Understanding How Students Learn

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• Slides will be available at

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Here is our Professional Obligation

We must follow where the research leads us even if it makes us uncomfortable or results in major changes in our teaching practices.
Here is Our Challenge?

We as teachers can’t make informed decisions about which teaching approaches or tools to use if we don’t first understand how our students learn.
Here is Our Challenge?

To understand how our students learn we must understand how their brains take in, process, and retrieve information as well as the numerous factors that affect these processes.
Key Teaching Questions

1. What Content Should We Teach?

What would make us happy that our students still knew and could apply from the content and skills of our course a year later?
Key Teaching Questions

2. What can students do on their own?

What knowledge and skills do students need our help to learn and what can they look up and learn on their own?
Key Teaching Questions

3. What is the **best use of our time**?

What teaching actions optimize the opportunities for students to master the learning outcomes of our courses?
Former View of Education
The Definition of Learning

Learning is a change in the neuron-patterns of the brain.

(Goldberg, 2009)
Learning is the ability to use information after significant periods of disuse and it is the ability to use the information to solve problems that arise in a context different (if only slightly) from the context in which the information was originally taught.

Basic Finding from Neuroscience Research about Learning

It is the one who does the work who does the learning

(Doyle, 2008).
What Instructors Don’t Control about the Learning Process

• Genes
• Family life
• Home environment
• Stress levels
• Sleep
• Diet
• Hydration

• Exercise
• Prior knowledge*
• Language skills*
• Work Ethic
• Financial situation
• Other priorities
• Mindset
• Learning strategies/disabilities
What Instructors Do Control about the Learning Process

• Our emotional readiness to teach
• Our level of organization and planning
• The quality of our learning activities, assessments and content
• Respect we have for students
What Instructors Do Control about the Learning Process

- Our accessibility to students
- The level of challenge/expectation
- The level of support of the learner
- Level of overall preparedness
- Quality and timeliness of feedback
- The learning environment of the classroom/online
You can make a significant difference

Gallup-Purdue Index survey (2014) of 30,000 college graduates found the most important combination of factors in a successful college experience were:

1. A professor who care about you as a person
2. A professor who made you excited about learning
3. Finding a mentor who encouraged you to pursue your dreams

• Only 14% said they had all of these experiences in college
Success and happiness in life

• The same Gallup-Purdue survey found that success and happiness in life was not tied as closely to your grades or how much you learned in college but to your relationship with faculty.
Learning is Enhanced by Movement

Natural selection developed a human brain to solve problems of survival in outdoor, unstable environments while in almost constant motion.

A brain in motion is a brain better able to learn.

(Medina, 2008)
Moving to Learn

• A growing body of evidence suggests we think and learn better when we walk or do another form of exercise.

Rhodes, 2013
Movement and Learning

• Even mild movement, like walking, sitting on balance balls or working a stationary bike all improve learning.

• Ratey, 2013
Attention Drives Learning

Attention is almost magical in its ability to physically alter the brain and enlarge functional circuits.

(Merzenich and colleagues, UCSF, 2011)
Attention and Learning

When we attend to something we are readying various cognitive process we may need for learning.

(Merzenich and colleagues, UCSF, 2011)
Keeping Students’ Attention

Neuroscientists have a saying: **Emotion drives attention and attention drives learning**—this makes **Attention** the key to learning.

(Merzenich and colleagues, UCSF, 2011)
General Consensus about
Attention Capacity

Attention capacity will increase or decrease
due to:

One’s arousal level
meaningfulness/relevance/interest

Type of task
new vs. automatic

How people allocate attention
previous experiences
Cognitive Load and Student Learning

3 Parts

1. Intrinsic load
This is the effort required for a student to understand a concept–

Teachers can’t do a lot about this.

(Sweller, 1988)
Cognitive Load and Student Learning

2. Germane mental load

This is the load due to the pedagogy and activity relevant to schema formation.

- PBL is high cognitive load
- Lecture is low cognitive load

*(Sweller, 1988)*
Cognitive Load and Student Learning

3. Extraneous Mental load

- These are activities not relevant to schema formation.
- Distractions, poor communication, poor humor.

(Sweller, 1988)
Cognitive Load and Student Learning

Information overload is not just a metaphor it is a physical state.

When learning is important we need to turn the information faucet down to a trickle.

