

2019 Professional Development Days  
Husson University

## Working Memory, Teaching, & Learning

Fostering Deep and Flexible Learning



Peter E. Doolittle  
Director, School of Education  
Professor, Educational Psychology  
Virginia Tech

## Working Memory Capacity



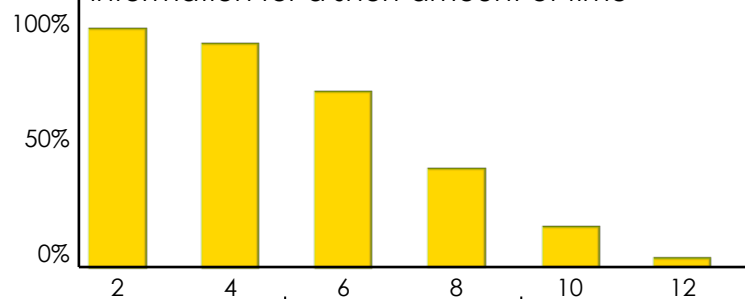
Letters →

Write down as many letters as you can remember, in order.

BCYHLPFTNWBWZSCPL

## Short-Term Memory

Short term memory = retention of a small amount of information for a short amount of time



Magic Number  $7 \pm 2$

(Miller, 1956)

## Working Memory

Attentional Control

- Crucible of Thought
  - Stores Immediate Experiences
  - Access Long-Term Memory
  - **Processes Experience and Memory**
  - Maintains Current Goal for Processing
  - (especially in the presence of distraction)
- STM = Storage
- WM = Storage + Processing

(Doolittle & Mariano, 2008; Unsworth & Engle, 2007; Vergauwe et al., 2015)

## Working Memory Capacity

Positive impacts (↑WMC) include:

- Fluid Intelligence/Fluid Reasoning
- LTM Activation
- Attentional Control
- **Complex Cognition**

(Doolittle & Mariano, 2008; Unsworth & Engle, 2007; Vergauwe et al., 2015)

## Working Memory Capacity

Recall the words out loud, in order.

(8 + 3) = 11 Star ? Star

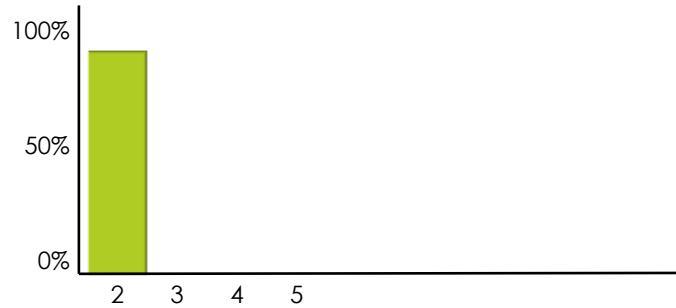
Operation Span Task

## Working Memory Capacity

Recall the words out loud, in order.

(5 + 6) = 11 Phone ? Phone

## Working Memory Capacity

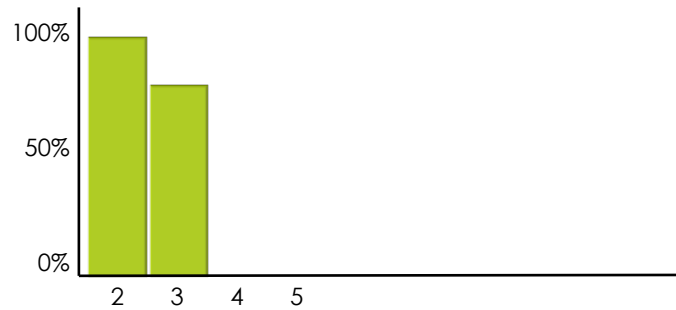


## Working Memory Capacity

Recall the words out loud, in order.

Wife, Pen, Point

## Working Memory Capacity

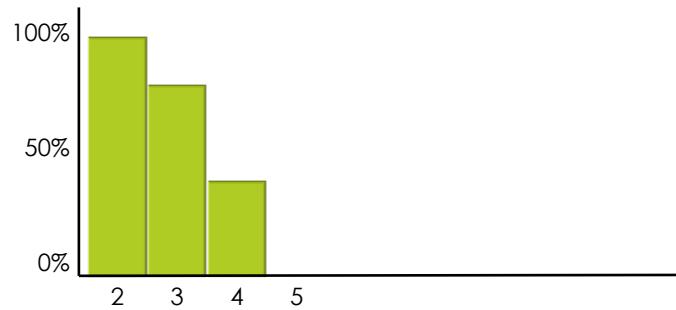


## Working Memory Capacity

Recall the words out loud, in order.

