term memory free up capacity within working memory to grapple with *new* topics and ideas. Luckily, long-term memory is both broad and deep, holding a vast quantity of memories and retaining them for months, years, or even a lifetime. However, storing new learning in long-term memory requires that individuals successfully **encode** it first. Encoding is the process of *taking in* information and then *relating* it to what's already known. Research suggests the basic goals when encoding new learning should be to make the initial intake of content and experiences distinctive—or unique and memorable—and to create **organizing schemas** that connect and relate different content and experiences.[20]

A memory can be made more distinctive through elements of the context that are present when the memory is first made—like sights and smells—as well as a learner's emotional state at the time. This is why moments associated with strong emotions like anger or awe are more likely to be remembered later. It is also why certain images or scents can trigger vivid memories. These memories are often referred to as flashbulb memories.[21] However, emotions like anxiety and fear can also embed negative experiences, and the beliefs and mindsets associated with them, into learners' long-term memory. This is one reason adverse childhood experiences (ACEs) can be so detrimental to development and learning—these experiences are embedded in long-term memory and may be triggered by sights, sounds, smells, feelings, or other contextual cues associated with the traumatic event.

Successful encoding also involves learners relating and building on ideas in ways that are logical and personally meaningful. This process is sometimes referred to as **cognitive elaboration** and involves connecting and grouping ideas into organizing schemas.[22] The relationships learners establish through these organizing schemas may be factual ("This event happened before that one") or conceptual ("The core themes here are the same"). Organizing

[20] Sweller, 1988
[21] Hunt, 2003
[22] Klein & Loftus, 1988

ideas into thematic categories, connecting visuals with written ideas, developing mnemonic devices, and outlining information are all examples of ways learners commonly develop organizing schemas. Research suggests that the importance of cognitive elaboration is likely part of the reason why generating one's own understanding of a topic can be so impactful.[23] It is also why having related prior knowledge helps to accelerate future learning—prior knowledge provides something for new learning to be related to.[24] [25] This increases the likelihood that the new learning will be remembered.[26] Continually expanding prior knowledge enables long-term memory to grow exponentially—the more that is stored in it, the easier it is to keep adding and the more complex ideas can be.

Implications for Learning Environments

Encoding content and experiences into long-term memory effectively must be a priority, otherwise what young people learn will not last. We can support this by making the actual experience of learning memorable, as well as by helping young people connect what they are learning to what is already in their long-term memory.

To support Meaningful Encoding, learning environments should:

- ❑ Promote distinctive or emotionally compelling learning experiences
- ❑ Ensure learners connect new learning to their prior knowledge and experiences
- ❑ Help learners make underlying factual and conceptual connections
- ❑ Integrate multiple representations of content through different modalities, problem types, and contexts

We can make the experience of learning more memorable by designing activities and contexts that inspire emotions like wonder, surprise, and even purposeful anger, as well as by building sensorily-rich (though not overwhelming) environments. Our designs can achieve this by, for example, connecting learning to topics that young people feel wildly angry or curious about, integrating hands-on learning experiences that appeal to learners' senses into the curriculum, or varying the physical space within which learning happens in purposeful ways. Collaborative learning can also foster positive emotions, plus it provides learners with a context to explain, compare, evaluate, and revise their understandings, leading to improved organizing schemas. However, all of these actions must be done in a way that supports learning goals versus just introducing new stimuli that might distract learners from the task at hand.

