Abstract
Metacognition is often used as a nebulous term referring to “thinking about thinking”, but this description obscures its function and utility in learning. Broadly, but more specifically, metacognition involves our knowledge and regulation of our thinking processes. While everyone is metacognitively active to one degree or another, we all have room to grow and benefit from improving our metacognitive skills. In particular, many students persist in predominantly using surface approaches to learning, such as rehearsal and memorization, but could benefit greatly from more elaborative and organizational approaches associated with deeper learning (e.g., transferable and lasting learning). This workshop focuses on understanding metacognition, modules instructors can use to engage students in their metacognitive development, and a tool for providing supportive feedback to students about their approaches to learning. Findings from our NSF-funded research inform this workshop.

Workshop Objectives
At the completion of this workshop, participants will be able to:

- define and describe key elements of metacognitive learning,
- articulate best practices for engaging students in their metacognitive development,
- adapt instructional materials for the participant’s own teaching context
- identify types of responses students may give to prompts eliciting self-examination of their approaches to learning
- formulate constructive and positive formative feedback to support student development as learners
- explain how seeing students develop as learners can make teaching more rewarding
**Prospective Schedule**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 am</td>
<td>Getting Situated</td>
</tr>
<tr>
<td>9:10 am</td>
<td>Defining Metacognition</td>
</tr>
<tr>
<td>9:35 am</td>
<td>Overview of NSF Project</td>
</tr>
<tr>
<td>9:45 am</td>
<td>Experiencing a Metacognition Training Module</td>
</tr>
<tr>
<td>10:15 am</td>
<td>BREAK</td>
</tr>
<tr>
<td>10:25 am</td>
<td>Practice Assessing Student Responses and Formulating Feedback</td>
</tr>
<tr>
<td>10:45 am</td>
<td>Discussing the Role of Context</td>
</tr>
<tr>
<td>10:55 am</td>
<td>Adapting a Metacognitive Training Activity for Your Context</td>
</tr>
<tr>
<td>11:25 am</td>
<td>Sharing Drafts of Adapted Activities</td>
</tr>
<tr>
<td>11:40 am</td>
<td>Discussing Student Metacognitive Development and Rewarding Teaching</td>
</tr>
<tr>
<td>11:55 am</td>
<td>Closing</td>
</tr>
</tbody>
</table>

**Opening Questions**

*Where do you have conversations with students about what learning is or how they approach learning?*

*What is your most rewarding teaching experience in regard to student learning?*

*What is your most frustrating teaching experience in regard to student learning?*
The Metacognition Model

Metacognition involves the cyclical interaction of knowledge and regulation of our thinking processes. Knowledge of cognition is comprised of knowing about *persons, tasks, and strategies*. Regulation of cognition is putting our knowledge into action through *planning, monitoring, controlling, and evaluating* activities. Brief descriptions of each sub-component follow.

**Knowledge of Persons**
Knowing about how people process information in general and how you process information in particular. For example, knowing that recall is more effective than rereading and your preference for visual representations.

**Knowledge of Tasks**
Knowing the cognitive demands of different cognitive tasks. For example, knowing that a particular math homework problem set requires less focus and time than writing a draft of a critical analysis.

**Knowledge of Strategies**
Knowing various ways of thinking about or engaging with different tasks. For example, deepening learning by making up applications for particular math concepts or creating a diagram to organize thoughts for a paper.

**Planning**
Taking stock of a cognitive task, to set goals and select initial strategies in balance with knowing how you process information. For example, choosing to do recall and review before each homework session.

**Monitoring**
Keeping track of progress on a task while doing the task. For example, tracking the number of problems completed or words written or noticing your level of mental effort.

**Controlling**
Taking action in response to monitoring assessments. For example, in response struggling to make progress on a problem, choosing to stop and explain your reasoning thus far to a friend.