Book, Pen, Paper, Duck

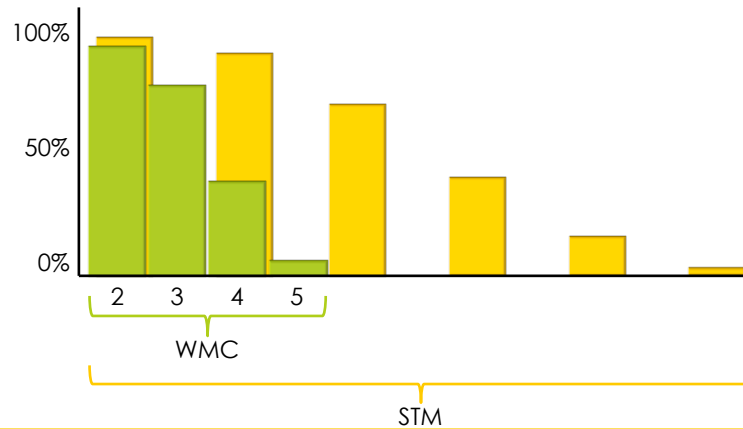
## Working Memory Capacity



## Working Memory Capacity

Recall the words out loud, in order.  
 System, ~~Explore~~, ~~Lips~~, ~~Wings~~, ~~Spring~~

## Working Memory Capacity



## Working Memory Capacity

Working Memory Training  $\neq$   $\uparrow$  WMC

Learn, Teaching, & Use Strategies

(Redick, Shipstead, Wiemers, Melby-Lervag, & Hulme, 2015)



## WMC Strategies

WMC Strategies (F2F, Hybrid, Online)

1. Segmenting Instruction
2. Scaffolding Instruction
3. Lower **Cognitive Load**/Lower Information Density
4. Examples, Examples, Examples
5. Practice with Developmental Feedback

## WMC Strategies in Action



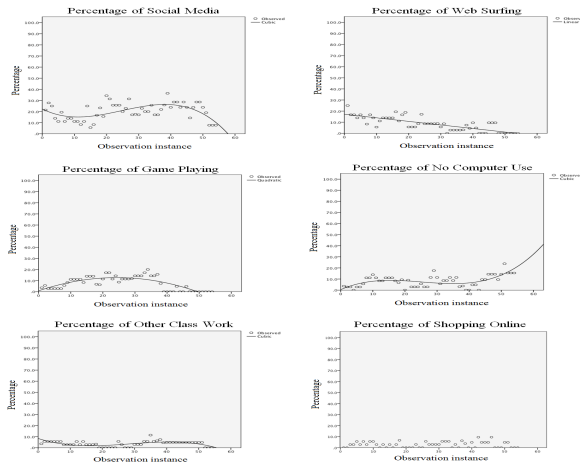
## WMC Strategies in Action

Working memory capacity (WMC) represents an individual's ability to simultaneously (a) process a primary task in working memory, (b) maintain relevant information regarding the primary task in working memory, and (c) access and retrieve relevant information regarding the primary task from long-term memory – especially in the presence of distraction (Unsworth & Engle, 2007). This concept of WMC moves beyond more traditional measures of working memory storage capacity (see Miller, 1956) to include both storage and processing capacity (see Daneman & Carpenter, 1980). This measure of storage and processing capacity has been interpreted as an assessment of *attentional control*, the ability to control the processing and maintenance of information in working memory, especially in the presence of internal (eg, thoughts, drives, feelings) or external (eg, talking, music, motion) distractions taxing the attentional system (Unsworth & Engle, 2007).