Once we design memorable processes and contexts for learning, we can work to help young people build rich organizing schemas for what they learn. These organizing schemas are created when learners make factual and conceptual connections between different things they

[23] Schmidt, 1983
[24] Tobias, 1994
[25] Lui ,Grady & Moscovitch, 2016
[26] Klein & Loftus, 1988

are learning. For example, a learner might see a cause and effect relationship between two historical events or a similar theme across two novels. They are also created when learners connect new learning to their own individual prior knowledge and experiences. Generating one's own understanding of a topic is a powerful way to support the development of organizing schemas because it requires learners to unpack relationships and use prior knowledge to make meaning of something new. Hands-on, discovery-based learning is one pedagogical approach that supports this. However, it also requires us to make hard decisions about pacing to ensure all learners have sufficient time to really grapple with tough concepts. Without sufficient time, learners may struggle to achieve competency with the knowledge and skills they will need to support subsequent learning. Unfortunately, many adults are not trained to facilitate the type of learning that supports meaningful encoding. They may feel uncomfortable letting young people grapple with ideas themselves versus providing them with the answers. Or they may not be well-versed in asking questions to deepen understanding or in providing appropriate scaffolds. Luckily, we can account for many of these barriers if we are proactive with our designs.

Additional Resources

- **Creating Multi-sensory Experiences to Improve Memory Retention** | Sanford Inspire
- **Engaging Emotions to Improve Memory Retention** | Sanford Inspire
- **Dual Coding** | The Learning Scientists
- **Organizing Information to Improve Memory Retention** | Sanford Inspire
- **Elaboration** | The Learning Scientists
- **Concrete Examples** | The Learning Scientists
- **What Works, What Doesn't** | John Dunlosky, Katherine A. Rawson, Elizabeth J. Marsh, Mitchell J. Nathan, and Daniel T. Willingham

Principle 4

Effective Practice

People learn best when they practice challenging-but-doable skills at frequent, focused intervals and across diverse contexts.

How It Works

Even if new memories are initially encoded into long-term memory, they may be forgotten without effective practice. Practice ensures a learner is engaging in **retrieval**—the process of drawing stored memories back into one's working memory to apply them. Retrieval itself helps to more deeply "wire patterns and processes into long-term memory"[27] and makes learning long-lasting.[28] Individuals engage in retrieval all the time: a simple example might be thinking repeatedly about a favorite scene from a movie. In learning environments, research suggests there are various characteristics that make practice more effective and enhance retrieval. Specifically, practice should be:

- **Purposeful** - Goal-oriented practice consciously devoted to achieving a specific, well-defined goal or skill that is important for a learner to achieve.[29]
- **Rigorous** - Practicing at the edge of one's "comfort zone" just beyond what is automatic for the learner so it is doable, yet challenging.[30]
- **Spaced** - Practicing in multiple sessions distributed over time versus all at once.[31]
- **Interleaved** - Mixing up, or weaving together, practice with related topics through different types of problems that require different strategies.
- **Across Contexts** - Practicing across diverse, authentic contexts to support transfer.[32]
- **Frequent and Focused** - Practicing at routine intervals that are brief enough to ensure 100% focus.[33] [34]

As these characteristics demonstrate, effective practice does not entail "cramming" or rote practice of the same types of problems over and over. These forms of practice may help a learner remember something for a short time, but the learning will not be as long-lasting as it would be with more effective forms of practice.[35]

Implications for Learning Environments

Learning environments must know what individual learners need to practice, as well as provide a sufficient number of well-designed opportunities to do so.

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[27] Hess & Saxberg, 2014, p. 41
[28] Melton, 1963
[29] Ericsson & Pool, 2016
[30] Ibid
[31] Hess & Saxberg, 2014
[32] Kirschner & van Merrienboer, 2008
[33] Willingham, 2004
[34] Ericsson & Pool, 2016
[35] Ibid

Understanding the current proficiency level of each learner is essential to designing impactful practice. If practice is focused on skills learners have already mastered, or the level is not matched to their current skill level, then it will not help learners improve. However, few schools have systems that allow them to understand each learner's proficiency in a comprehensive way, such as on-demand, formative assessment systems or competency-based approaches to grading.

