Get Engineering Students to Focus on Learning Instead of Grades: Teach Them HOW to Learn!

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Metacognition: The Key to Learning

The ability to:

- think about one's own thinking
- be consciously aware of oneself as a problem solver
- monitor, plan, and control one's mental processing (e.g. "Am I *understanding* this material, or just *memorizing* it?")
- accurately judge one's level of learning

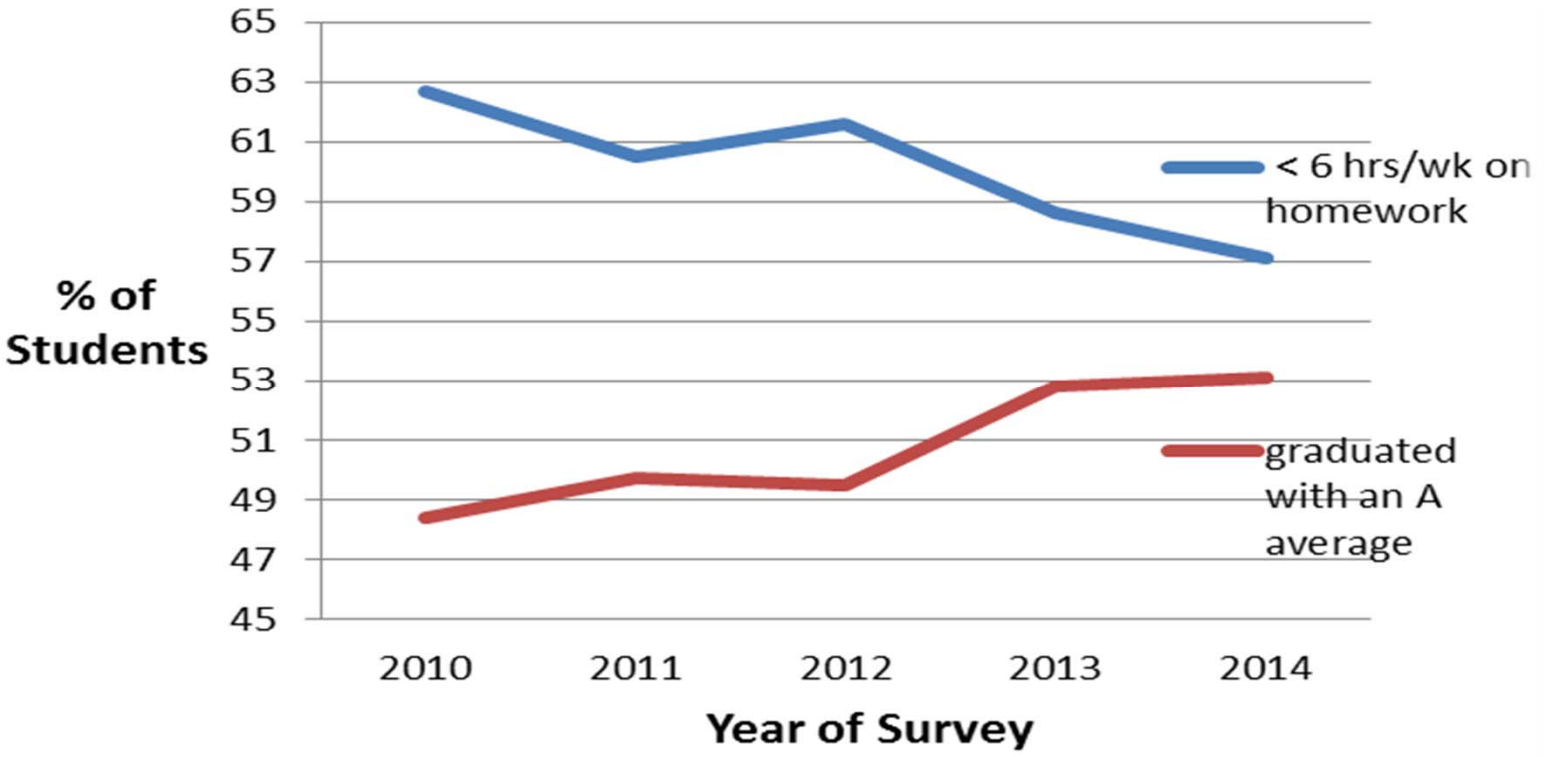
Flavell, J. H. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), The nature of intelligence (pp.231-236). Hillsdale, NJ: Erlbaum

Why haven't most students developed metacognitive skills?

It wasn't necessary in high school

Data from UCLA Higher Education Research Institute (HERI First Year Student Survey – 2010 - 2014

	% who spent < 6 hrs/wk on homework	% who graduated with an A average
2010	62.7	48.4
2011	60.5	49.7
2012	61.6	49.5
2013	58.6	52.8
2014	57.1	53.1



http://www.heri.ucla.edu/

How do you think most students would answer the following?

- What did most of your teachers in high school do the *day before the test*?
- What did they *do* during this activity?
- What grade would you have made on the test if you had gone to class *only* on the day before the test?

achieve more®

SAT®

2013 SAT® Report on COLLEGE & CAREER READINESS

2013 SAT® Report on College & Career Readiness

EXECUTIVE SUMMARY

The College Board's *2013 SAT® Report on College & Career Readiness* reveals that fewer than half of all SAT takers in the class of 2013 graduated from high school academically prepared for the rigors of college-level course work. This number has remained virtually unchanged during the last five years, underscoring a need to dramatically increase

STEM Faculty Must *Help Students Make the Transition to College*

Help students identify and **close "the gap"**

current *behavior* → ***current grades***

productive *behavior* → ***desired grades***

Reflection Questions

- What's the difference, if any, between *studying* and *learning*?

- For which task would you work harder?

