Improving Student Performance by Addressing Student and Teacher Misconceptions about Learning

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Belmont University
Commission on Colleges
August 12-13, 2013
Evolution of a Presentation

• Given many workshops for teachers on how to teach effectively
• In 2006, I was asked to give a presentation to Samford’s entire freshman class on how to study effectively in college
• Focus on what students need to know about how people learn in order to make them better learners
Specific Goals of the Presentation

• Give students a coherent, research-based framework that would allow them to become effective learners in any situation
  – More than disconnected study tips, e.g. space out learning; serial position; study in same place you will be tested
  – Not a recipe for best way to study

• Show them how to apply the framework to their study
How to Study Long and Hard and Still Fail… Or How to Get the Most Out of Your Studying

I. Beliefs about Learning that Make You Stupid (common misconceptions)

II. Metacognition and its consequences

III. So how accurate are your beliefs about how people learn? (A quiz)

IV. A demonstration of Levels of Processing

V. Operationalizing Levels of Processing

VI. Applying Levels to studying, note taking, and highlighting and reading
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
Metacognition

• A student’s awareness of his or her level of understanding of a topic
• Metacognition distinguishes between stronger and weaker students
• One of the major tasks for a freshman is developing good metacognition
  – In high school, students spent years developing a metacognitive sense that is likely inadequate or even counterproductive for college.
Which of the following is the MOST important ingredient for successful learning?

1. The intention and desire to learn
2. Paying close attention to the material as you study
3. Learning in a way that matches your personal Learning Style?
4. The time you spend studying
5. 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?
• **Distinctiveness**: How is this concept different from other concepts?
• **Personal**: How can I relate this information to my personal experience, say through example or story?
• **Appropriate to Retrieval and Application**: How am I expected to use or apply this concept?
Development of Video Series

• Have the same helpful tone as presentation
• Contain the same information as my two presentations
• Serve as a resource for students and teachers on how to study effectively
• Be as flexible as possible for different uses, such as online learning
  – Five brief modules
• Be worth the time invested in terms of information learned
  – 6-8 minutes each
Cognitive Load Theory  
(e.g. van Merrienboer & Sweller, 2005)

- Mental effort is the amount of concentration that a person has available to devote to tasks.
- Mental effort is 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 at once as long as the total cognitive load does not exceed available mental effort.
- If cognitive load exceeds available mental effort, then performance suffers.
Student mental effort must meet the demands of instructional mental load.

Tasks and concepts possess difficulty.

Students possess prior knowledge, learning strategies and mental effort.

Available Mental Effort

Cognitive Load

Extraneous Load (Minimize)

Germane Load (Optimize)

Intrinsic Load (Manage)

Teachers design instruction.
Implications of Cognitive Load Theory

• If the cognitive load demanded of students exceeds their available mental effort, then learning will not occur

• If the cognitive load demanded of students takes up most or all of available cognitive effort, then there will not be enough mental effort available for learning or schema formation

• Teachers must monitor, manage and minimize cognitive load to allow schema development as well as design activities to promote schema development
Cognitive Load of Various Tasks
(adapted from Piolat, Olive & Kellogg, 2004)
How do we deal with cognitive load?

• Deliberate Practice leads to automatic thinking

• Deliberate practice is intentional practice with the goal of improving a skill.
  – Not mindless drill
  – The goal must be apparent to the student, or the student must trust the teacher

• With large amounts of practice, a skill becomes automatic and no longer requires mental effort.

• Expertise is based on automatic processing
The Complexity of Teaching

- The number of teaching methods is large and diverse
- No teaching method is without limitations and pitfalls
- Teaching is a *contextual interaction*; Teaching effectiveness involves the dynamic interaction of multiple factors:
  - the outcomes that are desired by
  - the characteristics of the students by
  - the characteristics of the instructor by
  - the curriculum and content
- No single best way to teach
Take Home Message, part 1

• Students and faculty have misconceptions about learning that undermine effectiveness
• Described a live and video presentation for making students more effective learners
• Presented a more sophisticated understanding of how people learn
• Teaching is a complex interaction of factors that the teacher must manipulate, manage, and monitor
  – No single best teaching method
  – Requires constant monitoring and adjustments
Things That Do and Do Not Help Learning

What Doesn’t Help
• Motivation to learn
• Amount of time studied
• Memorization of isolated facts
• Learning styles
• Multi-tasking
• Pseudo-study or shallow study

What Does Help
• Developing metacognition
• Deep, appropriate processing of critical concepts
• Connected understanding
• Minimize distractions; Maximize focus
• Practicing retrieval and application
Bad Study Strategies

• Are usually easy to do, e.g. rote memorization of key terms, highlighting only key terms, reading only chapter summaries; “studying” with friends, studying with distractions

• They give you false confidence without actually understanding or learning, e.g. repeatedly skimming over notes or text

• They may be time consuming, but not mentally challenging, e.g. writing definitions on note cards

• Regardless of how effortful they are, they lead to shallow processing
Good Study Strategies

• Focus on meaning and comprehension
• Focus on connections and organizational structure among concepts
• Focus on key distinctions among related concepts
• Focus on recalling and applying information in the way the instructor expects
The Study Cycle

**Preview**
- **Preview before class** – Skim the chapter, note headings and boldface words, review summaries and chapter objectives, and come up with questions you’d like the lecture to answer for you.

**Attend**
- **Attend class** – GO TO CLASS! Answer and ask questions and take meaningful notes.

**Review**
- **Review after class** – As soon after class as possible, read notes, fill in gaps and note any questions.

**Study**
- **Study** – Repetition is the key. Ask questions such as ‘why’, ‘how’, and ‘what if’.
  - Intense Study Sessions* - 3-5 short study sessions per day
  - Weekend Review – Read notes and material from the week to make connections

**Assess**
- **Assess your Learning** – Periodically perform reality checks
  - Am I using study methods that are effective?
  - Do I understand the material enough to teach it to others?