To support Effective Practice, learning environments should:

- ❑ Use each learner's current proficiency to plan opportunities for practice
- ❑ Provide learners with ongoing opportunities to engage in focused, frequent practice, across diverse contexts
- ❑ Build learners' own understanding of effective practice

Our environments need to provide sufficient opportunities for effective forms of practice. As discussed earlier, this means practice is frequent, but spaced out; short enough to ensure learners can devote their complete focus to practicing; woven together—or interleaved—so learners are applying different but related skills and working through various types of problems; and occurring across different contexts and disciplines. Achieving this can be tough. Traditional school designs sometimes foster a sense of urgency and an inclination to push forward in the curriculum instead of building in more opportunities for practice. In addition, content areas are often very siloed from each other, making transdisciplinary practice rare. In addition, many adults are not deeply trained in the science of effective practice, making it hard for them to design for it. To combat this, our designs should purposefully consider the knowledge, skills, and mindsets adults need to support effective practice and work to build them. They should also consider ways to integrate more interdisciplinary work as well as ways to ensure the schedule and pace of learning provides sufficient time for practice.

Finally, for learners to become more self-directed, it's critical for them to understand the importance of practice and to know what effective practice does and does not look like. We can support this by building a culture of practice and explicitly teaching learners about the science of practice, just like we teach the adults who support them.

Additional Resources

- **Retrieval Practice Library & Downloads** | RetrievalPractice.Org
- **Spaced Practice** | The Learning Scientist
- **Interleaving** | The Learning Scientist
- **Retrieval Practice** | The Learning Scientist
- **Strengthening the Student Toolbox** | American Educator
- **Expert Practice** | Character Lab

Principle 5

High-Quality Feedback

People learn best when they receive timely and targeted feedback to guide their improvement.

How It Works

Practice alone is not enough; in order to optimize learning, it must be coupled with targeted feedback. Targeted feedback helps address misconceptions and guides further practice. However, not all feedback is equally effective for supporting learning. Feedback should be:

- **Specific and Accurate** - Feedback should accurately communicate *specific* aspects of performance relative to *specific* goals.[36]
- **Process- *and* Outcome-Focused** - Feedback about both the process *and* the outcome of learning is helpful. Learners need to know whether the strategies they're using to complete a task are appropriate *and* whether they're meeting performance standards.[37]
- **Elaborative** - Feedback should explain a learner's performance and how improvements can be made versus just providing a summary of what was correct and incorrect or a single grade.[38]
- **Timely** - Ideally, feedback should be provided soon after practice and with sufficient time for learners to correct misunderstandings and practice more. However, even feedback delivered much later can be helpful if it is followed by additional opportunities to practice.[39]

Implications for Learning Environments

High-quality feedback helps learners correct misunderstandings and chart a path forward. Our learning environments can support this by building learners' understanding of the goals they are working toward, integrating sufficient and well-placed opportunities for feedback into the schedule, and ensuring the content of feedback will help a learner improve.

To support High-Quality Feedback, learning environments should:

- ❑ Build learners' understanding of what success looks like
- ❑ Offer sufficient, timely opportunities for giving and receiving feedback so learners can improve
- ❑ Ensure feedback provides a sufficient and accurate analysis of a learner's progress and guidance for improving

Feedback will be less meaningful if learners do not know the goals they are working toward and what success looks like. As a result, our curricula and instructional approaches should clearly communicate the learning objectives. In

[36] Ambrose et al., 2010
[37] Hattie & Timperley, 2007
[38] Ambrose et al., 2010
[39] Ibid.

addition, learners should have access to exemplars against which they can compare their own work as a form of self-reflective feedback.

As described above, for feedback to drive learning it must be provided at a point in time that ensures learners still have an opportunity to improve after receiving it. This requires thoughtful scheduling so that educators can review work, formulate feedback, and provide that feedback to learners before it is irrelevant. It may also require new ways of allocating adults' time and using space so that adults can provide feedback in small groups or one-to-one versus trying to do so in large groups. The importance of timely feedback also suggests a need to shift away from using only large summative projects and exams to assess learner progress toward more bite-sized checks for understanding that can provide more timely and formative feedback.

