




Working Memory and Classroom Learning



“Working memory capacity is more highly related to ... learning, both short-term and long term, than is any other cognitive factor.”

- P. Kyllonen



What is Working Memory?

Working Memory is our ability to hold ‘in mind’ and mentally manipulate information over a short period of time. It is like a “mental workspace” that is used to store important information as we problem-solve.

Everyday Working Memory tasks:

- Remembering a phone number long enough to write it down
- Following spoken directions
- Remembering the unfamiliar, foreign name of a person long enough to introduce that person to someone else
- Measuring & adding the correct ingredients to a recipe when you are no longer looking at the page



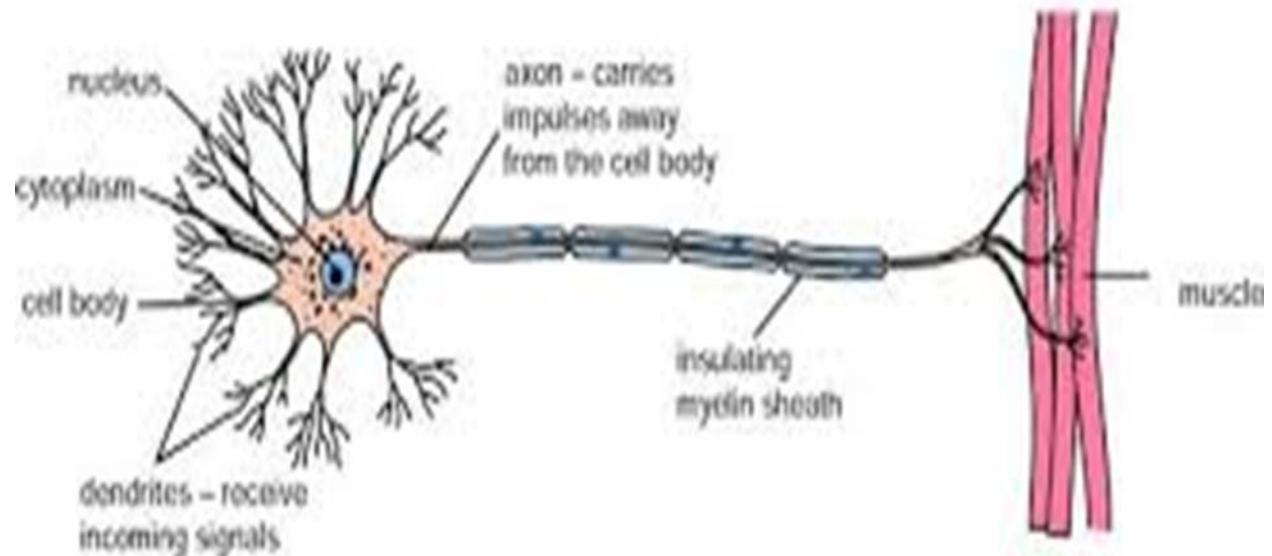
Working Memory is important because:

- It's a core cognitive process
- It's a strong predictor of academic learning
- One in ten children have a WM impairment
- WM deficits are often mistaken for attention or motivation problems

