

# Memory within classrooms

What teachers can do

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Gronada, 10/06/2016

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## 1. EXPERIENCE YOUR MEMORY. METAMEMORY

Memorize telephone number



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What did you do?

**032853450**

- 'Memory span': remember the correct sequence
- Inner speech
- Chunking, classification: 03/285/345/0
- Activate background knowledge
- Motivation, no stress, no distraction

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'Memory'

in foreign languages

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'Memory'

|            |
|------------|
| pamięć     |
| muisti     |
| kumbukumbu |
| paměť      |
| memorija   |

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## 'Memory'

|         |  |
|---------|--|
| Polish  |  |
| Finnish |  |
| Swahili |  |
| Czech   |  |
| Bosnian |  |

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## 'Memory'

|         |                   |
|---------|-------------------|
| Polish  | <b>pamięć</b>     |
| Finnish | <b>muisti</b>     |
| Swahili | <b>kumbukumbu</b> |
| Czech   | <b>paměť</b>      |
| Bosnian | <b>memorija</b>   |

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## What did you do?

- Remember task
- Activate background knowledge: what are Eastern European languages?
- Focus attention
- Associate language – words
- Internal speech
- Register differences
- Same structure offering back

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## Mental arithmetic

multiplication

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## What did you do?

**27 x 19 = 513**

- Retain the factors
- Retrieve the properties of multiplication
- Use 'easy-calculation rules'
- Look for results in your 'memorized multiplication tables'
- Retain steps and partial solutions
- Add and subtract

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## Reflection:

How would you learn this poem by heart?

### ***Eternity***

*Who binds to himself a joy  
Does the winged life destroy;  
But he who kisses the joy as it flies  
Lives in eternity's sun rise.*

William Blake, 1757 - 1827

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## What should you do?

- Understand the words and sentences
- Capture the meaning
- Notice the rhyme
- Break up
- Rehearsal
- Distributed practice
- ...

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## Metamemory

Type of metacognition:

- Understanding how human memory works
- Self-awareness of personal memory's strengths and weaknesses
- Knowing what you know
- Conscious control of memory
- Knowledge and regulation of effective memory strategies

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### ***Metamemory enhances learning***

*Better control of memory processes and flexible use of effective memory strategies*

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## Mini quiz:

What do you (and your neighbour) know about (your) memory?

1. What different types of memory do you know?
2. What memory strategies do you use? When?
3. What kind of instruction would be responsible for high load on the memory and learning? Give an example
4. How do you (a teacher) try to adapt your teaching to maximize memorising and learning? Give an example

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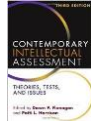
## 2. SOURCES OF INSPIRATION AND OBJECTIVES

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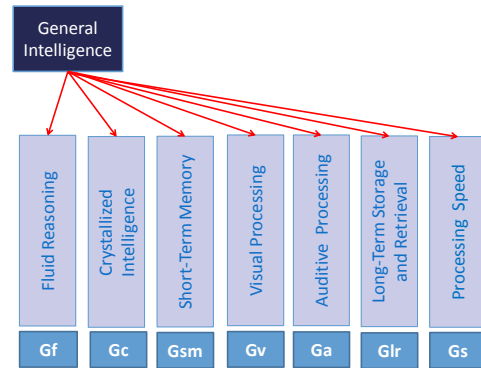
## Inspiration 1

### Cattell-Horn-Carroll: CHC Model of intelligence

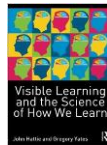
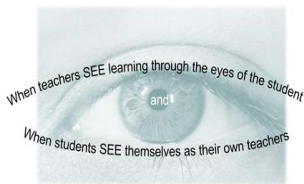


*D.P. Flanagan:* linking cognitive abilities to academic achievement and intervention

*K.S. McGrew:* linking cognitive abilities to information processing



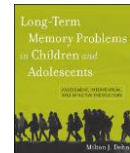
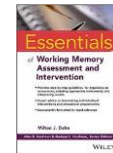
## Inspiration 2



*J. Hattie:* linking learning to instructional practice

## Inspiration 3

*"No learning without memory and  
no memory without learning"*



*M.J. Dehn:* memory and effective instruction

## Objectives

*"How do children learn and how do we make learning visible in the classroom? How can we stimulate the learning process in teaching practice?" (Hattie)*

*"The requirements of a task and the student's performance are influenced by the student's biological functions, motivation, cognitive strategies and memory." (Mitchell)*

### → FOCUS

How does memory work when learning?