  A. Make an A on the test

  B. Teach the material to the class

The Story of Two Students

- **Travis**, *junior psychology student*

  47, 52, 82, 86 B in course

- **Dana**, *first year physics student*

  80, 54, 91, 97, 90 (final) A in course

A Reading Strategy that Works: SQ3R (4R or 5R)

- **Survey** (look at intro, summary, bold print, italicized words, etc.)
- **Question** (devise questions survey that you think the reading will answer)
- **Read** (one paragraph at a time)
- **Recite** (summarize in your own words)
- **Record or wRite** (annotate in margins)
- **Review** (summarize the information in your words)
- **Reflect** (other views, remaining questions)

Travis, *junior psychology student*

47, 52, 82, 86

Problem: Reading Comprehension

Solution: Preview text before reading*
Develop questions*
Read one paragraph at a time
and paraphrase information

*Develop anticipatory set

First Voyage of Christopher Columbus

WITH HOCKED GEMS FINANCING HIM/ OUR HERO BRAVELY DEFIED ALL SCORNFUL LAUGHTER/ THAT TRIED TO PREVENT HIS SCHEME/ YOUR EYES DECEIVE/ HE HAD SAID/ AN EGG/ NOT A TABLE/ CORRECTLY TYPIFIES THIS UNEXPLORED PLANET/ NOW THREE STURDY SISTERS SOUGHT PROOF/ FORGING ALONG SOMETIMES THROUGH CALM VASTNESS/ YET MORE OFTEN OVER TURBULENT PEAKS AND VALLEYS/ DAYS BECAME WEEKS/ AS MANY DOUBTERS SPREAD FEARFUL RUMORS ABOUT THE EDGE/ AT LAST/ FROM NOWHERE/ WELCOME WINGED CREATURES APPEARED/ SIGNIFYING MOMENTOUS SUCCESS

Dooling, J.D. and Lachman, R. Effects of Comprehension on Retention of Prose, *Journal of Experimental Psychology,* (1971), Vol. 88, No. 2, 216-222

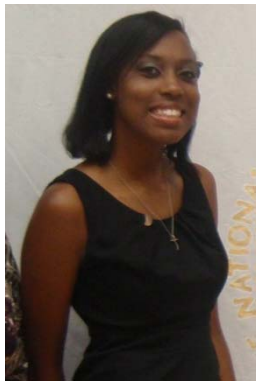
Anticipatory set CAN interfere!

Let's look at the car on the next slide…

Is this a 2-door or 4-door car?

Dana, *first year physics student*

80, 54, 91, 97, 90 (final)



Problem: Memorizing formulas and using online homework aids

Solution: Solve problems with no external aids and test mastery of concepts

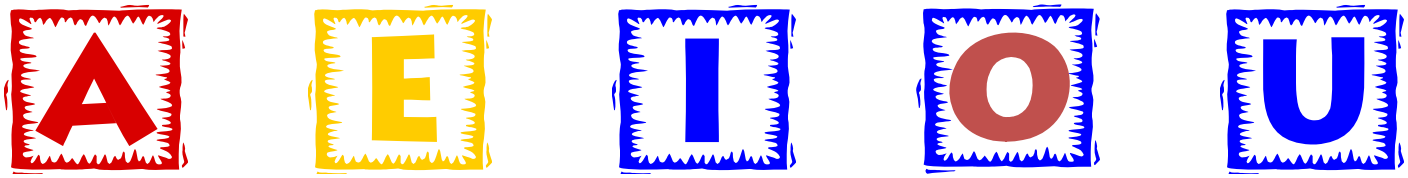
Homework system that can be taught

- Study information before looking at the problems/questions
- Work example problems (without looking at the solutions) until you get to the answer
- Check to see if answer is correct
- If answer is not correct, figure out where mistake was made, without consulting solution
- Work homework problems/answer questions as if taking a test

Why Can Students Make Such a Fast and Dramatic Increase?

It's all about the ***strategies***!

Counting Vowels in 45 seconds



How accurate are you?

Count the vowels
in the words on the next slide.

Dollar Bill
Dice
Tricycle
Four-leaf Clover
Hand
Six-Pack
Seven-Up
Octopus

Cat Lives
Bowling Pins
Football Team
Dozen Eggs
Unlucky Friday
Valentine’s Day
Quarter Hour

How many *words* or *phrases* from the list do you remember?

Let’s look at the words again…

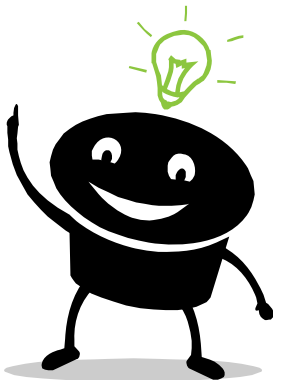
What are they arranged according to?

Dollar Bill
Dice
Tricycle
Four-leaf Clover
Hand
Six-Pack
Seven-Up
Octopus

Cat Lives
Bowling Pins
Football Team
Dozen Eggs
Unlucky Friday
Valentine’s Day
Quarter Hour

NOW, how many *words* or *phrases* from the list do you remember?

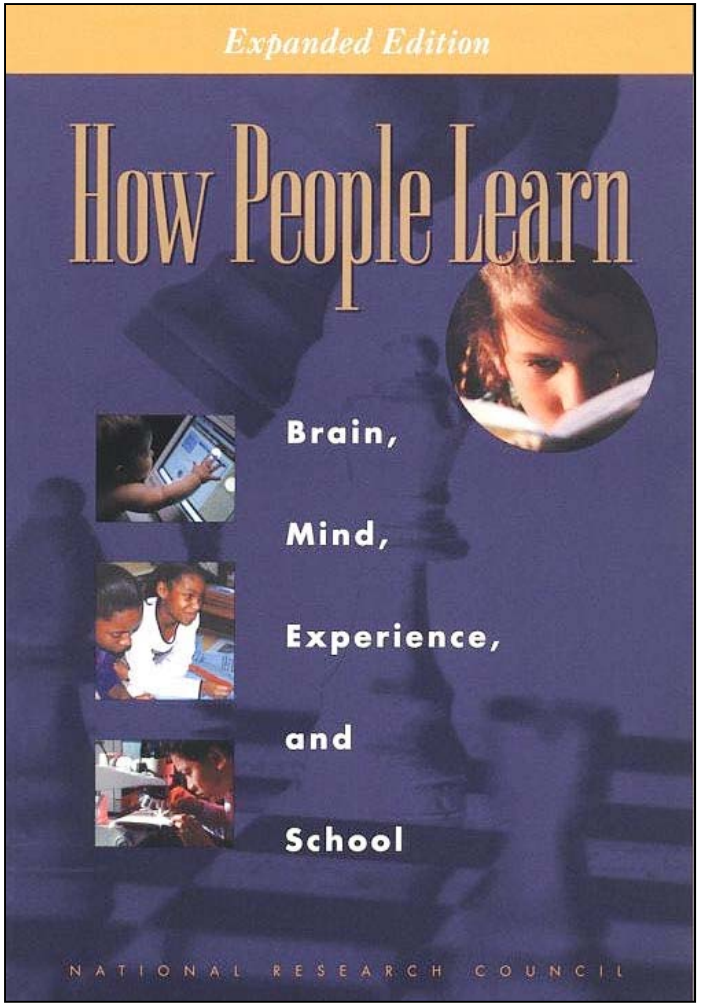
What were two major ***differences*** between the 1st and 2nd attempts?