The content of feedback is also incredibly important. For feedback to drive learning, it needs to focus on the process of learning and how a learner can improve versus only focusing on one's current level of achievement. It is hard, if not impossible, to give this type of feedback without deep understanding of what is being learned, how people typically learn it, and common misconceptions that occur along the way. Some learning environments are tackling the very real challenge of giving high-quality feedback to many students by using adaptive technologies to help young people understand what they got wrong and why; other schools have tutoring systems where specialists are assigned to a small group of learners to give them more time and feedback on a specific subject. Schools that use a lot of manipulatives may have feedback built into the materials themselves. For example, consider a learner who is putting a square block into a triangular slot: this material—given the way it is designed—provides the learner immediate feedback that squares and triangles are not the same shape.

Additional Resources

- **Delivering Effective Feedback** | Sanford Inspire
- **5 Research-Based Tips for Providing Students with Meaningful Feedback** | Edutopia

Principle 6

Metacognitive Thinking

People learn best when they are able to plan, observe, evaluate, and adjust their own learning processes.

How It Works

While feedback from adults and peers can effectively support learning, as young people progress through their education and lives they will need to take greater responsibility for their learning. To do this, learners need to develop **metacognitive thinking skills**—or the ability to think about their own thinking.[40] [41] When applying metacognitive skills, learners engage in a variety of processes to *monitor* and *control* their own learning.[42] These processes include assessing the demands of a task, evaluating their knowledge and skills, planning their approach, monitoring their progress, and adjusting their strategies as needed.[43] Metacognitive thinking is a powerful driver of learning. Research suggests that it increases one's ability to transfer learning to different contexts because it supports a higher level of understanding that extends beyond the specific task or subject area.[44]

However, metacognitive thinking is challenging, particularly for learners with cognitive load issues stemming from grappling with a lot of new content or managing negative emotional states. Luckily, research suggests that just like other skills, metacognition can be developed through instruction, practice, and feedback focused on skills like goal setting, planning, and assessing progress.[45] [46] In fact, simply asking learners to explain why they got something correct or incorrect or how well they believe they understand a certain concept or skill can push them toward thinking more metacognitively. Research also suggests that metacognitive skills are more likely to develop in learners who believe that intelligence is malleable and that learning requires effort. Finally, research on brain development suggests that metacognitive thinking skills also tend to deepen as learners get older and executive functions develop further, especially throughout adolescence and young adulthood.[47] This does not mean young learners can't engage in metacognitive thinking by—for example—identifying learning strategies they used or exploring why they got an answer wrong; it simply suggests increasingly complex metacognitive work should be asked of older learners.

[40] Ibid.
[41] Bransford, Brown, & Cocking, 2000
[42] Zimmerman, 2001
[43] Ambrose et al., 2010
[44] Bransford, Brown, & Cocking, 2000
[45] Ambrose et al., 2010
[46] Tanner, 2012
[47] Ambrose et al., 2010

Implications for Learning Environments

Being able to think metacognitively is an important part of being a self-directed learner. However, metacognitive thinking takes real work; like anything we want young people to learn, it needs to receive dedicated time and focus within our learning environments.

To support Metacognitive Thinking, learning environments should:

- ❑ Make the skills and mindsets that support metacognition explicit learning objectives
- ❑ Help learners understand how different beliefs and messages may be impacting their thinking
- ❑ Ensure opportunities for learners to apply metacognitive thinking strategies across all learning contexts
- ❑ Develop a culture where thinking about one's thinking is the norm

Learners should receive explicit instruction on goal setting, planning, reflecting on progress, and making adjustments, and they should have opportunities to apply these skills across different contexts. To support this, we can make creative choices about how time is used. For example, our schedules could include 30 minutes each week for young people to reflect on the learning strategies they're using, their progress, and what to do next. This time could be further maximized by using it as an opportunity for feedback or relationship building as well. Alternatively, we could train educators to include more metacognitive practice alongside the learning young people are already doing. This can be as simple as adding a self-reflection component to existing assignments, projects, and exams that asks learners to recount the learning strategies they used, challenges they faced, and how much they believe they learned.