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**Intense Study Sessions**

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<td>1</td>
<td>Set a Goal</td>
<td>1-2 min</td>
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<td>Study with Focus</td>
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<td>3</td>
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<td>4</td>
<td>Review</td>
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Intense Study Sessions (ISS)

1) Set a Goal (1-2 min)
   • Decide what you want to accomplish in your study session
2) Study with Focus (30-50 min)
   • Eliminate all distractions and temptations
   • use deep processing
3) Reward Yourself (5-10 min)
   • Take a break—call a friend, play a short game, get a snack
4) Review (5 min)
   • Go over what you just studied
   • Recall without looking
Take Home Message, Part 2

To improve learning:
• Change or avoid ineffective study strategies using principles of deep processing
  – Avoid “pseudo-studying” e.g. recopying notes, group study that isn’t studying
• Minimize distractions and maximize focus on studying
• Allow sufficient time for study
  – Space out study time; avoid cramming; and maximize review time.
• Embrace the time and effort required to develop and use effective study strategies
Using the Study Videos Effectively

Why just assigning them for students to watch isn’t enough
Using the videos effectively

• Need to ensure watching and engagement
• Need to scaffold content
  – Discrepancy between video content and student beliefs
  – Ideas are counterintuitive and contrary to popular misconceptions
  – Discuss how to apply information for your class
• Need to be viewed multiple times, at different intervals.
  – Information dense
  – Need periodic reminding of content
• It is a resource that will save teacher time, but will not replace the teacher.
Some suggestions

• Assign one at a time and discuss
• Use study questions, assignments, or formative assessments to ensure deep processing
• Revisit them after exams
• Use as a resource in working with struggling students
• Use jigsaw technique
• Reflection questions for bonus points
Using Formative Assessments to Promote Conceptual Change and Understanding
Formative Assessments

• Brief, low stakes assessments that give students (and teachers) feedback BEFORE exams/high stake grades


  e.g. Minute papers, muddiest point, think-pair-share
  – Brief
  – Low stakes
  – Provide feedback to teacher and student
  – Occur before summative assessments
Common Misconceptions

• Counterintuitive
  – People behave rationally
  – Blind people have unusually sensitive organs of touch.

• Popular belief and stereotypes
  – Use 10% of the Brain
  – Schizophrenia is Split Personality

• Counter to personal image or idea of justice
  – Milgram’s obedience studies
  – Brain and aggression

• Difficult or confusable concepts
  – Negative reinforcement and punishment
  – Heritability of traits
Peer Instruction: Eric Mazur

Properties of Conceptests (Mazur, 1997)

A multiple choice question that...
- Focuses on a single concept
- Requires conceptual understanding to solve
- Has adequate response alternatives
  - Ideally the incorrect alternatives should reflect the most common misconceptions
- Be unambiguously worded
- Be neither too easy nor too difficult
The ConcepTest General Format

1. Present ConcepTest to class – 1 minute
2. Students given time to think – 1 minute
3. On a given signal, students indicate their answer by number of fingers.
4. Have the students pick someone around them, preferably with a different answer, to discuss their choices – 1- 2 minutes
5. Repeat step three to see how choices have changed
6. Explain and discuss the answer as a class – 2+ minutes
The Critical Components of ConcepTests

• The Quality of the Question
  – Engaging
  – Models desired thought process such as appropriate application or relevant implications
  – Unexpected or not obvious
  – Acceptable cognitive load

• The Peer Discussion between Polls
Low Prep, Easy Techniques I

• **Background Knowledge Probe**
  – Short, simple surveys for use at the start of new material
  – Identifies misconceptions

• **Think-Pair-Share**
  – Give students a prompt, allow them to think/write, pair up and exchange ideas with a partner
  – Gives students time needed to process information
  – Allows for collaborative learning
Low Prep, Easy Techniques II

• Directed paraphrasing
  – Students paraphrase concepts for a specific audience
  – Letter to Mom and Dad

• Application cards
  – Students generate real-world applications for principles, theories, or concepts they have just learned
  – Goes beyond traditional note card
Low Prep, Easy Techniques III

• **Headline Writing**
  – Students write a headline for a reading or activity. Second, the student writes a paragraph explaining the headline.

• **Minute Papers**
  – Typically: What was the most important thing you learned during this class? And What important question remains unanswered?
  – Encourages students to think about what they DON’T know
Take Home Message

• Formative assessments make the level of learning visible to both student and teacher
  – The exam should never be the first time a teacher has assessed student understanding
• They increase engagement, reduce whining, and promote desirable thought processes
• They are easy to do and improve student learning and understanding
• There are many formative assessments and they are flexible
• There is little cost in using them
Critical Thinking and Critical Thinkers
(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)

• It involves an awareness of one’s own thought processes (metacognitive awareness)
  – Quality, completeness, accuracy, vulnerability to error
  – It is not about content

• “Critical thinkers use these skills appropriately, without prompting, and usually with conscious intent in a variety of settings.” (p. 451)

• In the long run, critical thinkers will make better decisions and fewer mistakes than non-critical thinkers
Critical thinking is more than content

• Teaching critical thinking involves teaching both content and content-related thinking skills
  – Reflection, elaboration, application

• Content and skill are not separable
  – Critical thinking for literature, science, art, history, etc

• Many teachers confuse content delivery with teaching, and technology with pedagogy
Take Home Message

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
  – Change learning strategies if needed
• Understand if they know enough to meet their learning goal