1. We knew what the task was

2. We knew how the information was organized

An Excellent Introduction



Bransford, J.D., Brown, A.L., Cocking, R.R. (Eds.), 2000. *How people learn: Brain, Mind, Experience, and School.* Washington, DC: National Academy Press.

What we know about learning

- Active learning is more lasting than passive learning
  -- Passive learning is an oxymoron*

- Thinking about thinking is important
  – Metacognition**

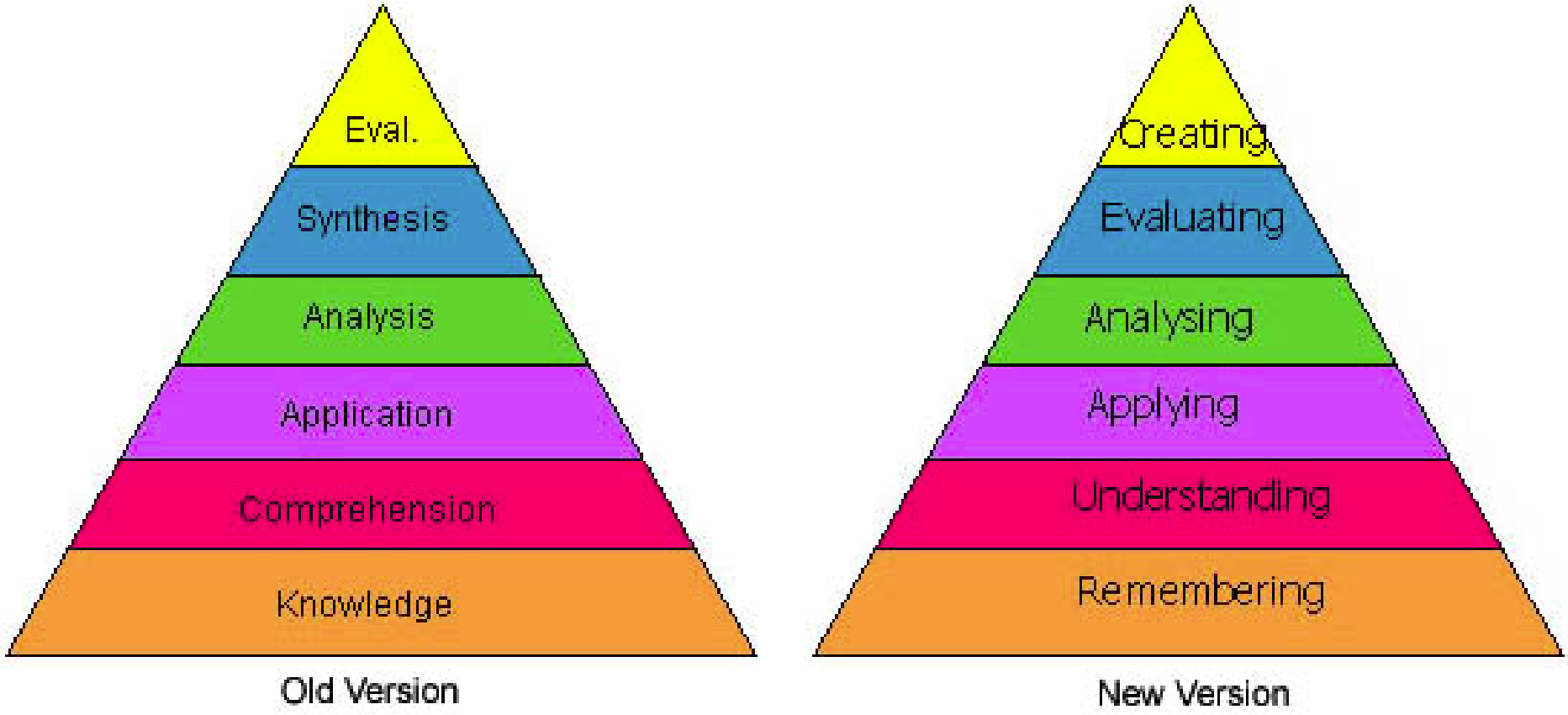
- The level at which learning occurs is important
  – Bloom's Taxonomy***

*Cross, Patricia, "Opening Windows on Learning" League for Innovation in the Community College, June 1998, p. 21.

** Flavell, John, "Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry." *American Psychologist*, Vol 34(10), Oct 1979, 906-911.

