Teach Students HOW to Learn: Metacognition is the Key!

Saundra Yancy McGuire, Ph.D.
Retired Asst. Vice Chancellor & Professor of Chemistry
Director Emerita, Center for Academic Success
Louisiana State University
Desired outcomes

- We will understand why many students are not taking responsibility for their learning
- We will have concrete learning strategies that faculty can teach students to increase critical thinking
- We will view our students differently
- We will see positive changes in our students’ performance and self-perception
- We will understand how mindset impacts success
- We will understand how metacognition and mindset work together to help students take personal responsibility and excel
Metacognition

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

Why haven’t most students developed these skills?

It wasn’t necessary in high school
## Data from UCLA Higher Education Research Institute (HERI)
First Year Student Survey - 2010 - 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>% who spent &lt; 6 hours/wk on homework</th>
<th>% who graduated from HS with an A average</th>
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</thead>
<tbody>
<tr>
<td>2010</td>
<td>62.7</td>
<td>48.4</td>
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<tr>
<td>2011</td>
<td>60.5</td>
<td>49.7</td>
</tr>
<tr>
<td>2012</td>
<td>61.6</td>
<td>49.5</td>
</tr>
<tr>
<td>2013</td>
<td>58.6</td>
<td>52.8</td>
</tr>
</tbody>
</table>

![Graph showing the percentage of students who spent less than 6 hours per week on homework and the percentage who graduated with an A average from 2010 to 2013.](http://www.heri.ucla.edu/)
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...
Faculty Must Help Students Make the Transition to College

Help students identify and close “the gap”

current behavior → current grades

MIND THE GAP

productive behavior → desired grades
Turn Students into Expert Learners:

Teach Them Metacognitive Learning Strategies!
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
Problem: Reading Comprehension

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

*Develop anticipatory set
WITH HOCKED GEMS FINANCING HIM/ OUR HERO BRAVELY DEFINED 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

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 www.cramster.com

Solution: Solve problems with no external aids and test mastery of concepts
Why the Fast and Dramatic Increase?

It’s all about the *strategies*, and getting *them* to *engage their brains*!
Counting Vowels in 45 seconds

A E I O U

How accurate are you?

Count all 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* do you remember?
Let’s look at the words again...

What are they arranged according to?
NOW, how many words or phrases do you remember?
What were two major differences between the two attempts?

1. We knew what the task was
2. We knew how the information was organized
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***


Bloom’s Taxonomy

Anderson & Krathwohl, 2001

Bloom’s Taxonomy

- **Remembering**: Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
- **Understanding**: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
- **Applying**: Carrying out or using a procedure through executing, or implementing.
- **Analyzing**: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure.
- **Evaluating**: Making judgments based on criteria and standards through checking and critiquing.
- **Creating**: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

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.

For more information, visit:
[http://www.odu.edu/educ/llschult/blooms_taxonomy.htm](http://www.odu.edu/educ/llschult/blooms_taxonomy.htm)
When we teach students about Bloom’s Taxonomy...

They GET it!
How students answered (2008)

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

1. Remembering
2. Understanding
3. Applying
4. Analyzing
5. Evaluating
6. Creating
At what level of Bloom’s do you think you’ll need to operate to make an A’s in college?

1. Remembering
2. Understanding
3. Applying
4. Analyzing
5. Evaluating
6. Creating
How students answered (in 2013)

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

![Bar Chart]

- Remembering: 6%
- Understanding: 9%
- Applying: 23%
- Analyzing: 40%
- Evaluating: 11%
- Creating: 11%
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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set a Goal</td>
<td>1-2 min</td>
</tr>
<tr>
<td>2</td>
<td>Study with Focus</td>
<td>30-50 min</td>
</tr>
<tr>
<td>3</td>
<td>Reward Yourself</td>
<td>10-15 min</td>
</tr>
<tr>
<td>4</td>
<td>Review</td>
<td>5 min</td>
</tr>
</tbody>
</table>

- Decide what you want to accomplish in your study session
- **Interact with material**– organize, concept map, summarize, process, re-read, fill-in notes, reflect, etc.
- **Take a break**– call a friend, play a short game, get a snack
- **Go over what you just studied**
Metacognitive Get Acquainted Activity*

• What do you believe is important to understand and learn in ______________________?

