DISCUSSION GUIDE

Study Questions for
STEM by Design: Strategies and Activities for Grades 4 – 8.

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You can use these study questions as you read STEM by Design (Routledge, 2016) individually or in a team. Often a team study will surface more ideas, generate discussions, and drive learning deeper. In either case, spend time with those questions that will generate the most learning for you.

Grab a journal to jot down ideas and information as you read this book. If you are working with others, discuss the answers to these questions together. If working alone, you can journal your answers.

Chapter 1: What Is STEM Education?

Help! No one seems to be able to tell me exactly what STEM is! If that's your problem, read on. Material in this chapter is designed to help you define STEM and develop an understanding of STEM education.

1. On page 1 of Chapter 1, read the thought bubble in the margin. What is your current definition of STEM?

2. Pages 3 and 4 contain a story titled *Ms. Rizzo's STEM Class: A True Story.* Take a moment to thoughtfully analyze what is happening in the classroom during this STEM lesson. *Design Tool 1.2: A STEM Class Analysis* can give you a good way to analyze this scenario.

3. The four components of STEM are explained in the section titled *What is STEM?* As you go over this section, what new thoughts about science, technology, engineering, and math jump out at you?

4. Enjoy watching this great 4-minute FastDraw Whiteboard video: *STEM Integration in K-12 Education*. How might you use this video?

5. One important takeaway from this chapter is the idea of *integrated* STEM. What does integrated STEM require in terms of how we teach students?

6. *Design Tool 1.3: STEM Basics* summarizes the fundamentals of STEM lessons, teaching practices, and student activities. If you used these criteria to analyze a lesson you are teaching now, how would your lesson line up?

7. Please consider some things you learned in this chapter about STEM education. Jot down a few thoughts you want to remember as well as questions you have. You can post these on the book website at at http://wp.me/p7Gw3Q-H.

Chapter 2: Why Teach STEM?

Why has STEM surged into the education scene with such vigor? This chapter focuses on the impact and importance of STEM, and on some compelling reasons for involving students in STEM.

1. Imagine you are on an elevator and someone asks you to explain the value of STEM education. What could you tell them that summarizes that importance in a 30-to-40 second answer?

2. Each of the seven compelling reasons to involve students in STEM in this chapter ends with a teaching tip. Which of the seven teaching tips will require the most thoughtful effort on your part? Which do you already incorporate in your teaching?

3. *Design Tool 2.1: The Ideal STEM Class* gives you an opportunity to compare a current class with a fictitious "ideal" STEM class. The point of this is not to critique your current classes, but to start the wheels turning about where you might want to fine tune your teaching for STEM classes. If you had to pick one or two of these for deeper focus, which ones would you pick and how would you proceed to make adjustments?

4. You can share ideas or post questions about the "why" of STEM, or about the STEM class exercise on the book website, at at http://wp.me/p7Gw3Q-H.

Chapter 3: STEM Variations

What about all of those confusing acronyms? This chapter is designed to help you think through the various programs that fly under the banner of STEM, and to analyze these in terms of STEM criteria.

1. Suppose you are asked to evaluate whether or not a particular program is truly a STEM program. You need some criteria that define what a STEM program should look like. Before reading the chapter, discuss or make a list of some criteria you would include. Note that page 25 lists eight criteria for STEM programs. What do you think about these criteria? Would you add any of these to your list?

2. After reading the sections titled “STEM Minus Schools” and “STEM Plus Schools” do other STEM -and STEM + programs come to mind? What do you think a STEM - classroom curriculum might look like? What would a STEM + curriculum look like, in your opinion?

3. You may have a position on the STEM / STEAM issue. What did you read in this chapter that challenges your stance, or gives you new ideas to consider? How would you define your position on this issue now?

4. *Design Tool 3.1: STEM School – Yes or No?* asks you to evaluate 10 programs claiming to be STEM programs according to eight criteria. After doing that, consider the STEM model you are currently using; one that you may work with in the future; or one that you simply know about. How well does that model dovetail with *Design Tool 3.2: Eight Criteria for STEM Programs?* How would you adjust it, if needed, so that it fits well with the criteria?