*** Bloom Benjamin. S. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain.* New York: David McKay Co Inc.

Bloom's Taxonomy

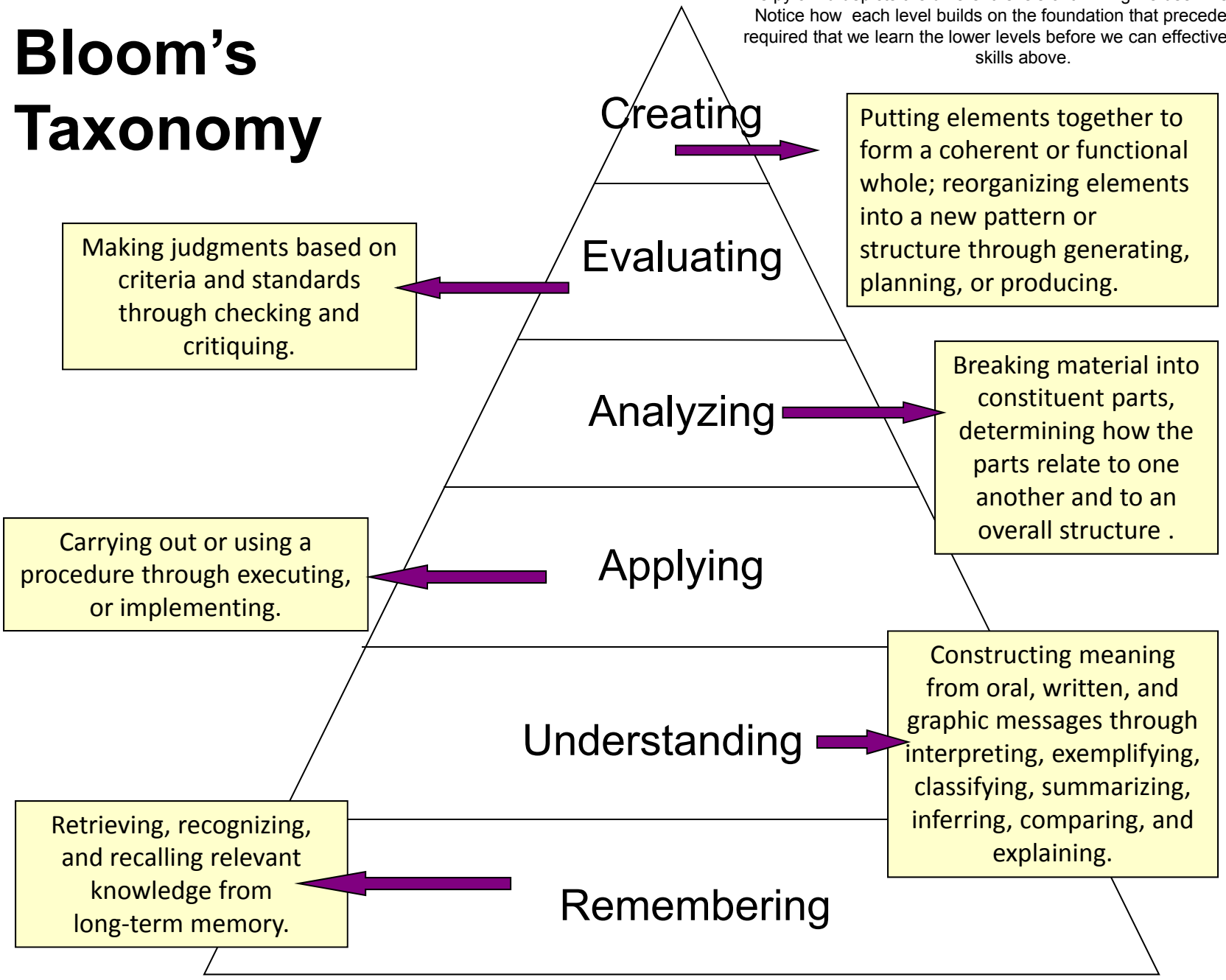


Anderson & Krathwohl, 2001

http://projects.coe.uga.edu/epltt/index.php?title=Bloom's_Taxonomy

Bloom's Taxonomy

This pyramid depicts the different levels of thinking we use when learning. Notice how each level builds on the foundation that precedes it. It is required that we learn the lower levels before we can effectively use the skills above.



http://www.odu.edu/educ/llschult/blooms_taxonomy.htm·

When we teach students about Bloom's Taxonomy…

They GET it!

How do you think students answered?

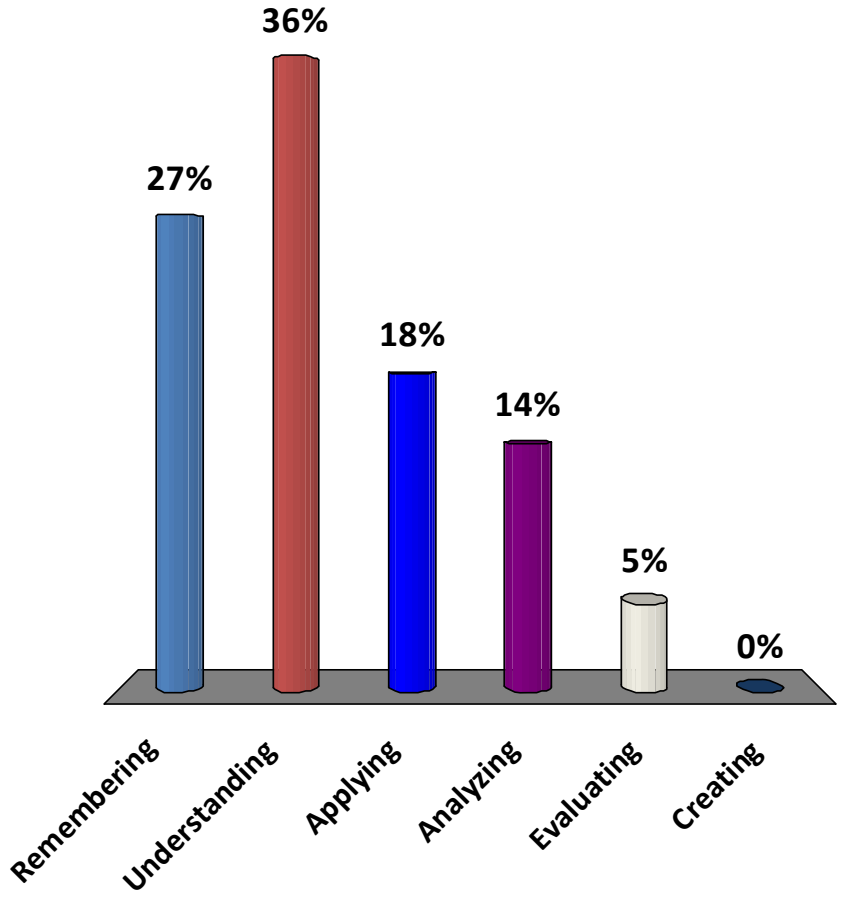
At what level of Bloom's did you have to operate to make A's or B's in high school?

1. Remembering
2. Understanding
3. Applying
4. Analyzing
5. Evaluating
6. Creating

How students answered (2015)

At what level of Bloom's did you have to operate to make A's and B's in high school?

A. Remembering
B. Understanding
C. Applying
D. Analyzing
E. Evaluating
F. Creating



How do you think students answered?

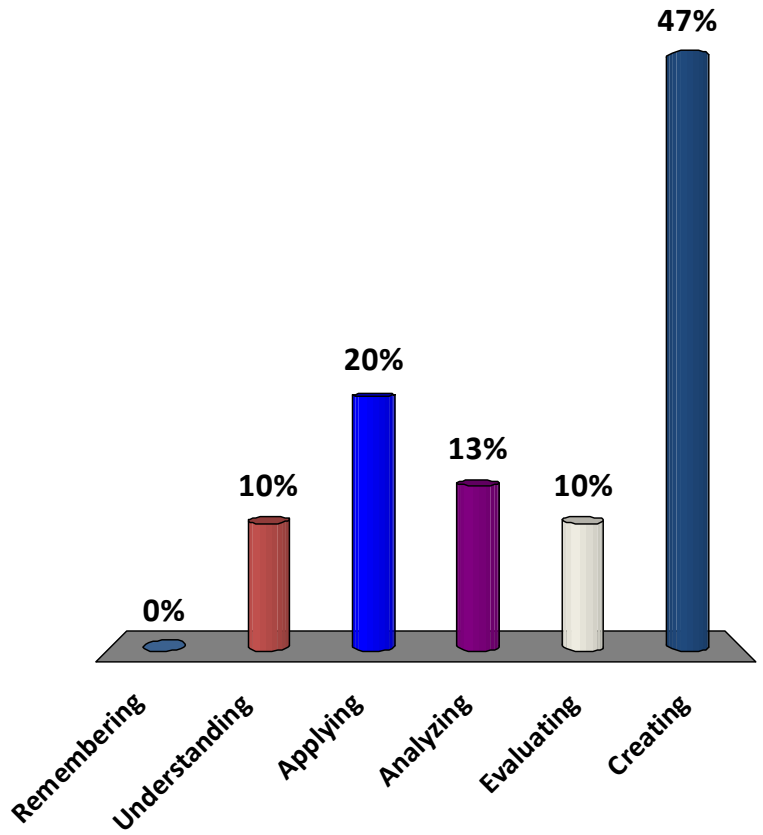
At what level of Bloom's do you think you'll need to operate to make A's in college courses?