How can we support memory in teaching practice?

## What can teachers do?

Understand how human memory works

- Knowledge of effective instructional practices that support memory
- Self-reflection about which of one's own teaching methods supports or puts load on memory: "evaluate your impact"
- Implement effective evidence-based memory practices in classroom

The diagram illustrates the architecture of the human mind, showing the flow of information from input systems to working memory and then to long-term memory.

- Input Systems:** On the left, four boxes represent input systems: **Expression**, **Behavior**, **Task**, and **Information**. Arrows point from these boxes to the **Motor Systems** and **Perceptual Systems**.
- Motor Systems:** A yellow box that receives input from **Expression** and **Behavior**. It has a bidirectional arrow connecting it to the **Working Memory**.
- Perceptual Systems:** A blue box that receives input from **Task** and **Information**. It has a bidirectional arrow connecting it to the **Working Memory**.
- Working Memory:** A large red box in the center. It contains three sub-components: **Verbal STM**, **Visuospatial STM**, and **Executive WM**. Arrows point from these sub-components to the **Working Memory** box. It has bidirectional arrows connecting it to the **Motor Systems**, **Perceptual Systems**, and **Explicit Long-Term Memory**.
- Explicit Long-Term Memory:** A large blue box on the right. It contains two sub-components: **Episodic LTM** and **Semantic LTM**. Arrows point from these sub-components to the **Explicit Long-Term Memory** box. It has a bidirectional arrow connecting it to the **Working Memory**.

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## Active processing of information

- Selecting and updating incoming information
- Starting encoding information in long-term memory through the use of memory strategies
- Selecting relevant information from long-term memory
- Inhibiting irrelevant information from long-term memory
- Switching and coordinating between task, storage, information processing and retrieval of information

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## Expansion of storage capacity

*How can you expand storage capacity?*

- Use simple rehearsal strategies such as chunking
- Avoid environmental distraction
- Reinforce your prior knowledge
- Strengthen your automated knowledge and skills

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## Cognitive load theory

General limited capacity of working memory:

The greater the processing demands, the less can be retained in working memory

Working memory is mostly heavily loaded during classroom learning

High processing demands due to:

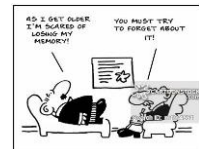
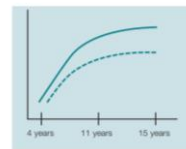
- The nature of the learning content and materials
- Type of instruction
- Learner's internal processing

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## Development of working memory

Changes in working memory capacity with age

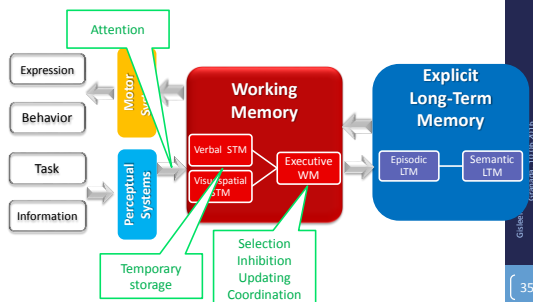


The changes in working memory capacity with age for an average child are shown by the solid line. Scores of a child with a low working memory capacity are represented by the broken line.  
S.E. Gathercole, 2007

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## Information Processing & Structures



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Naar: MCGREW, K.S. (2015) CHC Theory @ 20+ Years: Beyond CHC. Presentatie, Congres Intelligentie in nieuwe banen! Het CHC-model onder de loep, Thomas More



### Working memory:

- Limited general capacity: temporary storage decreases if much processing is required
- Use simple rehearsal strategies to remember more
- Heavily loaded in classroom learning by the nature of the learning content and the type of instruction

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## 3.2 EXPLICIT LONG-TERM MEMORY

- Episodic memory
- Encoding
- Semantic memory
- Consolidation
- Retrieval
- Why do we forget?