5. You could post your thoughts and questions about STEM / STEAM issue on the book website, at at http://wp.me/p7Gw3Q-H. You might also consider sharing your thoughts about the eight STEM criteria listed in Design Tool 3.2.

Chapter 4: Gearing Up for Teaching STEM

How do I get ready for teaching STEM? Material in Chapter 4 suggests a number of points for you to consider as you prepare to teach STEM lessons.

1. *Design Tool 4.3: Where Am I Now?* is a useful checkup to determine how you are thinking and feeling about STEM at this point. You may want to take this brief self-assessment now and after you finish reading this book. Which areas do you want to give special attention as you prepare to develop and teach STEM lessons?

2. After reading the section, *Ten Think-Abouts for Preparing to Teach STEM*, where do you think you will face your biggest challenges? *Design Tool 4.1: STEM Planner* can help you organize your ideas and make notes about each of the ten questions.

3. Exactly what kinds of engineering challenges should your students focus on in your classes? After reading pages 38-40, brainstorm some authentic challenges your students can realistically address. Consider involving your students in coming up with challenges. They can also help to correlate these with science and math objectives they could use in solving these problems. This approach can create a lot of student buy-in to their STEM lessons.

4. The *Design Tool 4.2: Dear Student* letter is a succinct, simple explanation of the why and what of STEM. In what ways might this letter could serve as a communications tool for STEM, and how will you make use of it?

5. What are you thinking in terms of possible engineering challenges your kids could tackle? What other ideas do you have to add to this chapter? Please share these on the book website, at at http://wp.me/p7Gw3Q-H.

Chapter 5: Choosing Good STEM Lessons

Where are the STEM lessons? This chapter helps you answer that question by explaining what quality STEM lessons look like and providing a way to examine possible lessons.

1. What do you consider to be a good STEM lesson? Is a science lesson, or a math lesson, the same as a STEM lesson? Discuss, or journal, your thinking about this issue.

2. The STEM lesson specifications discussed in this chapter provide a lens through which to view existing lessons labeled as STEM lessons. How well do your STEM lessons fit with these suggestions? As you study this chapter, you'll find it helpful to use *Design Tool 5.1: STEM Lesson Specifications* to examine a STEM lesson and discuss each question as you read about it.

3. Take a breather and use this time to think about what the chapter says about quality STEM lessons. As you mentally click through the eleven specifications listed, discuss or journal how you feel about these. What concerns do they present, if any? What implications do they have for your current and future lessons? How will you use these specifications?

4. Please share your thoughts about the STEM lesson specifications on the book website, at http://wp.me/p7Gw3Q-H. Feel free to make suggestions and throw out different ideas.

Chapter 6: Analyzing Lessons for STEM Potential

Do you need some guidance in determining what is and isn't a STEM lesson? Chapter 6 gives you practice in locating and assessing lessons for STEM value.

1. As you study the analysis of the "Touchdown on the Moon" lesson on pages 65-67, discuss (or journal) whether you would have arrived at the same conclusions about the lesson. Would you make the same modifications as those suggested? Offer different modifications?

2. Think about Lesson Example 2 on page 69. What STEM features does the lesson have? What does it lack? What did you learn from studying this?

3. By the time you examine Lesson Example 3 you're probably getting the hang of how to look for the STEM features needed to make something a STEM lesson. What are the primary features that key you in to whether the lesson is (or is not) a STEM lesson?

4. Now that you have a handle on how to look for and adapt STEM lessons, take a moment to examine the *Chapters 5-8 STEM Lesson Sources* in Appendix B of this book. Which ones look as if they offer the most promise for you presently? For your convenience, that section of the Resources Page is the last page of these Study Questions. If you view the Study Questions online, you can simply click on the links.

5. What works for you about analyzing lessons for STEM potential in this manner? What suggestions would you make? Please share your thinking on the book website, at http://wp.me/p7Gw3Q-H.

