

## What Learning Science Says (and Doesn't Say) about Creating Critical Thinkers

### Critical Thinking (Halpern, 1998)

"When people think critically, they are evaluating the outcomes of their thought processes – how good a decision is or how well a problem is solved" (p. 451)

Consists of accurate metacognitive awareness of

- Quality of evidence
- Quality of argument, reasoning, or problem solving
- Quality of solution

Used without prompting or conscious intent

Knowledge and learning undergird critical thinking, but critical thinking is more than content

To be critical thinkers, students must be critical learners

- Understand the goal of the learning
- Monitor the quality of their learning
- Have a variety of effective learning strategies that can be used flexibly
- Understand if they know enough to meet their learning goal

### Beliefs about Learning that Make You Stupid

- Learning is fast
- Being good at a subject is a matter of inborn talent rather than hard work,
- Knowledge is composed of isolated facts
- I'm really good at multi-tasking, especially during class or studying

### Fixed vs. Growth Mindset (Carol Dweck)

Student mindset is his or her attitudes, beliefs, and expectations about learning and the whole academic context

Fixed Mindset: Ability and aptitude is inborn and unchangeable

Growth Mindset: Ability and aptitude are a product of effort and practice

### The Nature of Attention

- Attention is like a small spotlight in a darkened room.
- The focus of attention is so narrow that we can't take in a whole scene at once
- Anything that draws attention away from the critical feature hurts attention
- Inattention blindness and Attentional Blink

### Metacognition

- A student's awareness of his or her level of understanding of a topic
- Distinguishes between stronger and weaker students
- Part of being incompetent is not understanding just how incompetent you are.

Which of the following is the MOST important ingredient for successful learning?

- The intention and desire to learn
- Paying close attention to the material as you study

- Learning in a way that matches your personal Learning Style?
- The time you spend studying
- What you think about while studying

#### Levels of Processing

- Shallow processing focuses on spelling, appearance and sound.
  - Rote memorization of facts
  - Flashcards with isolated facts
- Deep processing focuses on subjective meaning.
  - Relating new information to prior knowledge or other information
  - Making information personally meaningful

#### Achieving Deep Processing while Studying

As you study, follow these principles:

- **Elaboration:** How does this concept relate to other concepts? Can I make a story?
- **Distinctiveness:** How is this concept different from other concepts?
- **Personal:** How can I relate this information to my personal experience?
- **Appropriate to Retrieval and Application:** How am I expected to use or apply this concept?

#### Cognitive Load Theory (e.g. van Merriënboer & Sweller, 2005)

- Mental effort is the amount of concentration that a person has available to devote to tasks
- Always a limited resource
- Cognitive Load is the total amount of mental effort a task requires to complete it
- A person can do multiple tasks as long as the total cognitive load does not exceed available mental effort
- If cognitive load exceeds available mental effort, then performance suffers

#### The Curse of Expertise (aka Curse of Knowledge)

- The more one knows about a topic, the harder it becomes to remember not knowing a topic and the effort required to learn that topic
- Experts are overconfident in their ability to explain concepts (Fisher & Keil, 2015)
- Experts are poor at estimating the time and difficulty for novices to learn a concept (Hinds, 1999)

#### Formative Assessments

Brief, low stakes assessments that give students (and teachers) feedback BEFORE exams/high stake grades Angelo, T. A. and K. P. Cross (1993), e.g. e.g. Predict-Observe-Explain, muddiest point, think-pair-share, in-class quiz

- Reveals student understanding to both teacher and student
- Improves learning through appropriate recall and application
- Helps students develop self-regulation and metacognition

#### The Cognitive Challenges to Teaching (that we know about thus far)

- Student Mental Mindset
- Metacognition and Self-regulation
- Student Fear and Mistrust
- Prior Knowledge

- Misconceptions
- Ineffective Learning Strategies
- Transfer of Learning
- Constraints of Selective Attention
- Constraints of Mental Effort and Working Memory

And they all interact with each other

#### A Teachable Moment Occurs When We...

- Become aware of gap or error in our knowledge
- See the value of correcting it
- Have a trusted source of accurate information
- Believe we can master new understanding given sufficient effort
- Have sufficient resources to attend to that source
- Have sufficient prior knowledge to comprehend information
- Recognize when we have mastered the new understanding
- Process new information for long-term recall
- Prime new information to be recalled appropriately and be preferred over prior knowledge

#### A Test of Critical Thinking



## Resources

Video Series: How to Get the Most Out of Studying  
[www.samford.edu/how-to-study](http://www.samford.edu/how-to-study)

Introductory Video: Developing a Mindset for Successful Learning  
Video 1: Beliefs That Make You Fail...Or Succeed  
Video 2: What Students Should Understand About How People Learn  
Video 3: Cognitive Principles for Optimizing Learning  
Video 4: Putting the Principles for Optimizing Learning into Practice  
Video 5: I Blew the Exam, Now What?

Video Series: The Cognitive Principles of Effective Teaching

<https://www.samford.edu/employee/faculty/cognitive-principles-of-effective-teaching/> or  
<http://bit.ly/1LDovLp>

Video 1: Beliefs about Teaching  
Video 2: The Cognitive Challenges of Teaching: Mindset, Metacognition, and Trust  
Video 3: The Cognitive Challenges of Teaching: Prior Knowledge, Misconceptions, Ineffective Learning Strategies, and Transfer  
Video 4: The Cognitive Challenges of Teaching: Constraints of Selective Attention, Mental Effort, and Working Memory  
Video 5: Teachable Moments, Formative Assessment, and Conceptual Change

Books on cognitive research applied to teaching:

*Applying Science of Learning in Education: Infusing Psychological Science into the Curriculum* (2014).  
A free e-book written by some of the best researchers in learning sciences:  
<http://teachpsych.org/ebooks/asle2014/index.php> or <http://bit.ly/KbYLtG>

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., Norman M. K. (2010). *How Learning Works: Seven Research-Based Principles for Smart Teaching*. San Francisco, CA: Jossey-Bass

Brown, Roediger, & McDaniel (2014). *Make It Stick: The Science of Successful Learning*. Belknap Press.

Books on Formative Assessment:

Angelo & Cross (1993). *Classroom Assessment Techniques*. Jossey-Bass.

Ritchart, Church, & Morsion (2011). *Making Thinking Visible: How to Promote Engagement, Understanding, and Independence for All Learners*. Jossey-Bass.

Barkley & Major (2016). *Learning Assessment Techniques: A Handbook for College Faculty*, Jossey-Bass.

Blogs and Twitter Feeds

- Daniel Willingham: <http://www.danielwillingham.com/>
- Learning Scientists Blog: <http://www.learningscientists.org/ourteam/>