1. Remembering
2. Understanding
3. Applying
4. Analyzing
5. Evaluating
6. Creating

How students answered (in 2015)

At what level of Bloom's do you think you'll need to operate to make A's in college?

1. Remembering
2. Understanding
3. Applying
4. Analyzing
5. Evaluating
6. Creating

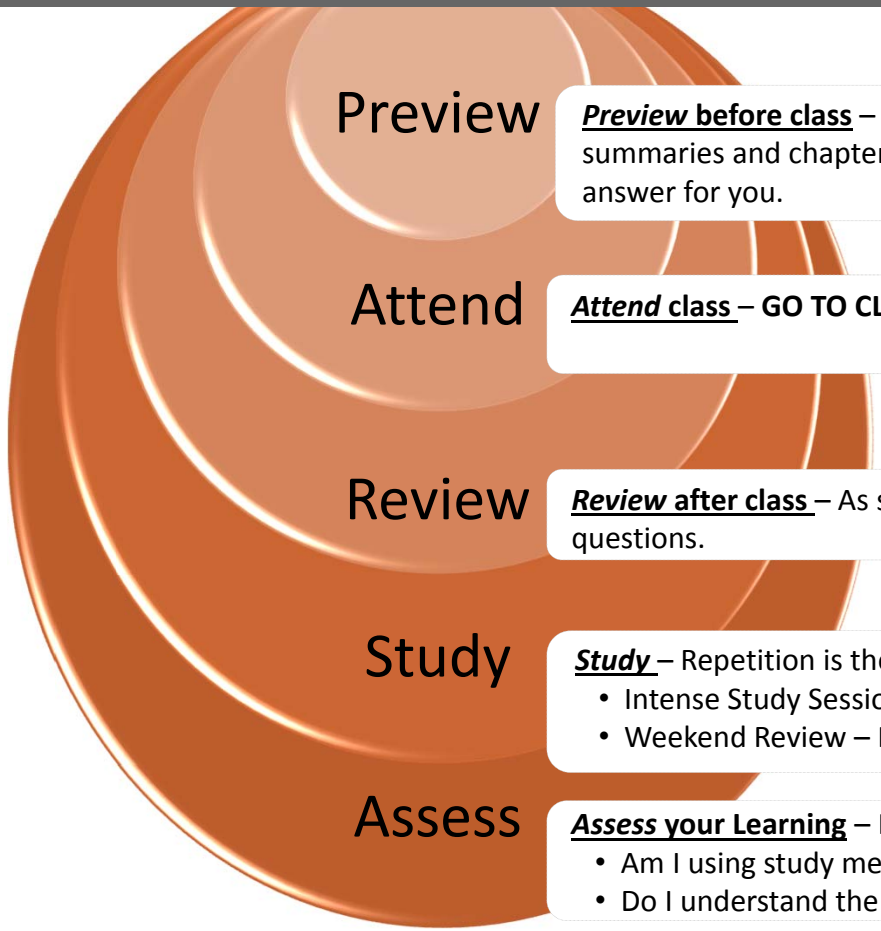


How do we teach students to move higher on Bloom's Taxonomy?

Teach them the Study Cycle*

**adapted from Frank Christ's PLRS system*

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?

Intense Study Sessions

1	**Set a Goal**	1-2 min	**Decide what you want to accomplish in your study session**
2	**Study with Focus**	30-50 min	**Interact with material**- organize, concept map, summarize, process, re-read, fill-in notes, reflect, etc.
3	**Reward Yourself**	10-15 min	**Take a break**– call a friend, play a short game, get a snack
4	**Review**	5 min	**Go over what you just studied**

LSU

Center for Academic Success

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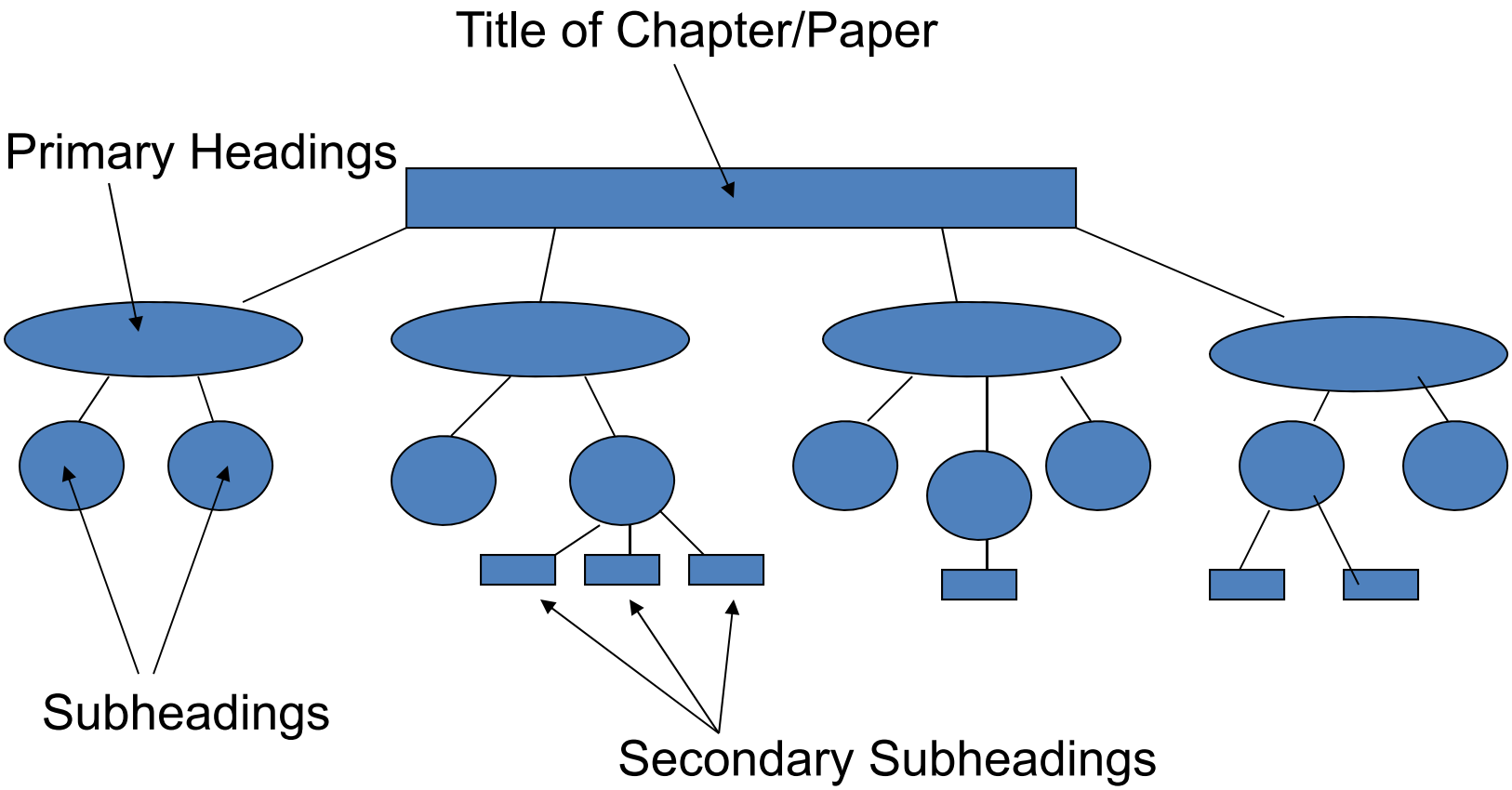
Concept maps can develop ability to think critically