(Nicholas Carr, What the Internet is doing to our Brains, 2010)
A Learner Needs a Clear Rationale for Learning

To help students become life long learners.

To help students gain employment and keep that employment.

Meet the survival need of the learner.
Developing a Clear Rationale

1. Why are we learning this?

2. How does it advance students skills or understanding?

3. How does it help students become life long learners?

4. How does it fit with the students degree or job goals?

5. What challenges would students face without this skill or knowledge?
Why does this matter?

• Our brain prioritize. Students are less likely to be bored or prioritize other learning when they understand how the new learning matters to them.

(Brown, Roediger and McDaniel 2014)
What matters to your students?

• If you understand what matters to your students you have a much better chance of getting them to see what matters to you. (Bowen & Watson, 2017)

• Example—why does music matter to you?
• Find something interesting in the text.
Fix Prior Knowledge Deficits

• The brain's goal is to find established patterns of learning with which to connect new learning. (Ratey 2001)

• The more prior knowledge a student has, the easier new learning usually is for them.

• Deficits in prior knowledge need to be repaired in order to enhance the likelihood of new learning.
Fix Prior Learning Deficits

• Assessment of prior knowledge

• Tutoring or supplemental work time

• Online learning activities
Prior Knowledge

• Recalling prior knowledge can also mean recalling misconceptions, information that is in error or has a strong bias that may resist change.
The Brain Needs to be Ready for Learning

- Hydration = drink when thirsty
- Diet = balanced and eat before learning
- Food (glucose) is the energy source of the brain
- Exercise = dramatically improves the brain’s readiness to learn
- Sleep = making new memories and avoiding the harmful effects of sleep deprivation
“Given the latest research on the many functions of sleep, skimping on sleep is looking like a worse and worse strategy for dealing with the demands of daily life.” (Strickgold, 2015)

“Research on the role of sleep in hormonal, immunological and learning and memory function suggest that if you don’t get enough (sleep) you could—besides being very tired—wind up sick, overweight, forgetful and very blue.” (Strickgold, 2015)
Sleep and Learning

• Adults need 7 to 9 hours of sleep each night. (Dement, 2005)

• Memories are made during sleep and mostly during the last 2 hours of sleep so sleeping 5-6 hours impairs memory formation.

• (Walker, Strickgold, Alsop, Gaab & Schlaug, 2005)
Exercise Improves Learning Readiness

Exercise is the single most important thing a person can do to improve their learning.

(John Ratey, 2013, Spark, The Revolutionary New Science of Exercise and the Brain)
Learning and Memory are Enhanced when Multiple Senses are Engaged

• Humans are powerful visual and auditory learners—evolution made certain of it.

• Each sensory pathway creates its own memory pathways—the more senses used in learning the more chances for understanding and recall.

• (www.human-memory.net/processes_encoding.html)
The brain is a pattern seeking device

The brain is a pattern seeking device that relates whole concepts to one another and looks for similarities, differences, or relationships between them.”

(Ratey, 2001, pg.5)
Which of the following slides is easier to remember and why?
(491) 580-2979
What are the patterns of your content?

• We need to teach students the patterns of our content.

• How it is organized.

• What types of thinking are most often used.

• How does one learn to think like a scientist, business person or public servant etc. ?
Common Patterns for Learning

- Similarity and Difference
- Cause and Effect
- Comparison and Contrast
- In students’ own words
Actions that Improve Memory Formation and Recall

1. Attention
2. Prior knowledge
3. Spaced learning
4. Naps and wakeful rest
5. Sleep
6. Wanting to remember
7. Distribute practice
8. Elaboration
9. Interest
Factors Impacting Recall

1. Number of memory pathways

2. The number of senses used in the learning process

3. The strength of the memory

4. The cue that is given to spark the memory

5. Was the information learned as a part of a whole idea or concept
Keys to Remembering

Three Rules

1. Repetition over time (distributive practice)

2. Elaboration of material

3. Wanting to remember
Keys to Memory Formation

• The more elaborately you encode new information at the moment of learning the stronger the memory —make it detailed, multifaceted and emotional.

  • (Squire and Kandel, 2000)
Keys to Memory Formation

• The same neural pathways used to process new learning are the same ones used to store it.

• So the initial moments of learning are crucial to helping us to recall what we learned.

