

# ***TEACHING AND LEARNING STEM: A PRACTICAL GUIDE***

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## **READING GUIDE (for reading circles and self-study)**

### **Chapters 2–11**

- **Introduction.** The first section of each of Chapters 2–11 gives a list of questions the chapter will address. Formulate one-minute answers in your own words.
- **Try this in your course.** The final section of each chapter suggests several techniques for the reader to try. Choose one, try it two or three times (enough for both you and the students to become familiar with it), and discuss what happened and your conclusions about the technique.

### **Chapter 1 Introduction to College Teaching**

1. Read the Brainwave at the beginning of Section 1.1 (pp. 2–3). Based on the ideas it presents, what might you do in your classroom that would improve your students' learning?
2. How do the authors define *learner-centered teaching*? Which teaching methods do you use that would fit that definition? Which would not?

### **Chapter 2 Learning Objectives: A Foundation of Effective Teaching**

1. Look over the list of desirable STEM graduate skills in the Interlude before Chapter 2 (p.14). Are you addressing any of those skills in the courses you teach? Are there others you might address? What specifically could you have students do to help them develop one of the skills you've identified?
2. Discuss the Thought Question in Section 2.1.3 (p. 26).
3. Try the Exercise in Section 2.2 (p. 33). Were there items where your answer differed from the one offered by the authors? How might two people come up with different answers for the same objective, both of which could be correct?
4. Estimate the percentage of time you spend on knowledge and skills at each level of Bloom's Taxonomy (Section 2.2, p. 31) in a course you teach. Are you satisfied with the distribution? What might you change the next time you teach the course?
5. The authors suggest that writing good learning objectives and sharing them with the students is important when teaching higher-level thinking skills? Do you agree? Why or why not?

### **Chapter 3 Planning Courses**

1. Look over the Interlude *Good Cop, Bad Cop* before Chapter 3 (pp. 39–40). Which role comes more easily to you as a teacher: *coach* or *gatekeeper*? What might you do to strengthen both roles as you relate to your students?
2. What process do you use for planning a class session? How long does it usually take you to plan a 50–60-minute session? What strategies have you found (on your own or in this chapter) to streamline the process?
3. Look over your lecture notes for enough class sessions to provide a representative sample of your teaching. What percentage of the content would you classify as *need-to-know* material and what percentage is *nice-to-know* (Section 3.2, p. 44)? What would you like the percentages to be?
4. Take a look at your grading policies and syllabus in light of the material included in Sections 3.4 and 3.5 (pp. 47–52). What changes (if any) would you consider making?
5. How do you start your courses off on the first day? Which ideas (if any) in Section 3.6 (pp. 52–63) would you consider adding?
6. If you don't already have one, try constructing a graphic organizer of your course as described in Section 3.6.3 (p.58). Share your efforts with several colleagues to get feedback and additional ideas.

## Chapter 4 Planning Class Sessions

1. Which of the common planning errors listed in Table 4.1-1 (p. 68) have you made? Which (if any) ideas on the chart or in the chapter might you try to correct them?
2. Section 4.3 (pp. 70–74) contains several teaching tips, including giving students opportunities in class to reflect on and practice methods presented in the lecture and making explicit connections between new material and students' prior knowledge. Formulate a brief cognitive science-based explanation of why those techniques should promote learning.
3. Discuss the Thought Question in Section 4.3 (p. 74).
4. Think about the questions you ask in class. Do you make them up on the spot or plan them in advance? What types of questions do you tend to ask? Use the ideas in Section 4.5 (pp. 76–78) to develop some new questions and activities for a topic you teach.
5. Do you make extensive use of slides (e.g., PowerPoint) in your lectures? If so, would you consider the slides effective or ineffective for promoting learning? (Give an explanation based on cognitive science.) How might you improve them?
6. Have you ever used handouts with gaps (Section 4.7, pp. 81–84) as a student or to teach a topic? If so, how well did they work? Discuss concerns you may have about using this approach.

## Chapter 5 Elements of Effective Instruction

1. Look over the Brainwave on *chunking*, *working memory*, and *cognitive overload* in Section 5.1 (pp. 92–93), and then reflect on the last typical class session you taught.
  - a. How were the objectives for the class communicated to the students?
  - b. Were there opportunities for students to process information you presented? If so, what were they, and were most students actively engaged in them?
  - c. Were questions used to check for student understanding? If so, how were student responses collected—from volunteers immediately after asking, from volunteers after students had time to think, by calling on individual students immediately after asking, or by calling on them after they had time to think? After reading this chapter, do you have any plans for modification?
  - d. What changes might you make to help students absorb and retain more of the material you teach in class? (Glance through pp. 93–96 to get some ideas.)
2. Do you expect students to complete pre-class assignments? If so, how do you structure the assignments to motivate the students to complete them? Which (if any) ideas in Section 5.2 (pp. 96–99) might you incorporate into your teaching to increase the motivation?
3. How do you improve your teaching from semester to semester? Look over the ideas in Section 5.4 (pp. 100–104) and identify one or two additional strategies you would consider adopting.

## Chapter 6 Active Learning

1. A colleague of yours claims to be using active learning. When you ask about it, the description involves asking questions in class and having whole class discussions. Would you consider those techniques to be good examples of active learning? Why or why not?
2. In the Brainwaves in Sections 4.3 (p. 71) and 6.3 (p. 116), we identified *rehearsal/retrieval practice* (repetition of stored information) as an important strategy for strengthening learning, and in the one in Section 5.1 (pp. 92–93), we cited *cognitive overload* as a barrier to student learning. Discuss how active learning can help provide retrieval practice and reduce cognitive overload.
3. Do you use active learning in your teaching? (If not, skip to Question 4.)
  - a. What types of activities do you use, and how do you structure them? Which (if any) additional types or structures described in the chapter would you consider trying?
  - b. Have you made any of the mistakes listed in Table 6.5-1 (p. 123)? If so, how did you (or will you) address them?
4. What (if any) concerns do you have about using active learning? Discuss whether and how they are addressed in Section 6.6.