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## Explicit long-term memory

Partially overlapping processing and storage systems:

- Episodic memory: remembering
- Semantic memory: knowing

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## Episodic memory

Storage of experiences and events, including formal learning events

- New knowledge is primarily stored in episodic memory for days or weeks
- School learning is initially episodic
- Memory tests are episodic
- Rapid forgetting

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## Encoding

Transforming perceptual information in 'memory traces': verbal or visuospatial

Quality of encoding influenced by:

- Focused attention
- Prior knowledge
- Effective use of memory strategies: 'deep processing'

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## Semantic memory

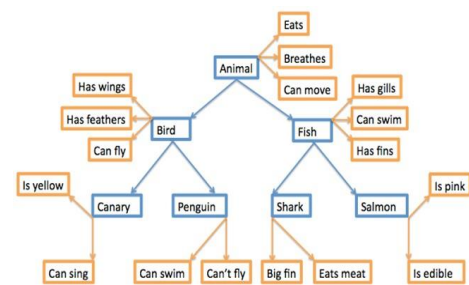


Storage of context-free factual and conceptual knowledge

- Organization based on meaning and conceptual and relational categories: SCHEMAS
- Unlimited capacity
- Visuospatial and verbal
- Gradually reorganized
- Episodic memories gradually become semantic
- Provides the schemas and scripts for the episodic memory

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## Schema



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## Schema: generalized knowledge

Background knowledge encourages to take in information in a consistent fashion

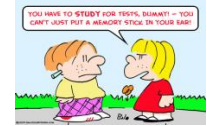
Schemas often influence our cognitive processes:

- in the initial selection of material
- in remembering visual scenes
- in abstraction
- in the final process of integration

Both schemas (top-down processing) and unique features of each stimulus (bottom-up information) influence memory

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## Consolidation



Memories become stable and resistant to interference over time:

- Takes time: hours to months, limited ability
- Primarily unconscious, mainly occurring during sleep
- Conscious cognitive processes enhance consolidation: elaborative strategies
- Reactivation improves consolidation
- Retrieval creates more persistent memory traces

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## Retrieval

Quality of retrieval depends on:

- Working memory and reasoning
- Encoding
- Degree of organization of semantic memory
- Presence of cues that were created during encoding
- Interference by prior retrieval of incorrect information

Practicing retrieval improves (testing effect)

- Consolidation
- Retrieval speed (more automatic)
- Accuracy of retrieval

Recognition is easier than recall

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## Why do we forget?



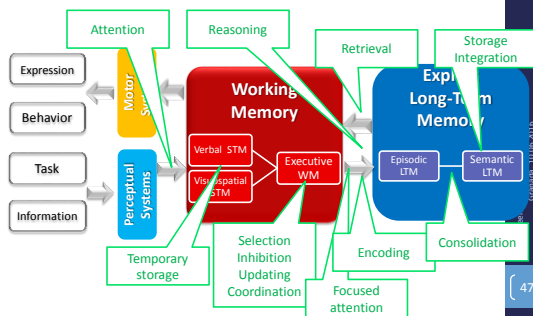
- Lack of consolidation
- Natural process of decay
- Interference: similarity of information
- Failure of retrieval

Less forgetting by:

- Relearning and overlearning
- Extending the interval between learning sessions
- In-depth knowledge

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## Information Processing & Structures



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Naar: MCGREW, K.S. (2015) CHC Theory @ 20+ Years: Beyond CHC. Presentatie, Congres Intelligentie in nieuwe banen! Het CHC-model onder de loep, Thomas More



