Explainer

Australian Education Research Organisation

Retention and recall

Students process limited amounts of new information

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Retention and recall are fundamental to successful learning outcomes. Knowledge needs to be retained so that it can be used. Retention is the ability to store information in memory over time, while recall is the ability to retrieve and use stored information when needed. When students effectively retain and recall information, they can easily access and apply it to build on existing knowledge and develop deeper understanding.

This explainer outlines how memory systems support learning and the conditions that optimise retention and recall, recognising the diverse ways students engage with and process information. A related explainer outlines how managing cognitive load optimises learning.

This explainer is one in a series of 4 that describe the cognitive science evidence of how students learn. Each explainer summarises an element of the student learning process outlined in the Australian Education Research Organisation (AERO)'s Teaching for How Students Learn model of learning and teaching.

Teachers and school leaders can use these explainers to deepen their understanding of the cognitive science of how students learn and consider implications for practice:

Attention and focus
Students are actively engaged when learning

Knowledge and memory
Learning is a change in long-term memory

Retention and recall
Students process limited amounts of new information

Mastery and application
Students develop and demonstrate mastery of their learning

How memory works

Learning occurs through the complex interaction between working memory and long-term memory. Working memory serves as the mental workspace where students process new information, but its capacity is limited when the information is new. Working memory can become overloaded when too much new information must be processed at once, creating cognitive overload (Baddeley, 1992; Sweller et al., 2011).

In contrast, long-term memory stores vast networks of interconnected knowledge. By linking new information to existing knowledge in long-term memory, students can reduce cognitive load – the amount of mental resources used to process information – and store and retrieve information more efficiently.

Students use information stored in long-term memory to manage actions, such as answering test questions or making decisions in real-world situations. To do this, long-term memory transfers the stored information back to working memory, where it helps determine the appropriate action. Unlike processing new and unfamiliar information obtained from a teacher or text, working memory has no known limits when handling stored information retrieved from long-term memory. This transforms students' ability to think and act in a given area, highlighting the powerful impact of education.

Information must go through 2 key processes to be retained effectively:

- **encoding**, where information is processed in working memory and converted into a form that can be stored in long-term memory
- **consolidation**, in which mental representations are strengthened and integrated into long-term memory (Baddeley, 1997).

These stored representations form mental models – organised networks of knowledge that link facts, procedures and concepts (Gentner & Stevens, 2014). Mental models represent what students understand about a learning area and develop through their experiences and prior knowledge (Johnson-Laird, 2006).

Each time students recall information, they strengthen the neural pathways in their long-term memory, making future recall easier (Marin-Garcia et al., 2021). This process of consolidation is essential for building robust and accessible knowledge that students can draw on in future learning.

Memory retention and learning

Memory retention follows predictable patterns. After students encounter new information, their ability to remember it decreases over time, with the steepest decline occurring shortly after the initial learning (Wixted, 2004). This pattern of memory decline illustrates how our brains process and store information – without reinforcement through review or practice, newly encoded information becomes harder to access, though the rate of decline slows over time. Information that connects meaningfully to existing knowledge is easier to retain, and actively retrieving information strengthens its storage in memory (Roediger & Butler, 2011).

These patterns of memory retention help explain why single exposures to information rarely result in long-term learning. Students often need multiple opportunities to engage with and recall information for it to consolidate in long-term memory (Dunlosky & Rawson, 2015). Consolidation is most effective when it builds on prior knowledge and creates meaningful connections, supporting long-term retention and deeper learning (Carpenter et al., 2022).

Learning processes that support retention and recall

Several key learning processes help students retain and recall information effectively. When students store information in long-term memory, they can access it using various retrieval cues – such as keywords, visual images or related concepts that trigger recall. Repeated retrieval strengthens these memory pathways, making the information easier to access over time (Carpenter et al., 2022). Some students may have more limited working memory or processing capacity than others, requiring more frequent practice to consolidate learning in long-term memory.

