Metacognitive Strategies: Do They Improve Student Learning?
(Spoiler: Sometimes!)

Metacognition FIG Group:
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How did this Metacognition thing begin?

> Science involvement in Southeast Regional PULSE (Partnership for Undergraduate Life Sciences Education)

> Developed a project to integrate metacognitive strategies into science courses

> Dove-tailed well with FIG to show institutional support and keep us accountable beyond the PULSE meeting
**Project Abstract and Description**

Students often report the grade they earned on an exam does not reflect the time and effort they spent studying for it. In an attempt to improve student performance, and link student preparation more closely with performance outcomes, we are undertaking a metacognitive course strategy as follows:

- After the first exam, metacognitive strategies were presented to the students.
- Grades from the first exam were compared to those from the second exam to see if there was any improvement.
- Metacognitive strategies will continue to be emphasized throughout the semester.
- Final grade distributions from courses receiving metacognitive strategy support will be compared with distributions from classes lacking this focus to determine if the strategies improved overall student performance.
- At the end of the semester, students in courses actively employing metacognitive strategies will be asked to reflect on their perceptions of their learning.
- Student perception, correlated with actual grade improvement, will guide future implementation of metacognitive strategies.

**Process and Procedure**

- Interested instructors within the Science Discipline agreed to add a lecture and/or activities on metacognition to their courses.
- Students were presented with various metacognitive-related handouts at the beginning of the semester, but not much time was given to talking about metacognitive strategies.
- Courses progressed as normal to Exam 1.
- After Exam 1 grades were posted, each participating instructor delivered a self-prepared presentation on metacognitive strategies, showing how they can help students succeed, based on information gathered from Saundra Yancey McGuire’s presentations and materials.
- Students were explicitly encouraged to use metacognitive strategies to prepare for Exam 2.
- Grades from Exam 1 were compared to grades from Exam 2, and students who improved their grades significantly were asked to describe what, if any, metacognitive strategies were used.

**Examples of Materials Presented**

- **What’s the difference between studying and learning??**
  - For which task would you study more?
  - Make an A on the test
  - Teach the material to the class

- **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 concepts, summarize, practice, re-read, list outcomes, reflect, etc.
  3. Reward Yourself (5-15 min) - Take a break, call a friend, play a short game, get a snack.
  4. Review (5 min) - Go over what you just studied.

- **Bloom’s Taxonomy**
  - Know
  - Remembering
  - Understanding
  - Applying
  - Analyzing
  - Evaluating
  - Creating

**Early Results and Testimonials – Was There Improvement?**

- **Microbiology Student**
  - First Exam: 82%
  - Second Exam: 98%
  - “Even though I studied hard for the first exam, I realized that it was not good enough. I asked myself the question: Am I reading just to get a good score or reading to understand and apply what I have learned in the future?”

- **General Biology Student**
  - First Exam: 62%
  - Second Exam: 87%
  - “I took [my teacher’s] advice and made concept cards after each lecture. I was able to review the cards and these told me what I didn’t know so I could review that [information] for the exam.”

**Difficulties Encountered and Future Directions**

- **Difficulties:**
  - Days missed due to inclement weather had an adverse impact on Exam 2 grades, making comparison problematic, if not impossible.
  - Material on Exam 2 in all courses studied was more difficult than material than Exam 1. A comparison of Exam 1 scores to the combined scores for all exams subsequent to the metacognitive strategy intervention may be more informative.

- **Next Steps and Future of the Project:**
  - Have students complete end of course questionnaire about study habits/metakognitive strategies they found most effective.
  - Tailor future classroom metacognition presentations to those strategies students found most effective.
  - Engage more instructors at Durham Tech in teaching metacognitive strategies through presentations in our Teaching and Learning Center.

**What is 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
- Accurately judge one’s level of learning

What does this mean for you?