(Squire and Kandel, 2000)
Keys to memory Formation

• The quality of our initial encoding of new learning is the greatest predictor of later learning success.

(Squire and Kandel, 2000)
Keys to Memory Formation

• The more closely you replicate the environment and conditions at the moment of learning when trying to recall something the easier remembering it will be.

• Studying in the place you will be tested is ideal.

(Squire and Kandel, 2000)
Learner’s Mindset and Learning

• Dr. Carol Dweck spent 30 years developing the theory of mindset.

• A mindset is belief a person has about their intelligence and abilities.
Growth or Fixed

• Dweck’s work found that only two belief systems developed in learners.

• In each learning situation learners either saw their intelligence as fixed at birth—hence a Fixed Mindset.

These learners see people as being born either smart average or below average and that is just the way it is.
Growth Mindset

OR

• Learners see intelligence as malleable and changeable and that a person never knows how smart they might become.

• You get smarter your whole life.
Students’ Mindsets

• Our students’ mindsets begin in middle school or even before.

• Correlated with the time when students, for the first time, are confronted with more difficult academic tasks.
Students’ Mindsets

• Students begin to see clear differences between themselves and other learners.

• A Mindset is situation specific. Fixed in one area---- growth in another.
Growth Mindset

In a growth mindset students believe their intelligence and abilities can be enhanced through hard work and practice.

They see failure as a result of lack of effort or strategy and it is something to learn from.
Fixed Mindset

In a fixed mindset students believe that intelligence is a fixed trait -- that some people have it and others don't -- and that their intelligence is reflected in their performance (Dweck, 2006).
Fixed Mindset

Fixed mindsets believe they either shouldn’t need to work hard to do well or putting in the effort won’t make any difference in the outcome.
Growth Mindset

Students are willing to take learning risks and understand that through practice and effort their abilities can improve.
Metacognition Skills and Learning

• Metacognition consist of two basis process occurring simultaneously: monitoring your progress as you learn, and making changes and adapting your strategies if you perceive you are not doing well.

( Winn & Snyder, 1996)
Suggestions for Building Metacognition

• When learners succeed at tasks of any kind, focus their attention on and label the thinking skills they used.

• (By permission E. Vockell, Educational Psychology)
Suggestions for Building Metacognition

• Provide feedback on the degree to which learners have **evaluated their comprehension correctly**, not just on the degree to which they have comprehended correctly.

• Emphasize not only knowledge about strategies, but also **why these strategies are valuable** and how to use them.
Suggestions for Building Metacognition

• Be aware that **students may not transfer thinking strategies far from the original setting**, unless they are guided to do so.

• (By permission E. Vockell, Educational Psychology)
Emotions and Learning

The emotional engagement pathway is effective in capturing and sustaining attention.

(LeDoux, 2003)
Dopamine is the Reward for Learning

Dopamine is there to reward your brain for learning new information, or engaging in new experiences.

Without dopamine, you would not be interested in learning or trying new things.

(LeDoux, 2003)
Emotional Contagion

• "A process in which a person or group influences the emotions or behavior of another person or group through the conscious or unconscious induction of emotion states and behavioral attitudes".

Emotion and Memory

Emotional arousal organizes and coordinates brain activity
(Bloom, Beal & Kupfer 2003)

When the amygdala detects emotions, it essentially boosts activity in the areas of the brain that form memories
(Phelps, 2004)
Short Term Stress Impairs Learning

Acute stress activates selective CRH molecules (corticotropin) releasing hormones, which disrupt the process by which the brain collects and stores memories. (Baram, 2010)
Technology and Learning

Serious Games

A serious game is a game designed for a primary purpose other than pure entertainment.

The "serious" adjective refers to products used by industries like defense, education, scientific exploration, health care, emergency management, city planning, engineering, religion, and politics.
Serious Games

• There is a growing body of research on the effectiveness of online games as learning tools. In her review of the peer-reviewed material from the last ten years, Mary Jo Dond linger concludes---

• “there is widespread consensus that games motivate players to spend time on task mastering the skills a game imparts...[A] number of distinct design elements, such as narrative context, rules, goals, rewards, multisensory cues, and interactivity, seem necessary to stimulate desired learning outcomes.”
Serious Games in Higher Education

- Give psychology students a way to understand mental illness
- Stage a play in the “original” Old Globe Theater
- Teach hedge fund management
- Accelerate time for science experiments
- Teach Arabic language, culture and customs

Virtual Textbooks
The Future is Here--Almost

Click on any bar in the timeline, and that bar expands to a list of images, which in turn are linked to video about that artist.

