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Supplemental Materials

for

Curricular Activities that Promote Metacognitive Skills Impact Lower-Performing Students in an Introductory Biology Course

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Appendix 1. Pre-assignment metacognitive questions. Variations of 1-2 of the following questions appear on the pre-assignments that students complete before each lecture section.

1. How much time did you spend on this pre-assignment (including the reading)? Do you feel it was an appropriate amount of time?
2. Which pre-assignment questions would you like to discuss with your groups or in class?
3. Which of the concepts from the pre-assignment are you having the most difficulty understanding and why do you think you are struggling?
4. Approximately what percentage of the information in this chapter/on this pre-assignment was new to you? What is one concept you learned previously?
5. Rate the following concepts (list concepts from pre-assignment) according to the confidence you have in your understanding of each (use Likert-like scale). This can be the first or last question on the pre-assignment.
6. What is one question you still have about the concepts on this pre-assignment?
7. How might scientific knowledge of (fill in relevant concept) contribute valuable information to society? There is no "correct" answer here. I want you to think about how the content of this chapter may be important or relevant.
8. Before you start reading, think about what you already know about (fill in the relevant concept) and jot down your knowledge in the space below. Don't worry about being accurate!
9. What is one item from the pre-assignment or your reading that really interested you - that you would like to discuss in class?
10. How might knowledge about (fill in relevant concept) help you with your academic or career aspirations?

Appendix 2. Exam Review assignment metacognitive questions. Students complete an Exam Review assignment after the first 3 unit exams. This assignment has 3 parts, and the third section includes a variation of the questions shown below.

Exam 1 Review:

1. Do you think your grade on the first exam reflects your knowledge **AND** the amount of time you spent studying? Explain why or why not.
2. Are you satisfied with the grade you earned on the first exam? If not, how might you improve your studying/learning for the second exam? Please provide some specific plans.
3. Describe your study behaviors/technique(s) for this exam – you can include how often, how much time, what methods you were using, etc.
4. Do you feel you could use some help with your study habits? If so, what do you think might help you most?

Exam 2 Review:

1. Did you perform better on Exam 2 than Exam 1?   Yes   No
2. If you did perform better, to what do you attribute your improvement? Did you study more or did you use a different strategy for studying? Was the subject matter easier for you to comprehend or something you were familiar with already? Were the pre- or in class assignments more useful? Are there other reasons?
3. If you did not perform as well on this exam, what do you think is/are the reason(s) for this, **AND** what will you try to do differently next time?
4. How much of the material in this unit was a review – from a previous high school or college course? Try to provide an approximate percentage (0%, 25%, 50%, etc.). Which topics were new?
5. With what material or with which concepts in this unit did you struggle the most? Why do you think that is?

Exam 3 Review:

1. In this first set of questions, please provide your opinions about the exam review assignments.
   a) Do you think that these exam review assignments have helped you (or will help you) in any way? Yes or No?
   b) If you answered yes, in what way have they helped (either with this course, or for future courses)?
   c) If you answered no, please explain your reasoning.
   d) Did you struggle with any particular task/section on the test corrections activity (perhaps, in which you could have used additional help or guidance)?
2. Have your study habits/skills changed at all over the course of the semester? If yes, or no, please explain.
3. With what material or with which concepts in Unit 3 did you struggle the most? Did you find this material to be conceptually more or less difficult than the material from Unit 1 and 2?

Appendix 3. Pre-MAI Assignment. This optional assignment is offered to students in the first two weeks of the course and is worth 5 points of extra credit.

To obtain the full credit, please carefully follow the instructions below.

1. Watch the video How to Get the Most Out of Studying: Part 1 of 5, "Beliefs That Make You Fail... Or Succeed" by Stephen Chew, professor of psychology, Samford University (~7 min)
2. Complete the Metacognition Awareness Inventory (do the scoring yourself according to the instructions).
3. Watch the video How to Get the Most Out of Studying: Part 2 of 5, "What Students Should Know About How People Learn" by Stephen Chew, professor of psychology, Samford University (~ 7 min)
4. Write a personal reflection on the two videos and the results of your Metacognitive Awareness Inventory. *Consider these questions for your essay: Did you discover anything new about yourself as a student? What might you be doing wrong when studying? What do you think you are doing right? What new strategies will you try this semester?*

The reflection should be typed and no more than 1-1.5 page double-spaced.

URLs for videos:
Video
1: https://www.youtube.com/watch?v=RH95h36NChI&feature=youtu.be&list=PLwy6TW5a0C3nmDrCaqtH6pwSGLym2HCm0

Video 2: https://www.youtube.com/watch?v=9O7y7XEC66M&feature=youtu.be

The MAI can be found at: https://www.harford.edu/~/media/PDF/Student-Services/Tutoring/Metacognition%20Awareness%20Inventory.ashx

Appendix 4. Post-MAI Assignment. This optional assignment is offered to students in the last week of the course and is worth 5 points of extra credit.