And there are many different forms of concept maps

Chapter/Paper Map



Compare and Contrast

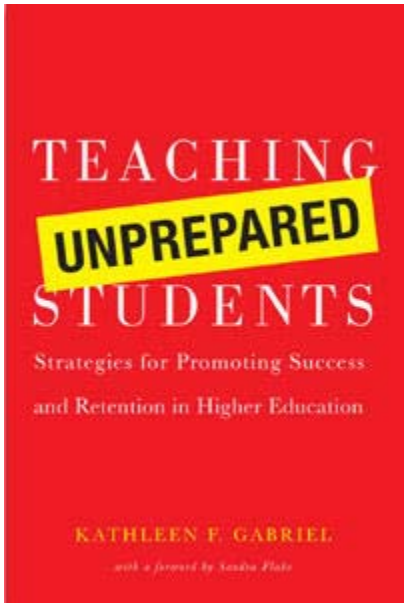
Thermodynamic Control

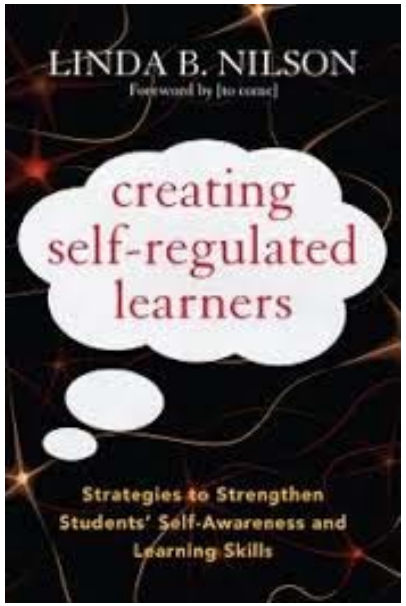
Kinetic Control

How are they similar?

How are they different?

Two Valuable References





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Teaching Unprepared Students.
Sterling, VA: Stylus Publishing

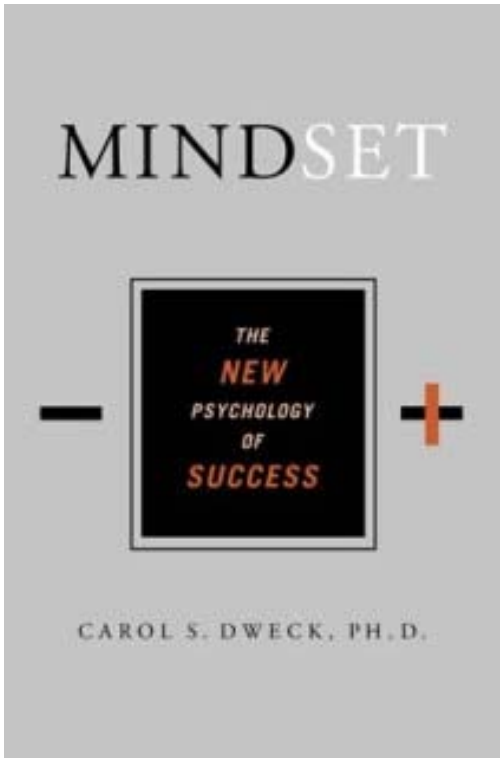
Nilson, Linda. (2013) *Creating Self-regulated Learners*
Sterling, VA: Stylus Publishing

Effective Strategies for Teaching Unprepared Students*

- Establish High Expectations
- Emphasize Consistent Contact
- Determine Students' Learning Styles
- Define Student Success
- Clarify Student Responsibility
- Establish a Learning Community of Scholars
- Meet Students Where They Are
- Interweave Assessment and Teaching

*Gabriel, Kathleen F. (2008) *Teaching Unprepared Students.* Sterling, VA: Stylus Publishing

Help Students Develop the Right Mindset



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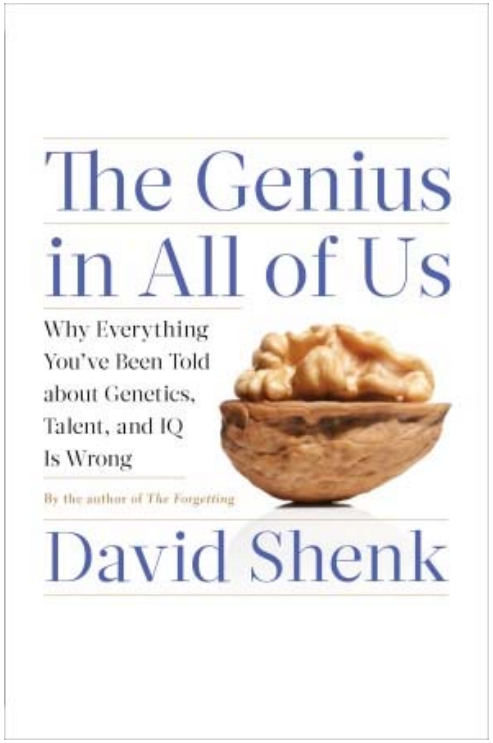
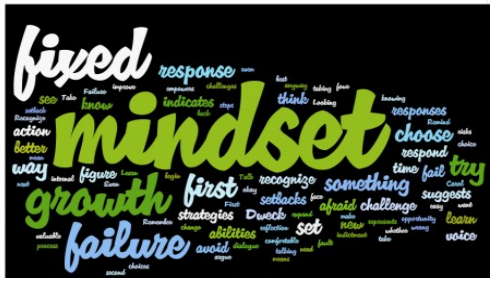


Shenk, David, 2010. *The Genius in All of Us: Why Everything You've Been Told About Genetics, Talent, and IQ Is Wrong. New York: Doubleday*

*Mindset** is Important!