**Evaluating**
Assessing how a cognitive task went after completing the task, building your cognitive knowledge. For example, noticing that you are more confident and doing better on quizzes since engaging in regular recall and review practice.
The Intervention Modules

Each metacognitive instruction module is made up of a short pre-class video (~10 minutes) with 1/2 questions, a 5-10 minute in-class activity, and a post-class assignment that may take up to about 30 minutes. The modules provide 1) explicit instruction on metacognition and how it applies to authentic learning situations, situated within STEM; 2) opportunities for students to build accurate self-awareness and practice metacognitive skills; and 3) meaningful feedback on their practice. While formative feedback is a key component of the modules and metacognitive development, the assessment of activities check only for completion of the activities. The value is in engaging students in these activities and supporting their growth. While these modules were designed for use within existing courses, they can be adapted to other contexts. Recognizing the demands on instructors and required courses, our goals were to make the modules accessible, easy to use, and take limited class time.

Module 1: What is metacognition and why should I care? (Overview)
Introduce students to the metacognition framework and argues for importance of metacognitive knowledge and regulation

Module 2: Knowing about Thinking (Knowledge of Cognition)
Focus on metacognitive knowledge of self, tasks and strategies

Module 3: Reflecting on Our Thinking (Evaluation)
Introduce students to the idea of assessing a learning experience to determine what worked and what did not

Module 4: Planning for Our Thinking (Planning)
Introduces students to the idea of focusing on tasks that are part of big project and part of important goals rather than tasks that are distractions

Module 5: Optimizing Our Thinking (Monitoring & Control)
Introduces students to monitoring and controlling their learning during a learning experience, operationalized through Kolb’s experiential learning cycle.

Module 6: Thinking Back and Thinking Ahead (Summary & Extension)
Serves as a summary that asks students to reflect on topics from the prior weeks and think about how they can apply what they have learned going forward
Knowing About Thinking (Metacognitive Knowledge)

Pre-class Video & Questions:

1. Do you identify with any of the elements in Joe or Sue's stories in the video? If so, which elements did you identify with and why? If not, how would you characterize yourself as a student?

2. Recall your primary learning strategy, which you were asked about on the last metacognition assignment. (If you didn't do it, state your primary learning strategy for problem solving classes like [particular course] here.) Using the framework of the learning strategy categories from the video: rehearsal, elaboration, and organization, evaluate how well your primary learning strategy helps you engage with course material. Summarize your thoughts here.
In-class Activity: Remind students of course homework format and its purpose, students reflect on use of example problems in their studying and how they can more actively engage with course material (individually), and a few students share responses with the class. Adaptable to different courses/contexts with other types of homework, labs, projects, etc. (~10 minutes)

The format is designed to teach a way of thinking AND more deeply engage you with using a concept to solve problems.

- Known, Find, Given Data & Schematic, Analysis, Comments
- State principle, such as, COM, COLM, …
- State assumptions

Biggest Potential Benefit of Using Example Problems to Study:

Biggest Potential Pitfall of Using Example Problems to Study:

“If people knew how hard I worked to get my mastery, it wouldn’t seem so wonderful at all.”
- Michelangelo

Ways to Actively Engaging with Example/Practice problems (Elaboration / Organization):
Post-class Assignment: Learning Strategies from the GAMES© Survey, Marilla D. Svinicki.

For each category, how often do you do the following when you study? (1-Never, 3-Sometimes, 5-Always)

Total the numerical values of your responses in the question above, and record the percentage of the total possible. Are there study behaviors, not listed here, that you engage in. If so, specify them here too

Goal-oriented Study
☐ Analyze what I have to do before beginning to study.
☐ Set a specific content learning goal before beginning to study.
☐ Set a specific work effort (time amount) before beginning to study.
☐ Figure out why I am learning the material I'm about to study.
☐ Be sure to understand what is expected of me in terms of learning assignments.