### Long-term memory

- School learning is initially episodic and subject to rapid forgetting
- Consolidation in semantic memory takes time and effort
- Elaborative strategies, retrieval and diminishing interference cause less forgetting

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#### 4. CLASSROOM INSTRUCTION THAT SUPPORTS MEMORY

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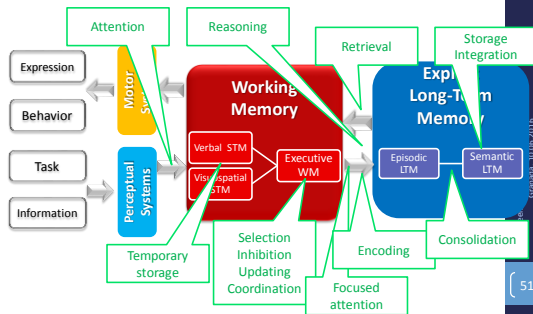
#### Memory-based instruction?

- Effective instructional practices generally support learning and memory
- Teachers who adopt more instructional practices that specifically support memory enhance the learning and performance of all students
- Especially students with difficulties in one or more aspects of memory, benefit
- Additionally: tailoring interventions for students with memory problems

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#### What can teachers do?



1. Reduce cognitive load
  - Learning content
  - Instruction
  - Support related cognitive processes
2. Teach simple rehearsal strategies
3. Provide metamemory instruction
4. Use instructional practices that enhance memory and explicitly teach memory strategies
5. Provide academic accommodations for children with memory problems

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#### Reduce cognitive load of learning content

- Simplify complex and difficult learning content where possible
- Limit the amount of new material to be learned and offer gradually
- Organize information
- Avoid the "split attention" effect
- Use completed and partially completed examples
- Teach learning contents that fit prior knowledge
- Make lessons meaningful
- Supply and encourage use of memory aids

Principle:  
More capacity left for storage

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#### Reduce cognitive load of instruction

- Post learning objectives and revisit during activity
- Review topic before starting activity
- Simplify grammatical sentence structure
- Slow down the pace of lesson presentation
- Recognize when working memory fails
- Be prepared to repeat important information
- Break multistep tasks into separate independent steps
- Combine visual and verbal
- Be aware of demanding mental processing tasks or activities
- Active learning
- Avoid multitasking, provide written notes, minimize copying
- Build in classroom routines and procedures

Principle:  
More capacity left for storage

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## Support related cognitive processes

**Principle:**  
More capacity left for storage

- Avoid environmental distraction
- Reinforce prior knowledge
- Built-in opportunities to rehearse and practice knowledge and skills to the point of mastery and automaticity

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## Simple memory strategies

**Principle:**  
Expand time of temporary storage

- Rehearsal
- Chunking
- Visualization
- Classification



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## “The mnemonic classroom”

Mastropieri & Scruggs (1991)

Focus on memory, strategies and mnemonics should permeate all of the instruction and learning activities



- Model and demonstrate flexible use of memory strategies
- Monitor and explain how to apply strategies to the task on hand
- Stimulate and reward the use of memory strategies

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## Metamemory instruction

- Teach about different kinds of memory
- Retention and recall is partially under the individual's control
- Can improve by use of effective strategies, saves study time
- Remembering information immediately after studying does not mean it will be remembered later on
- Takes time and effort to acquire knowledge
- Remembering is easier when information is encoded visually and verbally
- Offer practice opportunities to experience effectivity of strategies
- Stimulate the search of strategies that fit the individual student

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## Instructional practices that enhance memory

- Distributed and expanding-interval reviews
- Repeated testing, retrieval and corrective feedback
- Elaboration strategies
- Dual encoding
- Reading strategies
- Use of mnemonics: keyword



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## Distributed and expanding interval reviews

**Principle:**  
Retrieval + consolidation

Daily reviews are unnecessary  
Waiting until the day before an exam to review is ineffective

- Gradually increase the intervals between reviews:  
*end-of-the-lesson review, next day, a week later, after 2- and 4-week intervals*
- Critical variable: delay until effortful retrieval
- Teach explicitly