• What do you believe to be critical characteristics of successful students in __________?

• How will you study and prepare for exams in _________________________________?

Two Valuable References


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*

<table>
<thead>
<tr>
<th></th>
<th>Attended</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1 Avg.:</td>
<td>71.65%</td>
<td>70.45%</td>
</tr>
<tr>
<td>Exam 2 Avg.:</td>
<td>77.18%</td>
<td>68.90%</td>
</tr>
<tr>
<td>Final course Avg.:</td>
<td>81.60%</td>
<td>70.43%</td>
</tr>
</tbody>
</table>

**Final Course Grade:**

- **B** for Attended
- **C** for Absent

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

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

<table>
<thead>
<tr>
<th></th>
<th>Attended</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1 Avg.:</td>
<td>71.33%</td>
<td>69.27%</td>
</tr>
<tr>
<td>Homework Total:</td>
<td>169.8</td>
<td>119.1</td>
</tr>
<tr>
<td>Final course Avg.:</td>
<td>82.36%</td>
<td>67.71%</td>
</tr>
</tbody>
</table>

**Final Course Grade:** B D

The 50-min presentation on study and learning strategies resulted in an improvement of two letter grades!
Metacognition: An Effective Tool to Promote Success in College Science Learning

2014, Vol. 43, No. 4 pp. 48-53

Ninfeng Zhao¹, Jeffrey Wardeska¹, Saundra McGuire², Elzbieta Cook²

¹Department of Chemistry, East Tennessee State University
²Department of Chemistry, Louisiana State University
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
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.

<table>
<thead>
<tr>
<th>Self-Reported Use of Strategies</th>
<th>Exam 1</th>
<th>Exam 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not use the strategies</td>
<td>58</td>
<td>54</td>
</tr>
<tr>
<td>Used metacognitive strategies</td>
<td>95</td>
<td>80</td>
</tr>
</tbody>
</table>
Help Students Develop the Right Mindset


Think/Pair/Share

• Think of a subject/task/activity at which you think you are inherently unskilled. What evidence do you have that you are bad at this? How do you feel when someone asks you to perform this task?

• Think of a subject/task/activity at which you think you are inherently very good. What evidence do you have that you are good at this? How do you feel when someone asks you to perform this task?
**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

Responses to *Many* Situations are Based on Mindset

<table>
<thead>
<tr>
<th></th>
<th>Fixed Intelligence Mindset Response</th>
<th>Growth Intelligence Mindset Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges</td>
<td>Avoid</td>
<td>Embrace</td>
</tr>
<tr>
<td>Obstacles</td>
<td>Give up easily</td>
<td>Persist</td>
</tr>
<tr>
<td>Tasks requiring effort</td>
<td>Fruitless to Try</td>
<td>Path to mastery</td>
</tr>
<tr>
<td>Criticism</td>
<td>Ignore it</td>
<td>Learn from it</td>
</tr>
<tr>
<td>Success of Others</td>
<td>Threatening</td>
<td>Inspirational</td>
</tr>
</tbody>
</table>
Innovative Educators Webinar

October 20, 2010

Fixed Mind-set
Intelligence is static

Growth Mind-set
Intelligence can be developed

Leads to a desire to look smart and therefore a tendency to...

Leads to a desire to learn and therefore a tendency to...

CHALLENGES
...avoid challenges

...embrace challenges

OBSTACLES
...give up easily

...persist in the face of setbacks

EFFORT
...see effort as fruitless or worse

...see effort as the path to mastery

CRITICISM
...ignore useful negative feedback

...learn from criticism

SUCCESS OF OTHERS
...feel threatened by the success of others

...find lessons and inspiration in the success of others

As a result, they may plateau early and achieve less than their full potential.

All this confirms a deterministic view of the world.

As a result, they reach ever-higher levels of achievement.

All this gives them a greater sense of free will.

GRAPHIC BY NIGEL HOLMES
Neuroplasticity*

- The brain can reorganize itself, growing new neural pathways

- Individuals can raise their IQ, improve their memory, and sharpen intelligence

- New brain cells are generated by the process of neurogenesis

*term coined by Polish Neuroscientist Jerzy Konorski in 1948
"I was wrong...you can teach an old dog new tricks."
Which mindset about intelligence do you think *most students* have?