Active Study
☐ Make notes in the margins of the text when I read.
☐ Ask myself questions before, during, and after studying.
☐ Pause periodically to summarize or paraphrase what I've just studied.
☐ Create outlines, concept maps, or organizational charts of how the ideas fit together.
☐ Look for connections between what I'm studying right now and what I've studied in the past or heard in class.
☐ Write down questions I want to ask the instructor.
☐ Reorganize and fill in the notes I took in class.
☐ Work through any problems that are illustrated in the text or in my class notes.
☐ Create vocabulary lists with definitions and my own examples.
☐ Take breaks periodically to keep from getting too tired.

Meaningful & Memorable
☐ Make up my own examples for concepts I am learning.
☐ Put things in my own words.
☐ Make vivid images of concepts and relationships among them.
☐ Make connections between what I am studying and past classes or units.
☐ Be sure I understand any example the instructor gave me.
☐ Create concept maps and diagrams that show relationships among concepts.
☐ Ask the instructor for more concrete examples and picture them in my mind.
☐ Look for practical applications and real life settings for the things I'm learning.

Explain to Understand
☐ After studying, meet with a partner to trade questions and explanations.
☐ Write out my own descriptions of the main concepts.
☐ Discuss the course content with anyone willing to listen.
☐ Answer questions in class.
☐ Make a class presentation.
☐ Help another student who is behind in progress.

Self-monitor
☐ Make sure I can answer my own questions during studying.
☐ Work with another student to quiz each other on main ideas.
☐ Keep track of things I don't understand and note when they finally become clear and what made that happen.
☐ Have a range of strategies for learning so that if one isn't working I can try another.
☐ Remain aware of mood and energy levels during study and respond appropriately if either gets problematic.

In what area did you score the highest? In what area did you score the lowest? Consistently low ratings in a particular area may indicate an area you could work on to help you become a more efficient and effective learner. Pick an area in which you want to improve by the end of [particular course]. State why you picked that area and brainstorm three strategies you could and are likely to implement to improve in this area. What are you going to do tomorrow (or the next time you study [particular course]) to start doing this?
## A Metacognitive Indicator Rubric – Examples of Metacognitive Evaluation

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disconnected from question OR vague strategy with no or weak evidence.</strong></td>
<td><strong>Strategy named. Weak evidence, but attempt is made.</strong></td>
<td><strong>Clear strategy named. At least one piece of clear evidence (i.e. concrete, demonstrable, objective) for strategy attempted.</strong></td>
</tr>
</tbody>
</table>
| **Vague strategy.** Responses include phrases like: “doing homework”, “studying”, or “getting work done”.
OR
**Disconnected from question.** Responses include phrases like: “I don’t plan much” or “I haven’t implemented anything new”. | **Strategy named.** Responses include phrases like: “I talk to my peers about what’s happening in class”, “I think about why I’m choosing an approach”, and “I set up times to study before exams”.
 | **Clear strategy named.** Responses include phrases like: “I change the layout of past problems and imagine what [instructor] could ask to make it more difficult”, “I bring up things I have gotten wrong in the past and think about why I got them wrong”, and “I go talk to the professor after I have attempted the homework”. |
| **No/weak evidence.** Responses include phrases like: “it makes me faster” or “it makes me comfortable with the content”. Most responses in this ranking do not cite evidence for their strategies. | **Weak evidence.** Responses include phrases like: “it helps me learn”, I get everything done faster”, and “it helps me understand the content”. |
| | **One piece of clear evidence for strategy use (i.e. concrete, demonstrable, objective).** Responses include phrases like: “I did better on the second exam”, “I saw problems like the ones I made up on the next exam”, and “I can explain concepts to my peers so they can solve new problems”.