## Chapter 7 Teaching with Technology

1. Look over the technology tools in Table 7.1–1 (pp. 136–137). Do you use any of those tools? If so, how well do you believe they serve the functions of technology listed in Table 7.2-1 (p. 138)?
2. Reflect on the communication you have with your students during your course and the communication they have with each other. How do you think the rise in the use of technology in education has influenced that communication positively and/or negatively? Which (if any) of the approaches described in Section 7.3 (pp. 139–141) would you consider using to improve communication.
3. Discuss the Thought Question at the end of Section 7.5 (p.146).
4. Have you ever taught or been a student in an online class or MOOC? How would you rate the learning experience for the students in the course (give plusses and minuses)? What might have enhanced the experience? If you haven't taken a full class, consider webinars or other online learning or training experiences you have had.

## Chapter 8 Evaluating Knowledge, Skills, and Understanding

1. Read the Interlude before Chapter 8 (pp. 151–153) and think about yourself as a college student. Were you more like Michelle, Ryan, or Alex? How did that approach work for you? If you were to go back to college now, how do you think your approach might be different?
2. Identify two or three learning objectives in your course that involve a high-level thinking skill, and try to construct at least one multiple-choice or short-answer question that addresses each objective (Section 8.1, pp. 156–160.) Discuss what you might do to prepare the students to answer the question correctly on an exam (short of going over it class).
3. Identify several important concepts in your course that students frequently have misconceptions about. Create *ConcepTests* (Section 8.2.2, pp. 162–163) that assess the students' understanding of those concepts and identify their misconceptions. Try them out in class and discuss how well they worked.
4. What percentage of your class generally has adequate time to complete your mid-term exams and check their solutions in the scheduled test period? Is that percentage acceptable to you? If not, what might you do to change it?
5. Have you used a rubric or checklist to grade student products (project reports, papers, etc.). If so, where did you get it and how well did it work?
6. Reflecting on your assessment tools (assignments, tests, projects), what problems have you encountered with them? What ideas in the chapter (if any) might help you address those problems?

## Chapter 9 Problem–Solving Skills

1. Read the Interlude before Chapter 9 (pp. 187–188), and familiarize yourself with the different learning needs and preferences of Stan and Nathan. When you were in college, were you more like Stan or Nathan? Which of those two resembles the majority of your students now? What do you do in your class to address the needs and preferences of both types? What more might you do?
2. How do you teach your students to solve problems? What strategies have you found helpful in improving their problem-solving skills? How might you get even more improvement?
3. With which aspect of problem-solving expertise do you think your students have the most difficulty—*problem classification*, *metacognition*, or *self-efficacy*? How might you strengthen their mastery of that aspect?
4. If you assign problem sets in a course, skim through them. Do you think you are tending toward *overlearning* or *interleaving*? Do you think you should do more of one or the other?
5. Briefly describe assignments or projects you might give in your course for which you could use *problem-based learning* and/or the *McMaster structure*? What do you see as the pros and cons of doing so?

## Chapter 10 Professional Skills

1. Review the Interlude before this chapter about Dave, Megan, and Roberto (pp. 213–215) and the one before Chapter 8 about Michelle, Ryan, and Alex (pp. 151–153). What connections do you see between *deep*, *surface*, and *strategic* approaches to learning and levels of *intellectual development*? How might you move students in your course to adopt a deeper approach to learning and help them attain a higher level of intellectual development?
2. Do your course learning objectives explicitly target communication skills? Whether or not they do, what (if anything) do you do in your courses to help your students develop those skills? Are you satisfied with their progress? Identify and discuss one or two activities or assignments you might use to help them progress even more (see Table 10.1-1 for ideas).
3. Have you tried any of the types of creative thinking exercises described in Table 10.3-1 (p. 223), or any other assignments designed to help students improve their creativity? If so, how did they work? Are there others you would consider trying?
4. Section 10.4 (pp. 230–235) concerns *critical thinking* and notes the lack of a single definition of it. How do you define critical thinking, and how do you (or might you) promote its development in your students?
5. Section 10.5 (pp. 235–238) describes a number of actions self-directed learners take. What connections do you see between these actions and metacognition (as described in Section 9.1)?
6. Section 10.7 (pp. 239–241) suggests that both challenge and support are needed to help students develop higher-level skills. Think of one professional skill you are trying to develop in your students. Discuss the things you do to challenge them and the actions you take to support them as they develop the skill.

## Chapter 11 Teamwork Skills

1. Reflect on experiences you have had being part of a project team in a class you took. How have those experiences affected your attitudes toward team projects in the classes you teach?
2. Have you ever assigned problem sets or projects to student teams? If so, what (if anything) did you do to address any of the five conditions of instruction needed for group work to qualify as *cooperative learning* (p. 247). Discuss what did and did not work well. After reading this chapter, what (if anything) would you do differently now?
3. Have you used any strategies for adjusting team project grades for individual team member performance? What were they and how well did they work? How might a peer assessment tool like CATME change the dynamic of teamwork?
4. Have you ever had to deal with a dysfunctional group in a class you were teaching? If so, what did you do and how well did it work? What might you do differently now?
5. Discuss the Thought Question at the end of the chapter (p. 168).

## Chapter 12 Learner-Centered Teaching Revisited

1. What aspects of student diversity are most relevant to your institution and your teaching? How have you addressed them in your classes? What additional (if anything) will you do to address them in the future?
2. What changes (if any) are you planning to make in your teaching after reading this book?