**Fixed**

**Growth**
Which mindset about student intelligence do you think *most faculty* have?

- Fixed
- Growth
Which mindset about student intelligence do you think *most STEM faculty* have?

- Fixed
- Growth
Three illustrations of the *power* of mindset

- Attitude of Asian and American mothers and children about math ability*
- How students respond to criticism**
- Response of gifted middle school math students to challenging problems: idk***

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*** L. Java, personal communication, July 9, 2014
Two examples of the *power* of a growth mindset

- Adam, senior analytical chemistry student
  66, 61, 61,
  107 on final exam    B in course

- Sydnie, first year honors chemistry student
  65,
  95, 90, 70, 96    A in course
“…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
## LSU Analytical Chemistry Graduate Student’s Cumulative Exam Record

<table>
<thead>
<tr>
<th>Date</th>
<th>Result</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/04</td>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>10/04</td>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>11/04</td>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>12/04</td>
<td>Failed</td>
<td>Began work with CAS and the Writing Center in October 2005</td>
</tr>
<tr>
<td>1/05</td>
<td>Passed</td>
<td></td>
</tr>
<tr>
<td>2/05</td>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>3/05</td>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>4/05</td>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>10/05</td>
<td>Passed</td>
<td></td>
</tr>
<tr>
<td>11/05</td>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>12/05</td>
<td>Passed best in group</td>
<td></td>
</tr>
<tr>
<td>1/06</td>
<td>Passed</td>
<td></td>
</tr>
<tr>
<td>2/06</td>
<td>Passed</td>
<td></td>
</tr>
<tr>
<td>3/06</td>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>4/06</td>
<td>Passed last one!</td>
<td></td>
</tr>
<tr>
<td>5/06</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
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.
Changes Faculty Have Made that *Improved* Learning and Performance

- Provide learning strategies information to students after Test 1, and tell them about mindset *(Psychology Professor at Southern Crescent Technical College, 2013)*
- Increase the frequency of tests from three per semester to biweekly *(Mathematics Professor at Miles College, 2013)*
- Have students determine their learning style and write reflection on how they will use the information *(Entomology Professor at LSU, 2009)*
- Present one 50 minute session on metacognition, Bloom’s Taxonomy, and the Study Cycle *(Chemistry Professor at Middle Tennessee State University, 2012)*
- Partner with the learning center to teach metacognitive strategies *(Faculty at many institutions)*
Academic Services and Learning Resources

Welcome to Academic Services & Learning Resources!

Established in 1997, Academic Services helps Holy Cross students make the most of the academic opportunities at the College, within the Higher Education Consortium of Central Massachusetts (HECCMA) and beyond. Whether you are a first-year student or a senior preparing for graduation, this office should have something to offer you!

The office is located in Dinand Library 204 and is open Monday to Friday, 8:30 a.m. to 12:00 noon and 1:00 p.m. to 4:30 p.m. Any student who wishes to make an individual appointment is welcome to call 508-793-2713 and speak with Ms. Stephanie Outerson. Sorry, we do not make appointments by e-mail.

Please stop by to meet us!
Conclusion

We *can* significantly increase learning by...

- teaching students *how* to learn
- helping students develop the right mindset
- making the implicit *explicit*
- *not judging* student potential on initial performance
- encouraging students to *persist in the face of initial failure*
- *motivating students to use* metacognitive learning strategies
Final Reflection Question

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, 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.

Have fun teaching your students powerful metacognitive strategies that will lead to increased academic success!

Saundra McGuire
Acknowledgments

• Sarah Baird, Learning Strategist
• LSU Center for Academic Success
• Dr. Elzbieta Cook, LSU General Chem Instructor
• National College Learning Center Association
• All of the faculty who implemented these strategies and provided feedback
• All of the students who changed their attitudes and behaviors and showed me what was possible!
Useful Websites

- [www.cas.lsu.edu](http://www.cas.lsu.edu)
- [www.howtostudy.org](http://www.howtostudy.org)
- [www.vark-learn.com](http://www.vark-learn.com)
- [www.drearlbloch.com](http://www.drearlbloch.com)
- Searches on [www.google.com](http://www.google.com)
Additional References


*Excellent student reference*
Reflection Activity

- Pick an activity or strategy that we have talked about today that you would like to implement.

- Share with the group this afternoon how you plan to implement this.