### Metacognitive Indicator Rubric Usage

This rubric is designed for instructors and students to discover inconsistencies between what students say and do, which provides openings for re-alignment and change. The design of this approach is meant to make generating the critical and cyclical feedback needed to develop metacognition accessible, even without formal experience with metacognition. Consider the following suggestions for implementing the rubric:

- Situate the overall metacognition intervention in your class curriculum or even into individual learning tasks important to the core content of the course.
- Align the metacognition prompts with the purpose of the learning task/metacognitive activity.
- Use the rubric to give individual and class-wide feedback. For class-wide feedback, consider consolidating common responses and addressing key misconceptions.
- Remember, the rubric rates students’ responses and does not evaluate students. It is a tool to initiate positive and productive conversation toward metacognitive development. Any progress in the realm of metacognition should be considered noteworthy and important.
**Prompt:** Name one new thing you have been doing since completing the GAMES© survey from the Knowing About Thinking module. How is it helping you be a more skilled and efficient learner? [Video question from Reflecting on Our Thinking module]

<table>
<thead>
<tr>
<th>Possible Student Responses / Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Response:</strong> I get together and talk through homework problems with my friends now. This is helpful because by teaching it to someone else, it gives me a stronger understanding of the material.</td>
</tr>
<tr>
<td><strong>Feedback:</strong></td>
</tr>
<tr>
<td><strong>Response:</strong> After watching the video, I have been actively focusing on key concepts and definitions rather than just reading over my notes after class every day. This has helped because my review is active rather than passive.</td>
</tr>
<tr>
<td><strong>Feedback:</strong></td>
</tr>
<tr>
<td><strong>Response:</strong> Since completing the learning strategy survey, I now work many new examples, rather than already worked problems. I also now describe concepts to others who are willing to listen.</td>
</tr>
<tr>
<td><strong>Feedback:</strong></td>
</tr>
<tr>
<td><strong>Response:</strong> I now review HW before turning it in. This helps me reduce mistakes in the HW and helps me remember materials better.</td>
</tr>
<tr>
<td><strong>Feedback:</strong></td>
</tr>
<tr>
<td><strong>Response:</strong> I just prepared well before the exam, which helped me thinking more efficiently when taking the exam.</td>
</tr>
<tr>
<td><strong>Feedback:</strong></td>
</tr>
<tr>
<td><strong>Response:</strong> I have not made any changes. I am happy with my performance as a student. I have gotten no grades lower than a 92 and that was only one. The rest of my grades are 98 or above.</td>
</tr>
<tr>
<td><strong>Feedback:</strong></td>
</tr>
</tbody>
</table>
Generating Feedback for Students

Below are four characteristics of constructive and positive formative feedback that supports students' development as learners.

**Believing**
Address the students’ responses without making assumptions about them. Believe the best about them and aid their growth. See their potential.

**Affirming**
Find some element you can sincerely praise, even honest effort using an ineffective strategy. It needs to be real and genuine and directed at the behavior.

**Challenging**
Gently challenge students through questions. Lead them to self-discovery of incongruities and inconsistencies.

**Encouraging**
Let students know you believe in them and that they are capable of academic success – with effort and perseverance. Again, this must be authentic. If you say it, make sure you really mean it.
The Role of Context
Where are we having these conversations? (Share responses from opening question.)

In these contexts, how could you use these evaluation and feedback frameworks?

Context:

Framework Usage:
Adapting a Metacognitive Training Activity for Your Context

Objective & Metacognitive Focus (e.g., self-assessment accuracy, expanding strategy knowledge, practice monitoring) - Why?

Metacognitive Activity (what do/will you call it) - How?

Context (background information on the setting) - Where?

Logistics (e.g., time commitment, frequency, mechanisms) - When? How often? How much?

Risks (challenges, potential problems, concerns):
Experience
What must students experience to prepare them to think about their learning processes?

Prompt
How will you prompt students to interpret the experience, and explore and gain insight?

Document
How will students document their metacognitive reflection (experience, questions, exploration, and insight)?

Feedback
How will you provide feedback to the students?

Feedback
How will you assemble lessons learned and return them to the entire class?

Experience
What must students experience to prepare them to think about their learning processes?
**Actionable Takeaways**
Record 1-2 things you will do in the next week as a result of this practice session.

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Resources

_Papers related to this research project:_


_Things you can do with students:_