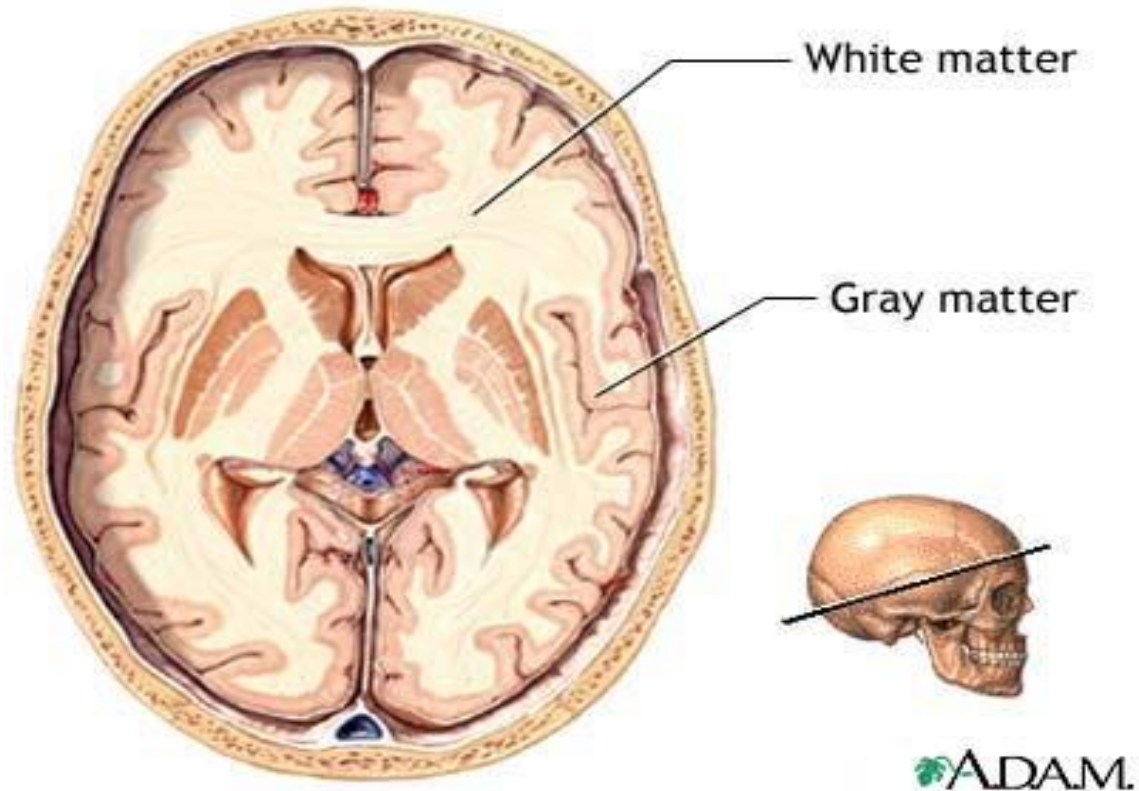
Physical structure of Working Memory


- Unlike most other cognitive processes which are located in the various lobes of the brain, Working Memory does not have its own brain structure.

WM is contained within the white matter (myelin) that insulates the bundles of axons that connect the regions of the brain.



Working Memory is contained in the brain's white matter:

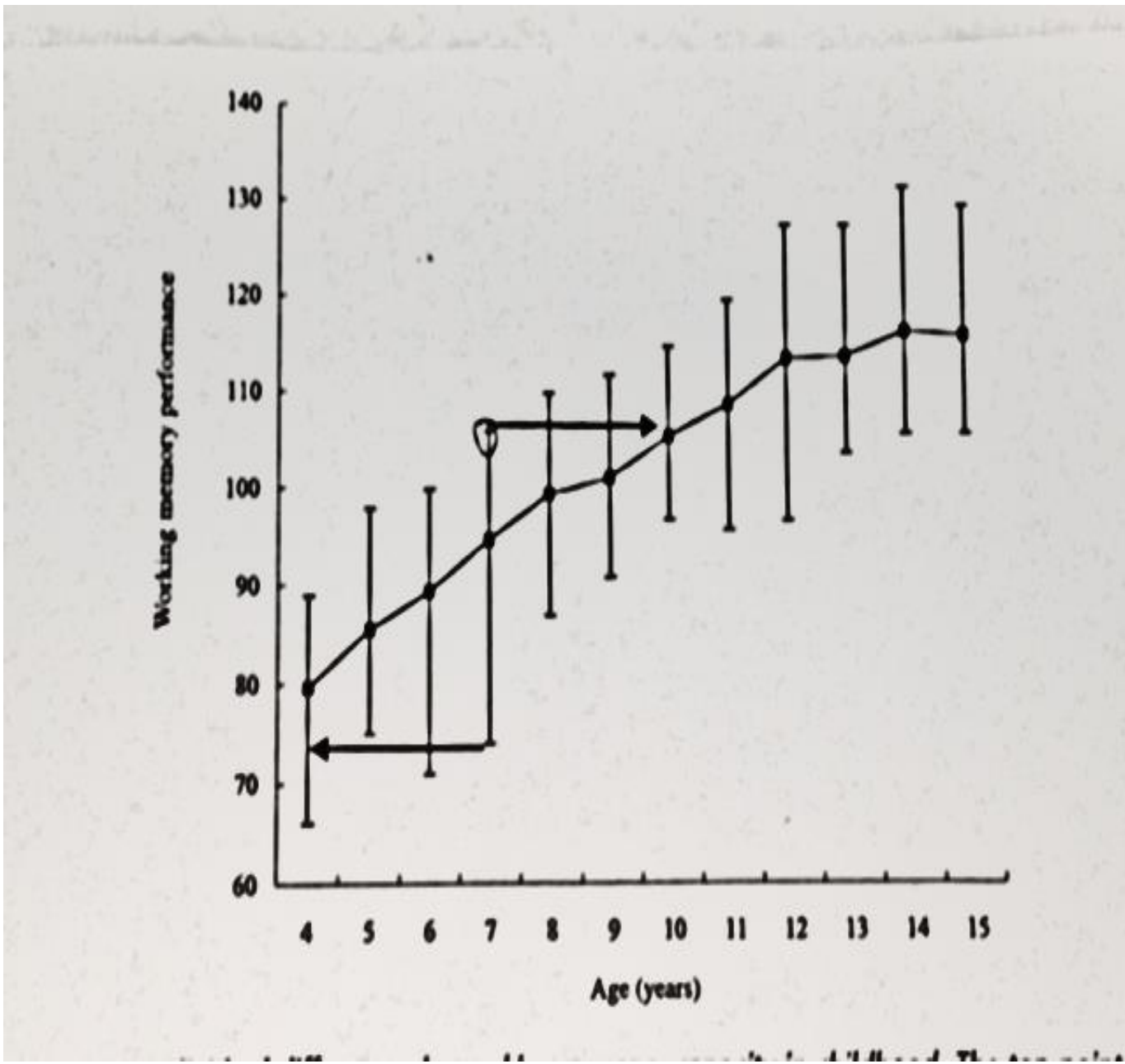




Working Memory capacity is related to the integrity (strength) and extensiveness of the myelinated axons.