That's key, because, like a great documentary, it makes learning about what can be a fairly narrow subject into something painless.
Explore Virtual Textbooks

• http://plc.cwru.edu/tutorial/enhanced/files/textbook.htm
Simulations and Models

• The ability for students to engage in a virtual world using simulations of the real world problems is a big step forward in enhancing learning.

• Visit the Concord Consortium
Cognitive Enhancement

Meditation

The training has shown success in enhancing mental agility and attention by changing brain structure and function so that brain processes are more efficient, the quality associated with higher intelligence (Neuroscientist Amishi Jha of the University of Miami)
Caffeine + Sugar and Learning

The combination of caffeine and sugar enhanced attention, learning and memory.

Improves cognitive performance in terms of sustained attention and working memory by increasing the efficiency of the areas of the brain responsible for these two functions.

(Grabulosa, Adan, Falcón, and Bargalló, 2010 reported in the journal Human Psychopharmacology: Clinical and Experimental)
Nicotine Promotes Cognitive Enhancement

Nicotine enhances attention—that key driver of neuroplasticity and cognitive performance in both smokers and nonsmokers.

Nicotine has significant positive effects on fine motor skills, the accuracy of short-term memory, some forms of attention, and working memory, among other basic cognitive skills.

(Martha Farah, University of Pennsylvania)

Scientists at the National Institute on Drug Abuse reported in a 2010 analysis of 41 double-blind, placebo-controlled studies.
Adderall has Cognitive Benefits

There are cognitive benefits of stimulants like Adderall, at least in some people for some tasks.

Enhance the recall of memorized words as well as working memory, which plays a key role in fluid intelligence.

(Martha Farah of the University of Pennsylvania)
Adderall has stronger effects on the prefrontal cortex and can therefore improve concentration and minimize fatigue much more so than caffeine.
Adderall has Side Effects

Adderall is not without health risks.

Side effects include difficulty sleeping, seizures, high blood pressure, loss of appetite, depression, and many others.
Modafinil

- A new analysis of the research revealed it does improve planning and decision making, flexibility, learning and memory, and even creativity.

http://www.dailymail.co.uk/health/article-3204567/Smart-drugs-really-work-Pills-taken-fifth-university-students-improve-memory-learning-raising-ethical-questions.html#ixzz3rrs0gfvg
Modafinil

• Professor Guy Goodwin, President of the European College of Neuropsychopharmacology (ECNP) said:

• “This overview suggests that, on current evidence, modafinil enhances cognition independent of its known effects in sleep disordered populations”.

![Neurotransmitters modulation by modafinil](image_url)
Modafinil

- However, they can have worrying side-effects — including headaches, irritableness, vomiting, irrational behavior, tremors, palpitations and broken sleeping patterns

- http://www.dailymail.co.uk/health/article-3204567/Smart-drugs-really-work-Pills-taken-fifth-university-students-improve-memory-learning-raising-ethical-questions.html#ixzz3rrsbXwZ
REFERENCES

- http://www.brainadvance.org/ Allen, Corinne (Water and Brain health)
Bibliography

REFERENCES

• http://www.brainadvance.org/ Allen, Corinne (Water and Brain health.
Bibliography

Bibliography


Bibliography

Bibliography


Bibliography

Bibliography


Bibliography


Bibliography

• Zull, J. (2002). The art of changing the brain. Sterling, Virginia: Stylus
Bibliography


Brain Energy Metabolism An Integrated Cellular Perspective
Pierre J. Magistretti, Luc Pellerin, and Jean-Luc Martin
http://www.acnp.org/g4/gn401000064/ch064.html

• Water enhances mental function and is essential to survival
• Published on October 15, 2010 by Joshua Gowin, Ph.D. in You, Illuminated
• http://www.psychologytoday.com/blog/you-illuminated/201010/why-your-brain-needs-water

• Feeding the Brain for Academic Success: How Nutrition and Hydration Boost Learning Philippa Norman MD, MPH

• The Handbook of Brain Theory and Neural Networks: Second Edition
• By Michael A. Arbib 2003