## WMC Strategies in Action

	Degree of Segmentation			
	SCIM1 <i>M (SD)</i>	SCIM7 <i>M (SD)</i>	SCIM14 <i>M (SD)</i>	SCIM28 <i>M (SD)</i>
Recall	004.10 (2.11) <sub>a</sub>	005.18 (2.18) <sub>a,b</sub>	006.00 (2.78) <sub>b,c</sub>	007.06 (2.60) <sub>c</sub>
Application	003.88 (1.88) <sub>a</sub>	004.36 (2.82) <sub>a</sub>	005.38 (2.40) <sub>b,b</sub>	006.48 (2.12) <sub>c</sub>
Engagement Time	547.30 (3.60) <sub>a</sub>	603.81 (52.0) <sub>b</sub>	645.93 (63.2) <sub>c</sub>	650.06 (64.3) <sub>c</sub>
Recall	004.10 (2.11) <sub>a</sub>	005.18 (2.18) <sub>a,b</sub>	006.00 (2.78) <sub>b,c</sub>	007.06 (2.60) <sub>c</sub>
Application	003.88 (1.88) <sub>a</sub>	004.36 (2.82) <sub>a</sub>	005.38 (2.40) <sub>b,b</sub>	006.48 (2.12) <sub>c</sub>
Engagement Time	547.30 (3.60) <sub>a</sub>	603.81 (52.0) <sub>b</sub>	645.93 (63.2) <sub>c</sub>	650.06 (64.3) <sub>c</sub>
Recall	004.10 (2.11) <sub>a</sub>	005.18 (2.18) <sub>a,b</sub>	006.00 (2.78) <sub>b,c</sub>	007.06 (2.60) <sub>c</sub>
Application	003.88 (1.88) <sub>a</sub>	004.36 (2.82) <sub>a</sub>	005.38 (2.40) <sub>b,b</sub>	006.48 (2.12) <sub>c</sub>
Engagement Time	547.30 (3.60) <sub>a</sub>	603.81 (52.0) <sub>b</sub>	645.93 (63.2) <sub>c</sub>	650.06 (64.3) <sub>c</sub>
Recall	004.10 (2.11) <sub>a</sub>	005.18 (2.18) <sub>a,b</sub>	006.00 (2.78) <sub>b,c</sub>	007.06 (2.60) <sub>c</sub>
Application	003.88 (1.88) <sub>a</sub>	004.36 (2.82) <sub>a</sub>	005.38 (2.40) <sub>b,b</sub>	006.48 (2.12) <sub>c</sub>
Engagement Time	547.30 (3.60) <sub>a</sub>	603.81 (52.0) <sub>b</sub>	645.93 (63.2) <sub>c</sub>	650.06 (64.3) <sub>c</sub>

# WMC Strategies in Action



# WMC Strategies in Action



Mental Break



MT →

What the...



## When Hype & Research Collide

### Multitasking

## Multitasking: The Hype

- Tapscott, 1998
  - multitasking
- Frand, 2000
  - "multitasking way of life"
- Prensky , 2001
  - "digital natives accustomed to the twitch-speed, multitasking "

Watson, C. E., Terry, K., & Doolittle, P. (2012). Please read while texting and driving. In J. Groccia (Ed.), *To improve the academy* (vol. 31) (pp. 295-310). Bolton, MA: Anchor.

## Was Any Research Available?

"The greater the number of objects to which our consciousness is simultaneously extended, the smaller is the intensity with which it is able to consider each."

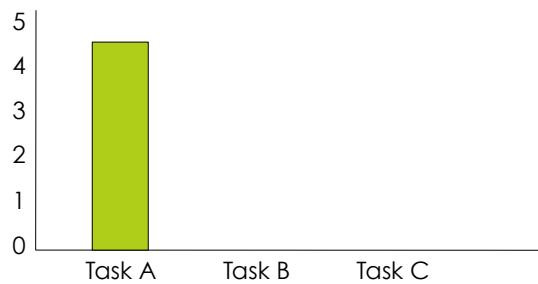
Hamilton, Mansel, & Veitch 1861

## Processing and WMC

2 to 60 by 2s

1. To what was pledged allegiance?
2. What country was mentioned in the passage?
3. For what does the flag stand?
4. The flag symbolizes how many nations?
5. What deity was mentioned in the passage?

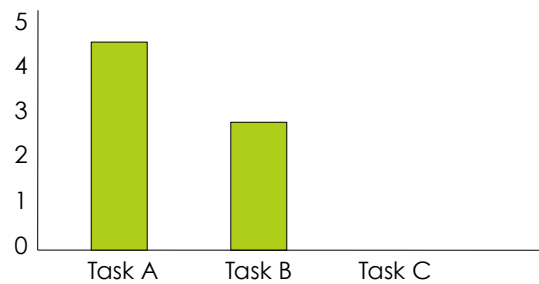
## Results



1 to 30 by 1s

1. What are we urged to do in the passage?
2. What was the original name of the drink?
3. What was the subsequent name of the drink?
4. How many actual liquids are mentioned?
5. What was distilled in the passage?

## Results

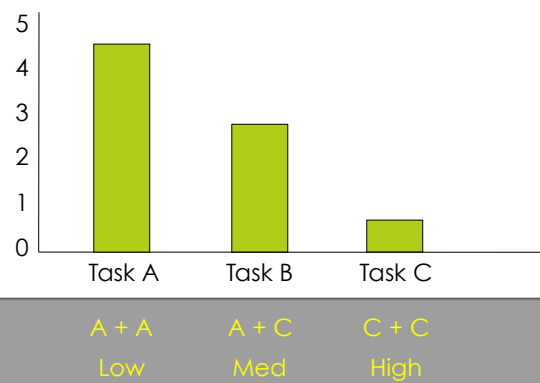


100 to 7 by -7s



1. What is a good name like?
2. Why is good name good?
3. What types of odors are "more durable?"
4. Odors are more durable than what?
5. What is the general point of the passage?

## Results



## Multitasking and Research

“The truth to **multitasking** is evident in the empirical studies... humans lack the cognitive, behavioral, and cortical structures necessary to multitask effectively.”