One especially critical understanding we want to build in our learners is that their thinking does not happen in a vacuum. Instead, it is impacted by a lot of different factors. These factors include their own personal values and beliefs, but also larger societal messages that may be shaping learners' thinking. These messages may be empowering or threatening. Either way, they are often very subtle, yet can have a great impact on learners' belief in themselves.

The development of a "culture grounded in metacognition" is also helpful.[48] In such an environment, everyone is open about their own learning, including the processes they are using and the progress they are making. To support this, we can ensure our instructional approach and schedule provides learners with opportunities to voice confusion and ask clarifying questions. Additionally, we can ensure adults are transparent about their own confusion and model their use of metacognitive skills.

[48] Tanner, 2012

Additional Resources

- **Boosting Metacognition and Executive Functions in the Classroom** | The Learning Scientists
- **How to Improve Your Metacognition and Why It Matters** | The Learning Scientists
- **Metacognition** | Vanderbilt University
- **Metacognition and Self-Regulation** | Education Endowment Foundation
- **Metacognition: How Thinking About Thinking Can Help Kids** | Child Mind Institute
- **Self Regulation Graduate Aims Entry** | Transcend
- **That's So Meta(cognitive)** | Smithsonian Science Education Center

Cognition 

The set of processes by which individuals take in both new and familiar stimuli from the world around them, process these stimuli into memories, and retrieve these memories to inform their day-to-day decisions and actions.

Principle #1:
Focused Attention

Principle #2:
Manageable Cognitive Load

Principle #3:
Meaningful Encoding

Principle #4:
Effective Practice

Principle #5:
High-Quality Feedback

Principle #6:
Metacognitive Thinking

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Cognition

Principle #1:

Focused Attention

People learn best when they direct their focus toward the content and experiences most relevant to learning.

How might we design learning environments that:

- Help learners feel physically and psychologically safe and healthy?
- Ensure learning objectives and activities are clear?
- Minimize sensory distractions?

Cognition

Principle #2:

Manageable Cognitive Load

People learn best when they are challenged but are processing a manageable amount in their working memory.

How might we design learning environments that:

- Minimize cognitive and emotional distractors?
- Break learning into manageable, logically sequenced increments?
- Represent content and experiences clearly?
- Respond to individual learner readiness with tailored supports and pacing?
- Ensure individual learners achieve competency with prerequisite objectives before they move on?

Cognition

Principle #3:

Meaningful Encoding

People learn best when new learning is experienced in memorable ways and is related to prior knowledge.

How might we design learning environments that:

- Promote distinctive or emotionally compelling learning experiences?
- Ensure learners connect new learning to their prior knowledge and experiences?
- Help learners make underlying factual and conceptual connections?
- Integrate multiple representations of content through different modalities, problem types, and contexts?

Cognition

Principle #4:

Effective Practice

People learn best when they practice challenging-but-doable skills at frequent, focused intervals and across diverse contexts.

How might we design learning environments that:

- Use each learner's current proficiency to plan opportunities for practice?
- Provide learners with ongoing opportunities to engage in focused, frequent practice, across diverse contexts?
- Build learners' own understanding of effective practice?

Cognition

Principle #5:

High-Quality Feedback

People learn best when they receive timely and targeted feedback to guide their improvement.

How might we design learning environments that:

- Build learners' understanding of what success looks like?
- Offer sufficient, timely opportunities for giving and receiving feedback so learners can improve?
- Ensure feedback provides a sufficient and accurate analysis of a learner's progress and guidance for improving?

Cognition

Principle #6:

Metacognitive Thinking

People learn best when they are able to plan, observe, evaluate, and adjust their own learning processes.

How might we design learning environments that:

- Make the skills and mindsets that support metacognition explicit learning objectives?
- Help learners understand how different beliefs and messages may be impacting their thinking?
- Ensure opportunities for learners to apply metacognitive thinking strategies across all learning contexts?
- Develop a culture where thinking about one's thinking is the norm?