- **Fixed Intelligence Mindset**

  Intelligence is static

  You have a certain amount of it

- **Growth Intelligence Mindset**

  Intelligence can be developed

  You can grow it with actions

Dweck, Carol (2006) *Mindset: The New Psychology of Success.* New York: Random House Publishing

Responses to *Many* Situations are Based on Mindset

	Fixed Intelligence Mindset Response	Growth Intelligence Mindset Response
Challenges	*Avoid*	*Embrace*
Obstacles	*Give up easily*	*Persist*
Tasks requiring effort	*Fruitless to Try*	*Path to mastery*
Criticism	*Ignore it*	*Learn from it*
Success of Others	*Threatening*	*Inspirational*

Email from a Spring 2011 General Chemistry Student

"…Personally, I am not so good at chemistry and unfortunately, at this point my grade for that class is reflecting exactly that. I am emailing you inquiring about a possibility of you tutoring me."

April 6, 2011

"I made a 68, 50, (50), 87, 87, and a 97 on my final. I **ended up earning a 90 (A) in the course**, **but I started with a 60 (D)**. I think what I did different was make sidenotes in each chapter and as I progressed onto the next chapter I was able to refer to these notes. ***I would say that in chemistry everything builds from the previous topic.***

May 13, 2011

Semester GPA: 3.8

What happens when we **teach metacognitive learning strategies**, Bloom's Taxonomy, and the Study Cycle **to an entire class**, not just individuals?

Performance in Gen Chem I in 2011 Based on One Learning Strategies Session

	Attended	Absent
Exam 1 Avg.:	71.65%	70.45%
Exam 2 Avg.:	77.18%	68.90%
Final course Avg*.:	81.60%	70.43%
Final Course Grade:	**B**	**C**

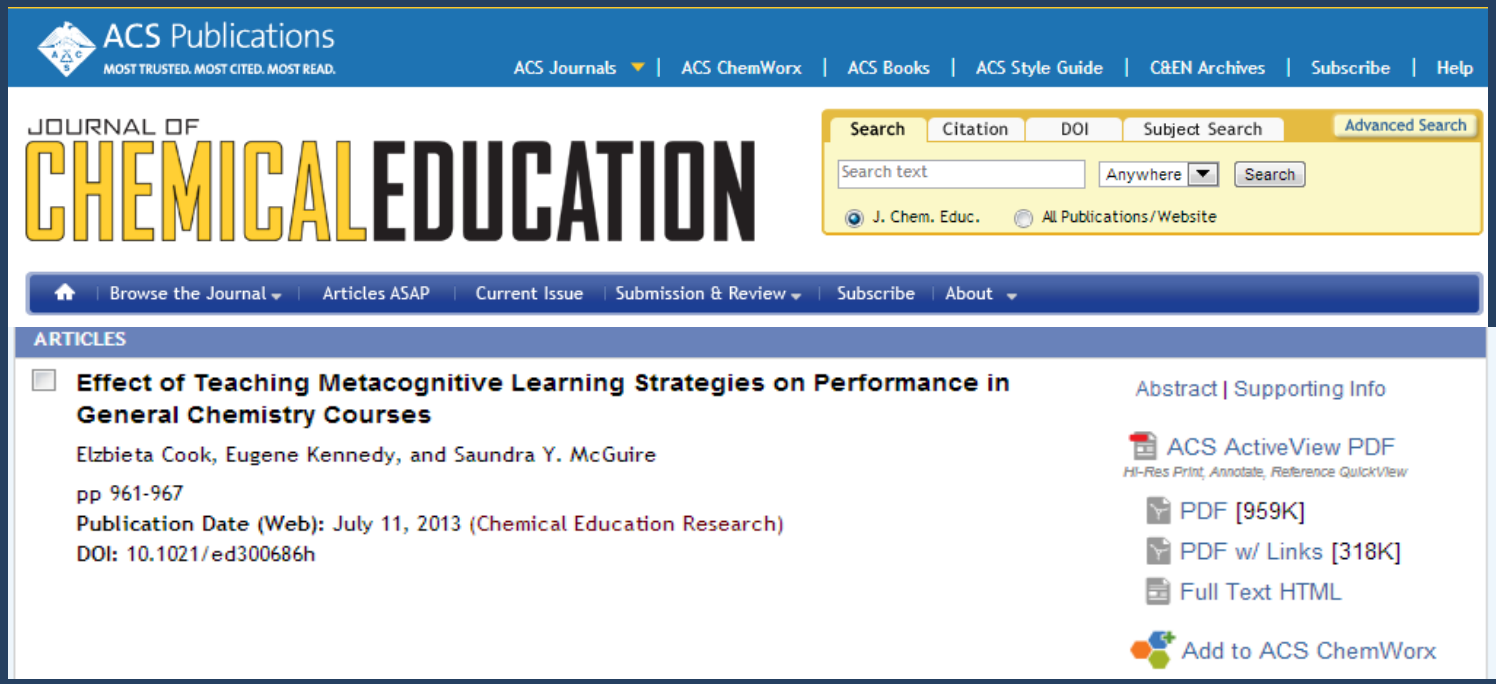
The one 50-min presentation on study and learning strategies resulted in an improvement of one full letter grade!

***Cook, E.; Kennedy, E.; McGuire, S. Y. *J. Chem. Educ*., 2013, 90 (8), 961–967**

Performance in Gen Chem 1202 Sp 2013 Based on One Learning Strategies Session

	Attended	Absent
Exam 1 Avg.:	71.33%	69.27%
Homework Total	169.8	119.1
Final course Avg*.:	82.36%	67.71%
Final Course Grade:	**B**	**D**

The 50-min presentation on study and learning strategies resulted in an improvement of *two* letter grades!