-- Watson, Terry, & Doolittle (2012)

## Multitasking and Research

“fMRI technology found that multitasking is not actually a concurrent process, but a sequential one that involves **task-switching**.”

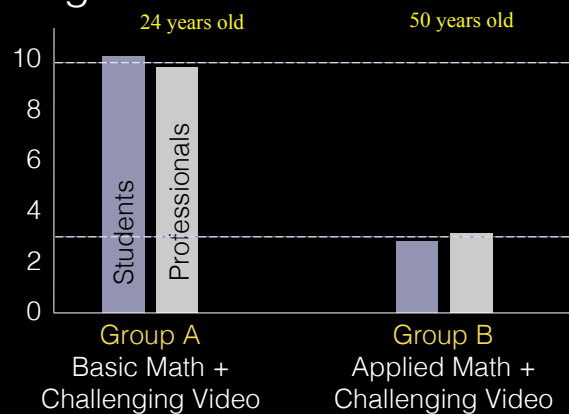
-- Charron & Koechlin, 2010

## A Few Multitasking Results

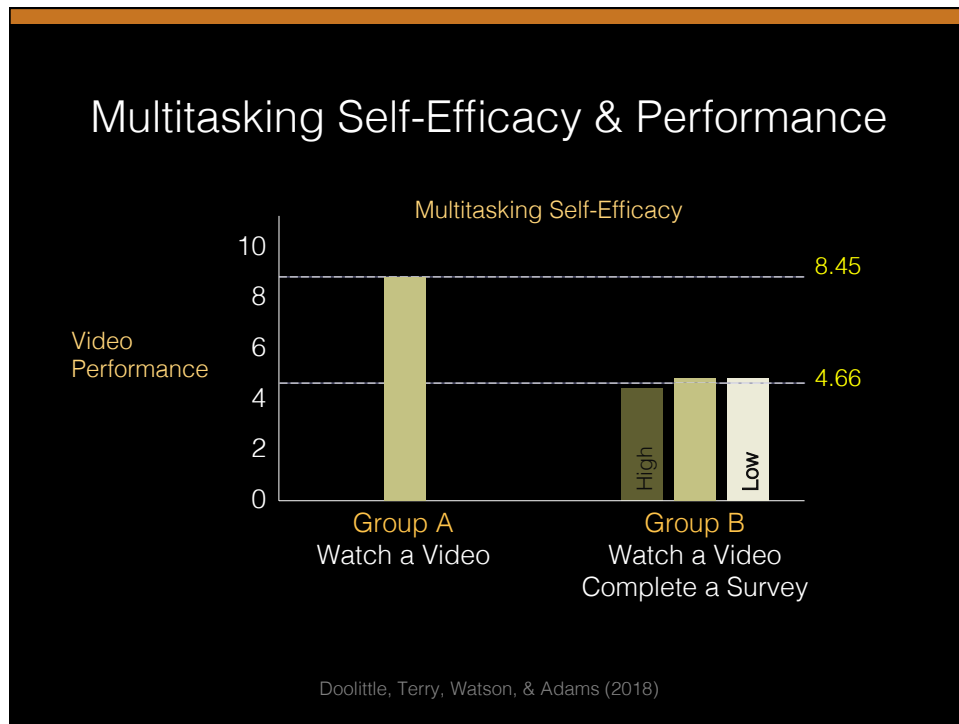
- ↑ MT with a laptop in class → ↓ retention & class performance
- ↑ MT while studying → ↓ class performance
- ↑ laptop multitasking → ↓ performance by multitasker (11 %)
- ↑ laptop multitasking → ↓ performance by nearby peers (17 %)

(Judd, 2013; Junco & Cotton, 2011; Sana, Weston, & Cepeda, 2012; Zhang, 2015)

## Accounting Students & Professionals



Negangard, Ozlanski, Pyzoha, & Doolittle



## WMC Strategies

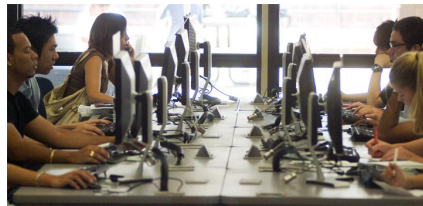
WMC Strategies (F2F, Hybrid, Online)

1. Segmenting Instruction
2. Scaffolding Instruction
3. Lower **Cognitive Load**/Lower Information Density
4. Examples, Examples, Examples
5. Practice with Developmental Feedback

2019 Professional Development Days  
Husson University

## Working Memory, Teaching, Learning

Fostering Deep and Flexible Learning



Peter E. Doolittle  
Director, School of Education  
Professor, Educational Psychology  
Virginia Tech