> The best strategies! (by student report)
> Scott – Active Reading
> Lori – Summarizing/Paraphrasing
> Olga – Study Groups/Teaching Others
> Gretel – Self-Testing
> Dorothy – Bloom’s Taxonomy/Scaffolding
So, what IS 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

Courtesy of Dr. Saundra McGuire
Dr. McGuire’s Successes

- Robert, freshman chemistry student
  > 42, 100, 100, 100  A in course

- Michael, senior pre-med organic student
  > 30, 28, 80, 91  B in course

- Miriam, freshman calculus student
  37.5, 83, 93  B in course
First Strategy: Reading Comprehension – Anticipatory Sets!

Knowing what to read FOR affects your comprehension of the material greatly!

> **Preview** material before reading

> **Develop questions** you expect the passage to answer

> **Read one paragraph at a time** while stopping to paraphrase the information read
Spring 2015: Initial Strategies, Successes, and (mostly) Failures

Strategy:

> Give a 15-30 minute lecture on metacognitive strategies to classes AFTER the first exam

> Continue to encourage students to use metacognitive strategies while studying

> Compare scores on first exams to those on second exams and look for improvements
Spring 2015: Initial Strategies, Successes, and (mostly) Failures

Successes? Sadly, not so much…

> Despite positive feedback from students on meta strategies, none of the courses showed any noticeable improvement!

> Weather issues (nearly two weeks of courses missed between Exam 1 and Exam 2)

> In most courses, Exam 2 was more difficult than Exam 1

> Were we maybe not really targeting the strategy correctly?
Second Strategy: **Summarizing/Paraphrasing**

- Students with the most success reported telling another person about what they learned in class daily.
- Explain a concept out-loud or to another person (teaching someone else).
- Pair-share.
Fall 2015: Changing the Strategy

- Targeting struggling students (C or lower on the first (or second for HS Biology) exam);

- Send emails requesting a one-on-one meeting (some students responded);

- Made metacognition materials available (posted on Sakai and/or presented at the S. McGuire seminar at the TLC in October).

- Some students have shown improvement at the next exam.
Was Changing the Strategy Useful?

• **Some** students have shown improvement at the next exam.

**Strategy focus**

Many students who improved their performance

• studied with a classmate or joined a larger study group and/or

• spent more time solving practice problems.
Came for the learning strategies discussion (total): 9, improved: 3
Came for the metacognition seminar (total): 14, improved: 4
A Story of Two CHM130 Students (the last two from the previous graph)

<table>
<thead>
<tr>
<th></th>
<th>Exam 1</th>
<th>Exam 2</th>
<th>Exam 3</th>
<th>Exam 4</th>
<th>Class grade</th>
<th>What did they do differently after they failed Exam 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student F.</strong></td>
<td>56</td>
<td>91</td>
<td>87</td>
<td>88</td>
<td>B</td>
<td>“I used the technique we were taught in the seminar and I went to tutoring 1 to 2 days a week. I also studied 1 hour day no matter what. Me and a couple of students had a study group also. The technique: the one where you read the chapters and put it in your own words. And the other technique where you work out the problems and check it to make sure it is right.”</td>
</tr>
<tr>
<td><strong>Student R.</strong></td>
<td>46</td>
<td>62</td>
<td>66</td>
<td>88</td>
<td>C</td>
<td>“I joined a study group. We taught each other.”</td>
</tr>
</tbody>
</table>
A Metacognition talk was given to the whole class.

None came for tutoring and advice on learning strategies.
Metacognition materials were made available to the whole class, students were encouraged to use them. The instructor had a one-on-one conversation with students who got <60% on Exam 1.
Came for the discussion (total): 8, improved: 7
For Whom Did the New Strategy Work?

• **BIO 275**: almost everybody (7 out of 8).

• **BIO 111**: B and C students (they not only used the strategies, but also changed their “academic behavior”).

• **CHM 130**: about one-third of the students. The most drastic improvement for two D students (they came to the metacognition seminar and then used suggested techniques the most aggressively).

• **High School Honors Biology**: almost everybody (7 out of 8)
Third Strategy: Study Groups/Teaching Others

“Words of wisdom” from Chm130 students themselves

• “If you can meet with other classmates to compare notes. It helps with other ways to understand material”.

