Design for the Mind: Cognition and Teaching in the Age of Technology

MICHELLE D. MILLER

DIRECTOR, FIRST YEAR LEARNING INITIATIVE, UNIVERSITY COLLEGE
PROFESSOR, DEPARTMENT OF PSYCHOLOGICAL SCIENCES
NORTHERN ARIZONA UNIVERSITY

AUTHOR, MINDS ONLINE: TEACHING EFFECTIVELY WITH TECHNOLOGY

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Memory Theory
The Three Memory Systems

- **Sensory Memory**
  - Information loss
  - Transfer to **Short-Term Memory**

- **Short-Term Memory**
  - Forgetting
  - Transfer to **Long-Term Memory**

- **Long-Term Memory**
  - Forgetting
  - Retrieval
The Three Memory Processes: Transfer, Retrieval, Long-Term Memory, Forgetting
Instead, contemporary theories emphasize:

- Working memory/multistore concept
- Goal relevance and memory
- Relationship between working memory and attention
- Relationship between existing knowledge and encoding new knowledge
Attention
the key to memory
Memory *without* attention?
Change Blindness

By J. Kevin O’Regan, Centre National de Recherche Scientifique

http://nivea.psycho.univ-paris5.fr
What about exposure?
Effortful, attentive practice: Useful
Passive exposure: Not so much
Testing is an especially effective form of practice

Especially when spacing and interleaving are used, quizzes provide the best results for time invested
According to a 2009 survey of college students:

- Rereading was ranked as the #1 strategy by 55%
- Self-testing was ranked as #1 strategy by 1.2%
- Only 18% preferred to self-test vs. re-studying a chapter they just read

Take-aways:

• Don’t think of memory like a holding tank – rather, a set of mechanisms for taking in and getting back goal-relevant information

• Attention drives memory; without attention, little will be remembered

• Retrieval practice (testing, quizzing) is particularly powerful for building memory
How Technology Can Help

1. More opportunities to take advantage of the testing effect
How Technology Can Help

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2. More options for spacing and interleaving practice
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1. More opportunities to take advantage of the testing effect
2. More options for spacing and interleaving practice
3. More options for aligning material with individual learners’ existing knowledge, goals
Higher Thought Processes
Reasoning
Try this reasoning task...
If a card has an odd number on one side, it has an animal on the other side.

Choose ALL of the cards you would need to turn over in order to verify that the rule is being followed. Choose ONLY the cards that would help you verify the rule.
If a card has an odd number on one side, it has an animal on the other side.

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1. 2. 3. 4.

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Choose ALL of the cards you would need to turn over in order to verify that the rule is being followed. Choose ONLY the cards that would help you verify the rule.
If a card has an odd number on one side, it has an animal on the other side.

Choose ALL of the cards you would need to turn over in order to verify that the rule is being followed. Choose ONLY the cards that would help you verify the rule.
Try another rule...
If a person is drinking alcohol, he/she is over 21.

Choose ALL of the cards you would need to turn over in order to verify that the rule is being followed. Choose ONLY the cards that would help you verify the rule.
If a person is drinking alcohol, he/she is over 21.

Choose ALL of the cards you would need to turn over in order to verify that the rule is being followed. Choose ONLY the cards that would help you verify the rule.
If a person is drinking alcohol, he/she is over 21.

1. Beer
2. 20
3. Age 30
4. Age 19

Choose ALL of the cards you would need to turn over in order to verify that the rule is being followed. Choose ONLY the cards that would help you verify the rule.
If a person is drinking alcohol, he/she is over 21.

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If a person is drinking alcohol, he/she is over 21.

Choose ALL of the cards you would need to turn over in order to verify that the rule is being followed. Choose ONLY the cards that would help you verify the rule.

Choose: Beer, Margarita

Age 30, Juice
What does this tell us about reasoning?
Other major challenges in reinforcing thinking skills:

1. Creating effective *transfer* is notoriously difficult
Other major challenges in reinforcing thinking skills:

1. Creating effective *transfer* is notoriously difficult
2. Thinking skills don’t just fall out of content knowledge
Problem Solving
Problem Solving

How does it happen?
How does it improve?
Key concepts:

1. Problem space – paths and constraints
2. Structural elements
What do we mean by *structural elements*?
Critical Thinking
Critical Thinking
What gets in the way?
Critical Thinking
What gets in the way?

1. Failing to foreground deep structure
2. Failing to realize critical thinking is needed (cuing)
3. Effort
4. Motivations to maintain illogical beliefs
Take-aways:

• Reasoning ability doesn’t flow from content knowledge – and many forms don’t come naturally
• Success depends on identifying structural elements of problems
• Students need abundant practice across examples with common structural elements, but varying surface elements
  – Especially true for critical thinking
How Technology Can Help

1. Expanded options for practice
Examples

• Argument mapping software
  – Rationale

• Experiment simulation software
  – Carnegie Mellon’s Causality Lab

• Collaborative annotation tools

• Others?
How Technology Can Help

1. More opportunities for practice
2. More systematic presentation of problems
How Technology Can Help

1. More opportunities for practice
2. More systematic presentation of problems
3. More opportunity for reflection, deliberation
Thank you – and keep up the good work!

michelle.miller@nau.edu
@MDMillerPHD
www.facebook.com/MichelleDMillerPhD
References and recommended reading

Memory and attention


References and recommended reading

Higher thought processes