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## Repeated testing, retrieval and corrective feedback

Principle:  
Retrieval + motivation to  
restudy

Extremely effective, not limited to items actually tested

- Use question-to-answer format during instruction
- First quiz immediately or within a day
- Expand intervals like periodic review
- Use recall-type tests
- Incorporate new questions each time
- Provide corrective feedback soon after testing
- Schedule tests in advance
- Encoding specificity principle
- Self-testing

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## Elaboration strategies

Principle:  
Consolidation + encoding

Relate new information to prior knowledge

- Begin lesson with advance organizer
- Reflect on a concept before instruction
- Allow enough time to retrieve related information
- Summarize information
- Interrogative approach:  
“Why does this make sense?”  
“Why is this true?”
- Self-generated elaborations are more effective

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## Dual encoding

Principle:  
Consolidation + encoding

Visual representation and mental imagery along with verbal instruction

- Use pictures, drawings, graphs, mind maps
- Encourage students to visualize verbal information
- Supports procedural learning

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## Reading strategies

Principle:  
Consolidation + encoding

Teaching reading comprehension strategies increases retention and recall as they induce elaboration

Example: **PQRST**

1. Preview and skim the passage
2. Generate **Q**uestions that need answers: who, what, when, where, why
3. **A**ctively read the passage to look for answers to the questions
4. **S**tudy the information
5. **S**elf-Testing on the answers to the questions

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## Mnemonics

Principle:  
Visual and verbal

Associating new information with well-established, logically unrelated memory representations

→ Easy and automatic recall

### Keyword

- Highly effective for learning terminology, facts, vocabulary
- Also for young children
- Retention over long periods of time
- Easily integrated in instruction

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## Keyword

gato (Spanish) = cat (English)

1. Keyword: gate
2. Image: cat on a gate
3. Retrieve meaning of 'gato': first keyword gate, then image



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## Academic accomodations for children with memory problems

- Errorless learning
  - *"People are learning from their mistakes"*
  - Prevent learning of errors, unlearning of errors is difficult
  - Prevent guessing, supply most of the answer at first
- Providing prompts and increasingly specific cues
- Extended examination time
- Recognition-type test
- Reduce amount of information
- Teach simple memory strategies: rehearsal, chunking, asking for help
- Allow the permanent use of memory aids and practice using them



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## Memory aids

- Checklists with step-by-step procedures
- Step-by-step instructions for using a strategy
- Memory cards with important factual information



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### Most effective

- Reduction of cognitive load
- Metamemory instruction
- Teach memory strategies explicitly
- Integrate memory strategies in instructional practices

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THANK YOU  
for your  
ATTENTION!

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- DEHN, M.J. (2010) *Long-Term Memory Problems in Children and Adolescents. Assessment, Intervention and Effective Instruction*. Hoboken, New Jersey: John Wiley & Sons
- DEHN, M.J. (2015) *Essentials of Working Memory Assessment and Intervention*. Hoboken, New Jersey: John Wiley & Sons
- GATHERCOLE, S. E. & ALLOWAY, T. (2008). *Working memory and learning: A practical guide*. Sage Press
- HATTIE, J. & YATES, G.C.R. (2014) *Visible Learning and the Science of How We Learn*. Londen-New York: Routledge
- MCGREW, K.S. (2015) *CHC Theory @ 20+ Years: Beyond CHC*. Presentatie, Congres Intelligentie in nieuwe banen! Het CHC-model onder de loep, Thomas More
- MITCHELL, D. (2014) What really works in Special and Inclusive Education. Using Evidence-Based Teaching Strategy. Londen-New York: Routledge
- SCHNEIDER, W. J., & MCGREW, K. (2012) The Cattell-Horn-Carroll model of intelligence. In D. Flanagan & P. Harrison (Eds.), *Contemporary Intellectual Assessment: Theories, Tests, and Issues* (3rd ed.) New York: Guilford.

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