• “Network with classmates”.

• “Find a study partner” (more than one comment of this type).
Reflections on the FIG

> Positive feedback from students

> Plans to continue using meta strategies

> Despite setbacks, if we can help just one student, then it is worth it!

> Spreading the joy
Fourth Strategy: Self-Testing Strategies

How to self test using the instructor’s powerpoint slides:

<table>
<thead>
<tr>
<th>Inorganic</th>
<th>Organic</th>
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<tbody>
<tr>
<td>Usually with + &amp; - ions</td>
<td>Always contain carbon and hydrogen</td>
</tr>
<tr>
<td>Usually ionic bonding</td>
<td>Always covalent bonding</td>
</tr>
<tr>
<td>Always with few atoms</td>
<td>Often quite large, with many atoms</td>
</tr>
<tr>
<td>Often associated with nonliving matter</td>
<td>Usually associated living systems</td>
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</tbody>
</table>

**Carbon**
- Carbon has 4 valence electrons
- Needs 4 more electrons to fill the shell

**Diversity of Organic Molecules**
A. Hydrocarbons - Molecules muo mostly C’s and H’s.
- Can be linear or in rings
- Breaking these bonds produces a lot of energy.
- Hydrophobic
- Examples: gasoline and fat

Why rewrite this?
Why reorganize this? I’ll just look this over – I’m sure I’ll remember it!
Fourth Strategy: **Self-Testing Strategies**

Why rewrite this? Why reorganize this? I’ll just look this over – I’m sure I’ll remember it! **Wrong!**

Print out your slides as a “handout” with 4 or 6 slides on a page. Use this as your study tool!
Define inorganic
Define organic

<table>
<thead>
<tr>
<th>Inorganic</th>
<th>Organic</th>
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List 4 characteristics of inorganic molecules.
List 4 characteristics of organic molecules.
Give an example of a molecule that is organic and inorganic.

**Carbon**
- Carbon has 4 valence electrons
- Needs 4 more electrons to fill the shell

**Diversity of Organic Molecules**
A. Hydrocarbons - Molecules made mostly of C’s and H’s.
- Can be linear or in rings
- Breaking these bonds produces a lot of energy
- Hydrophobic
- Examples: gasoline and fat

Why is she talking about carbon?
What is a valence electron?

What is a hydrocarbon?
List 3 characteristics of hydrocarbons.
Give some examples of hydrocarbons.
Next – do some verbal rehearsal!

1) Ask yourself one of your questions while covering up the slide.
2) Got it right? Move on!
3) Got it wrong? Study, and try again until you speak the correct answer out loud.
4) Now you know what you know!
Applications to Other Classes

> Metacognition is not just for Science AT ALL!

> Meta strategies help overcome learned helplessness (“I’m just not good at __________!!”)

> Student is a thinking, problem-solving being…active, not passive!
Fourth Strategy: Bloom’s Taxonomy/Scaffolding

To counter learned helplessness, build student confidence gradually within the work week.
Exams and assignments assess critical thinking skills and understanding of higher-level concepts.

**Creating**
- Use information to create something new
  - Design, Build, Construct,
  - Plan, Produce, Devise, Invent

**Evaluating**
- Critically examine information & make judgments
  - Judge, Test, Critique,
  - Defend, Criticize

**Analyzing**
- Take info apart & explore relationships
  - Categorize, Examine,
  - Compare/Contrast, Organize

**Applying**
- Use information in a new (but similar) situation
  - Use, Diagram, Make a Chart, Draw, Apply, Solve, Calculate

**Understanding**
- Understanding & making sense out of information
  - Interpret, Summarize, Explain, Infer, Paraphrase, Discuss

**Remembering**
- Find or remember information
  - List, Find, Name, Identify, Locate,
  - Describe, Memorize, Define

Formative assessments; introduce vocabulary and basic concepts.

Post-class quizzes; assess understanding and begin application of knowledge.

Wrapping it Up

> It’s about students becoming ACTIVE learners

> Take a moment…is there anything that you think you could use in your classes?
Thank you!