Active retrieval enhances the connections between stored information and retrieval cues, making future recall easier and more automatic. Spacing learning over time, rather than concentrating it in a single session, promotes deeper processing and better consolidation in long-term memory (Carpenter et al., 2022). Engaging with information in varied ways creates multiple retrieval cues, helping students build stronger and more flexible memory pathways (Brown et al., 2014). These processes ensure students can access their stored knowledge and apply it effectively in learning tasks.

Implications for teaching and learning

Understanding how retention and recall work has important implications for learning. Students benefit from multiple opportunities to engage with new information in ways that support strong connections to existing knowledge. To strengthen retention and recall, teachers can manage the cognitive load of learning tasks by:

- communicating learning objectives and activating prior knowledge
- explicitly teaching chunks of new information with explanation, demonstration and modelling
- guiding student learning and gradually removing scaffolds
- checking for understanding and giving additional instruction, guidance or feedback
- monitoring for additional learning needs and supporting students to access tiered interventions.

Optimal knowledge consolidation occurs when students can meaningfully connect new information to their existing understanding, including their cultural knowledges and ways of knowing (Miller & Armour, 2021). Students learn most effectively when they can focus their attention on processing manageable chunks of new information and have regular opportunities to practice recalling their learning (Chen et al., 2018). Students should also be provided with sufficient rest periods during the process of acquiring new information. This supports the development of robust mental models so that students can continue to build their understanding over time (Bucciarelli, 2007).

Students may require varying supports to effectively encode, retain and recall information. Some students may benefit from additional processing time, movement breaks or multisensory approaches to strengthen memory formation. Visual aids, clear routines and explicit instruction can help reduce cognitive load, allowing more mental resources for processing and retaining new information. Strategies that support retention and recall, such as regular retrieval practice and breaking complex information into smaller components, benefit all learners while being particularly valuable for students with diverse learning needs.

References

Baddeley, A. (1992). Working memory. *Science, 255*(5044), 556–559. https://doi.org/10.1126/science.1736359

Baddeley, A. D. (1997). *Human memory: Theory and practice*. Psychology Press.

Brown, P. C., Roediger, H. L., & McDaniel, M. A. (2014). *Make it stick: The science of successful learning*. Belknap Press.

Bucciarelli, M. (2007). How the construction of mental models improves learning. *Mind & Society, 6*(1), 67–89. https://doi.org/10.1007/s11299-006-0026-y

Carpenter, S. K., Pan, S. C., & Butler, A. C. (2022). The science of effective learning with spacing and retrieval practice. *Nature Reviews Psychology, 1*(9), 496–511. https://doi.org/10.1038/s44159-022-00089-1

Chen, O., Castro-Alonso, J. C., Paas, F., & Sweller, J. (2018). Extending cognitive load theory to incorporate working memory resource depletion: Evidence from the spacing effect. *Educational Psychology Review, 30*(2), 483–501. https://doi.org/10.1007/s10648-017-9426-2

Dunlosky, J., & Rawson, K. A. (2015). Practice tests, spaced practice, and successive relearning: Tips for classroom use and for guiding students' learning. *Scholarship of Teaching and Learning in Psychology, 1*(1), 72. https://doi.org/10.1037/stl0000024

Gentner, D., & Stevens, A. L. (2014). *Mental models*. Psychology Press.

Johnson-Laird, P. N. (2006). *How we reason*. Oxford University Press.

Marin-Garcia, E., Mattfeld, A. T., & Gabrieli, J. D. (2021). Neural correlates of long-term memory enhancement following retrieval practice. *Frontiers in Human Neuroscience, 15*, Article 584560. https://doi.org/10.3389/fnhum.2021.584560

Miller, J., & Armour, D. (2021). Supporting successful outcomes in mathematics for Aboriginal and Torres Strait Islander students: A systematic review. *Asia-Pacific Journal of Teacher Education, 49*(1), 61–77. https://doi.org/10.1080/1359866X.2019.1698711

Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences, 15*(1), 20–27. https://doi.org/10.1016/j.tics.2010.09.003

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory.* Springer.

Wixted, J. T. (2004). The psychology and neuroscience of forgetting. *Annual Review of Psychology, 55*(1), 235–269. https://doi.org/10.1146/annurev.psych.55.090902.141555

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