Journal of College Science Teaching

Metacognition: An Effective Tool to Promote Success in College Science Learning*

Ningfeng Zhao[1], Jeffrey Wardeska[1], Saundra McGuire[2], Elzbieta Cook[2]

[1]Department of Chemistry, East Tennessee State University

[2]Department of Chemistry, Louisiana State University

*March/April 2014 issue of JCST, Vol. 43, No. 4, pages 48-54

Sharing Strategies that Have Worked for Others Can Be Very Motivational

Top 5 Reasons Students Did Not Do Well on Test 1 in General Chemistry

1. Didn't spend enough time on the material
2. Started the homework too late
3. Didn't memorize the information I needed to memorize
4. Did not use the book
5. Assumed I understood information that I had read and re-read, but had not applied

Top 5 Reasons Students Made an A on Test 1:

1. Did preview-review for every class
2. Did a little of the homework at a time
3. Used the book and did the suggested problems
4. Made flashcards of the information to be memorized
5. Practiced explaining the information to others

Email from ENG Professor at New Mexico State Univ. Received on 10/22/2013

At the end of a 60 minute learning strategies presentation by the professor, students were given a survey to determine their self-assessment of whether they were using or not using the strategies. The average scores of the different groups on the first two exams are shown below.

Self-Reported Use of Strategies	Exam 1	Exam 2
Did not use the strategies	58	54
Used metacognitive strategies	95	80

Comments from Engineering Students about what they changed for Test 3*

- I changed my study habits by **doing the homework early**. I also **started reading some of the material before going to the class.** The most effective was **spending more time** on the material.
- I **started studying for the exam sooner**. I also took more time to do the homework. I **reviewed/rewrote my notes from class**.
- **I studied for the class as close to everyday** as possible
- **I got together with other classmates** and helped them with their weakness and of course they helped me with mine as well.

class average increased from 61% to 77%!

Mr. Lorenzo Foster's Physics I AP Class Test Scores

Strategies, Dedication and Hard Work PAID OFF!

Exam 1	Exam 2	Exam 3
73	95	100
90	86	100
50	90	67
83	100	100
57	98	93
80	85	100
50	95	100
37	89	100
89	100	100
47	79	100
95	98	100
67	74	78
39	87	84
43	64	95
40	90	100
85	100	100
90	75	100
84	94	100
67	94	93
90	97	93.5
100	85	88
42	100	100
22	86	98
99	100	100
53	69	100
66.88	**86.786**	**95.58**

Physics I AP Students
After Learning Their Test 2 Scores

Physics I AP Students
After Learning Their Test 3 Scores

LSU Analytical Chemistry Graduate Student's Cumulative Exam Record

2004 – 2005	
9/04	Failed
10/04	Failed
11/04	Failed
12/04	Failed
1/05	Passed
2/05	Failed
3/05	Failed
4/05	Failed

Began work with CAS and the Writing Center in October 2005

2005 – 2006	
10/05	Passed
11/05	Failed
12/05	Passed best in group
1/06	Passed
2/06	Passed
3/06	Failed
4/06	Passed last one!
5/06	N/A

Dr. Algernon Kelley, December 2009

From a Xavier University student to Dr. Kelley in Fall 2011

Oct. 17, 2011

Hello Dr. Kelley. **… I am struggling at Xavier and I REALLY want to succeed, but everything I've tried seems to end with a "decent" grade. I'm not the type of person that settles for decent. What you preached during the time you were in Dr. Privett's class last week is still ringing in my head. I really want to know how you were able to do really well even despite your circumstances growing up. I was hoping you could mentor me and guide me down the path that will help me realize my true potential while here at Xavier. Honestly I want to do what you did, but I seriously can't find a way how to. Can I please set up a meeting with you as soon as you're available so I can learn how to get a handle grades and classes?**

Oct. 24, 2011

Hey Dr. Kelley, **I made an 84 on my chemistry exam (compared to the 56 on my first one) using your method for 2 days (without prior intense studying). Thanks for pointing me in the right direction. I'll come by your office Friday and talk to you about the test.**

Nov 3, 2011

Hey Dr. Kelley! **I have increased my Bio exam grade from a 76% to a 91.5% using your system. Ever since I started your study cycle program, my grades have significantly improved. I have honestly gained a sense of hope and confidence here at Xavier. My family and I are really grateful that you have taken time to get me back on track.**

From a SUNY/Brockport Student to Dr. Kelley in Spring 2015

When you came to our biochem class to talk about improving study habits…I was very worried about my present ineffective study strategies for physics. I also was hoping to improve my biochem 2 grade… You gave me some of the best advice I have received in my three years of undergrad. **You told me to start 1) working out homework problems without the internet on paper, 2) going to every class, 3) reviewing what would be taught in class 4) getting help from the professor as a last resort when I couldn't figure out a problem** rather than turning to the internet, and finally **5) keeping my phone off as much as possible and not listening to music as I work**. After hearing all this… I really didn't think it would work for me…However, after talking to you, I decided to try some of the strategies. **I started working out 1-3 homework problems before class in a quiet room during my 1 hour break between classes. I also reviewed the chapter before going to class. I started keeping my phone off except for certain times like lunch or when I had to meet up with someone. The results were surprisingly drastic [*sic*].** The **next exam after talking to you I got over 20 points higher than the class average**... I was so excited and couldn't wait to tell you…I decided to also try to do as many odd-numbered end of chapter problems as possible to help prepare me for the next test… Again, I improved from the last test…

We *can* significantly increase learning by…

- teaching students *how* to learn
- making learning *visible*
- making the implicit *explicit*
- *not judging* student potential on initial performance
- Implementing *small interventions* to address psychological factors
- encouraging the use of *metacognitive tools*
- supporting the *campus learning center!*

Final Reflection Questions

Who is ***primarily*** responsible for student learning?

a) the student
b) the instructor
c) the institution

Who do you think *students* say is ***primarily*** responsible for student learning?

a) the student
b) the instructor
c) the institution

The reality is that…

when ***all three*** of these entities take ***full responsibility*** for student learning,

we will experience a **significant increase** in student learning, grades, retention, and graduation rates!

Special Note

Please visit the CAS website at www.cas.lsu.edu.

We have on-line workshops that will introduce you and your students to effective metacognitive strategies. Please feel free to contact me at smcgui1@lsu.edu.

Have fun teaching your students powerful metacognitive strategies!

Saundra McGuire

Useful Websites

- www.stemfye.org
- www.cas.lsu.edu
- www.howtostudy.org
- www.vark-learn.com
- www.drearlbloch.com

Additional References

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*Excellent student reference