Does WM capacity vary from one person to another?

- Each individual has a relatively fixed capacity that is greater or less than that of others.
- WM capacity increases with age. Young children have small capacities, but in adolescence and adulthood, capacity increases greatly.
- Differences in WM among same-aged children can be very great.



e

Children with WM Deficits:

- Have lower rates of learning
- Have difficulty acquiring & retaining skills
- Are reserved and don't volunteer answers in class
- Make place-keeping errors, fail to track how far they have progressed as a task is performed
- 'Task abandonment' - often give up or fail to complete tasks
- They behave as if they have not paid attention
- Forget messages and instructions
- MOST classroom activities require keeping information in mind while also cognitively processing



What causes poor Working Memory?

- Cause of weak WM capacity is not well understood.
- WM deficits don't seem to be related to a child's background or home environment.
- Genetic factors play an important role in the frontal areas of the brain that support WM.

Working Memory (WM) vs. Short-term Memory (STM)

- WM: The capacity to retain information while simultaneously manipulating the same or other information for a short period of time.
- WM = processing + storage
- WM is active & conscious; STM is passive & unconscious

Dehn's Cognitive Load Theory

- WM consists of both processing and storage of information.
- “Cognitive Load” is the **PROCESSING** portion of the processing + storage equation.
- The greater the processing demands, the less information will be retained (stored).



To summarize:

Learning and performance decline when the processing demands of the task are too great.

The student's Working Memory capacity becomes overloaded.

What does “processing” consist of ?

- Encoding
- Connecting new information with existing info
- Performing multi-step computations
- Holding procedures, formulas, guidelines in mind
- Retrieving prior knowledge
- Chunking (organizing) related items in to groups
- Multi-tasking



Cognitive Load (processing) in the Classroom is determined by:

- 1 - Nature of content & materials
- 2 - Type of instruction & teacher behaviors
- 3 - Learner's internal processing



To avoid Cognitive (Over)Load, reduce:

- Excessive length (of instruction & tasks)
- Unfamiliar, non-meaningful content
- Demanding mental activities
- Keeping track of steps while doing task
- Tasks that require a lot of transitioning of attention from one source to another

Classroom overload is also created by:

- Long, complex verbalization
- Inadequate time for processing or rehearsal
- Inadequate external memory aids
- Noisy environment
- Inadequate scaffolding or support
- Disorganized presentations
- Too many concurrent demands

Working Memory Classroom Interventions

I - Recognize Working Memory failures in your students

- Incomplete recall
- Failure to follow instructions
- Place-keeping errors
- Task abandonment

Interventions...

2 – Monitor the child

- Look for children who are inactive
- Ask the child what she is doing, what she needs to do next

Interventions...

3 – Evaluate the working memory demands of learning activities.

- Avoid excessive length
- Avoid content that is not meaningful & not familiar
- Reduce amount of material (shorter sentences, fewer steps)
- Act it out!

Interventions...

4 – Reduce working memory loads

- Identify desired outcome of task (e.g., draw a picture of a cell and label the parts)
- Simplify mental processing



5 – Restructure complex tasks

- Break task down into separate, independent tasks
- Introduce one step at a time
- Provide visual supports



6 – Develop child's use of strategies for supporting memory

- Encourage (and praise) the child for requesting help
- Rehearsal – repeating information silently or out loud
- Using acronyms to recall sequence of steps

Solutions & Recommendations

- Frequent repetition of new information
- Brief, linguistically simple directions
- Overlearn to AUTOMATICITY
- Teach WM strategies in the classroom
- Direct instruction is ideal when possible
- Reduction of processing load helps low WM kiddos the most
- Introduce one step or process at a time
- Allow time for processing and rehearsal

More...

- Provide worked, partially-completed examples
- Teach students to alternate between processing and refreshing and rehearsing
- Vertical math problems
- Side by side information (see all info at once) rather than stacked, overlapping information (e.g., computers)
- Avoid non-essential or confusing information

The Mnemonic Classroom

- Uses methods that support WM & reduce cognitive load
- Educates students about memory
- Teaches memory strategies / mnemonics
- Conveys message that you CAN improve your memory
- Mnemonic instruction improves academic learning
- Minimizes cognitive load