To obtain full credit, please carefully follow the instructions below.

1. Complete the [Metacognition Awareness Inventory](#) (do the scoring yourself according to the instructions).
2. Write a personal reflection focused on your learning, of content and skills (including metacognitive skills) this semester. Include a discussion of the results from the Metacognitive Awareness Inventory.

Consider these questions for your essay:

- *Did you discover any new study strategies/habits that helped you in the class or for the future?*
- *Did you your metacognitive skills (such as planning, self-evaluation or monitoring your comprehension) improve and what evidence do you have for this improvement?*
- *If you observed little or no improvement, to what do you attribute the lack of improvement?*

The reflection should be typed and no more than 1.5 page double-spaced.

The MAI can be found at: https://www.harford.edu/~/media/PDF/Student-Services/Tutoring/Metacognition%20Awareness%20Inventory.ashx

Appendix 5. Summary of 20 student responses to the Post-MAI reflection essay prompts, "Did you discover any new study strategies/habits that helped you in the class or for the future?" and "Did your metacognitive skills improve and what evidence do you have for that improvement?" Responses were coded based on the extent in which students described their use of "New Study Strategies/Behaviors" and "Metacognitive Skills Development". The third code "Academic Performance" was not derived from the prompts, but emerged from student responses.

Code: New Study Strategies/Behaviors	**# of Students (% of Students)**
Student communicated the use of specific, new study strategies	14 (70%)
Student learned about new strategies but evidence for use was vague	3 (15%)
Student indicated no change in their study strategies	3 (15%)
Code: Metacognitive Skills Development	
Student communicated a improvement of specific metacognitive skills	10 (50%)
Student learned about metacognition, but evidence for improvement was vague	8 (40%)
Student indicated no change in metacognitive skills	2 (10%)
Code: Academic Performance	
Student indicated an improvement in grades over the semester	9 (45%)
Student provided no evidence of improvement or lack of improvement	6 (30%)
Student indicated no improvement in grades over the semester	5 (25%)

Appendix 6. List of new study strategies/behaviors mentioned by students (n=20) completing the post-MAI with the total number of times each strategy was mentioned.

Specific Study Strategies/Behaviors	Number of Responses
Studied/read in advance or planned and paced studying	8
Studied with another student/groups	8
Changed strategies to focus on understanding, not memorizing	4
Checked comprehension/clarified misunderstandings	4
Practiced problem sets/self-assessed knowledge	4
Organized/mapped content to understand big picture/main concepts	3
Sought help from instructor	3
Drew diagrams from text	2
Translated diagrams into text	2
Paraphrased course materials	2
Made connections between concepts/with prior knowledge	2
Reviewed section summaries/key concepts	2
Worked on efficiency/minimized distractions	2
Used YouTube videos	1
Focused on important info/expectations from class	1
Increased and varied study strategies used	1
Used checklist of study strategies from exam review assignment	1
Found examples to support material	1
Used learning objectives and made connections with text	1
Changed note-taking strategy to connect lecture and text	1
Designed/anticipated test questions	1

Appendix 7. Reasons students provided in response to the Post-MAI reflection essay prompt "If you observed little or no improvement (to metacognition, study skills or performance), to what do you attribute the lack of improvement?" with the total number of times each reason was mentioned.

Challenges related to improvement	Number of Responses
Time management/planning issues	7
Stressors in/out of school	2
Lacked motivation	2
Struggled with style of test	1
Struggled with note-taking	1
Didn't set goals	1

Appendix 8. Correlation between Pre-MAI Scores, Exam Grades and Calibration Scores for students completing the Pre-MAI assignment (n=37)

	Pre MAI vs. Exam and Calibration Scores				
	MAI Survey Total	*Exam 1 Actual Score*	*Exam 1 Calibration Score*	*Exam 3 Actual Score*	*Exam 3 Calibration Score*
MAI Survey Total	1				
Exam 1 Actual Score	0.226	1			
Exam 1 Calibration Score	0.179	0.646**	1		
Exam 3 Actual Score	0.114	0.643**	0.534**	1	
Exam 3 Calibration Score	0.110	0.143	0.191	0.077	1

Numbers represent Pearson's r values, df = 35
** $p < 0.001$

Appendix 9. Correlation between Post-MAI Scores, Exam Grades and Calibration Scores for students completing the Post-MAI assignment (n=20)

Post MAI vs. Actual and Calibration Scores					
	MAI Survey Total	*Exam 1 Actual Score*	*Exam 1 Calibration Score*	*Exam 3 Actual Score*	*Exam 3 Calibration Score*
MAI Survey Total	1				
Exam 1 Actual Score	0.276	1			
Exam 1 Calibration Score	-0.085	0.499*	1		
Exam 3 Actual Score	0.185	0.464*	0.231	1	
Exam 3 Calibration Score	0.079	0.242	0.094	-0.175	1

Numbers represent Pearson's r values, df = 18
* $p < 0.05$