Chapter 7: STEM Lesson Design Preliminaries

Can't find any existing lessons you like, or that correlate with your science and math objectives, or that pique your student's interest and engagement? No problem. Get ready to write your own. This chapter will help you with that.

1. Think through a time you struggled with designing a particular lesson or effectively presenting it. What helped you the most in that situation?

2. Much research shows that teachers working together to plan and design effective lessons is a better scenario than the "lone ranger" approach. When have you worked with a team of teachers to do this? What makes this process effective? (Note: for tips on successful teaming, take a look at my book *Team to Teach: A Facilitator's Guide to Professional Learning Teams.*)

3. Do your students understand how to brainstorm? If you are working with a group, try out the brainstorming process described in *Design Tool 7.1: Brainstorm.* Would this work well for your students? If not, how could you simplify the language or otherwise adjust the tool so that it makes sense for them?

4. The Engineering Design Process (EDP), described in detail on pages 81-84, is a key component of STEM lessons. If you have used other design processes in teaching, how does the EDP differ? Discuss this, using *Design Tool 7.3: EDP Description for Teachers* to guide that discussion.

5. Since this process is an intentional component of STEM lessons, how will you call it to your students' attention as they are working on STEM challenges? Just as important, how can you help them understand that this process is iterative and not necessarily sequential? *Design Tool 7.2: The Engineering Design Process for Student Teams* can help you with this. This two-minute video on design thinking can also help them: http://bit.ly/1UjBtis.

6. What else do you want to know before beginning to write or adapt a STEM lesson? Please share your thinking on the book website, at http://wp.me/p7Gw3Q-H.

Chapter 8: Designing a STEM Lesson

Finally! What does putting pen to paper (fingers to the keyboard) involve? Chapter 8 will give you the before, during, and after particulars of designing a STEM lesson.

1. Have you already written lessons? What components did you include? Discuss the components that seem to be the most necessary when taking a lesson that someone else has written and trying to teach from it.

2. Time for you to plan a lesson! Hopefully this will be a lesson you will share with colleagues. To begin, pick a lesson idea for a practice run. Start by examining the STEM Front Matter Components (information about the lesson that comes before the actual teaching procedures). The information on pages 95-98 gives some preliminary information you need to include about the lesson you plan to write, especially if others will be using the lesson. Take a look at *Design Tool 8.1: Front Matter List,* and use it to guide discussion and/or journaling as you study this section.

3. What systematic process do you use for developing and writing specific lesson procedures? Take a moment to discuss these. (I generally use the EDP Template from Design Tool 7.4 as a basic organizer.) How will you use the nine suggestions listed on pages 99 – 103? These are vitally important components of STEM lessons. Discuss specific places and ways to include each component in the practice lesson you are designing.

4. Examine the ideas for practice lesson you began sketching out. If you were to decide to continue developing this lesson, how could you stay on track? In the happy event that you are working collaboratively with others on this, when could you meet with other teachers, and how often, to develop and field test this lesson? Note that *Design Tool 8.2: Lesson Design Checklist* can help to keep the lesson on track if you keep referring to it during the writing process.

5. Examine *Design Tools 8.3: Important Team Behaviors, 8.4: What Matters to Our Team?, and 8.5: Lesson Impact on Students*. How do you foresee these as useful and in lesson writing and in implementing your STEM lessons? Please share your thinking on the book website, at http://wp.me/p7Gw3Q-H.

Chapter 9: Assessing STEM Impact

How do you know whether kids are learning anything from your STEM lessons? This chapter is designed to help you with purposeful STEM classroom assessments.

1. What do you want to learn about your students from your STEM assessments? What specific student data and information that would help you to prepare and lead STEM lessons even more effectively? As you read Chapter 9, check to see if any of the assessment practices mentioned gives you ideas for how to get that information. If you want additional help with that, post your request on the book website at http://wp.me/p7Gw3Q-H.

2. Examine the six categories of STEM formative assessments discussed in the chapter. (Also check out the section titled *Some Other Areas You May Want to Assess*. What do you think about these assessment ideas? Are any of the ideas discussed new to you? Which ones have you already had experience in using?

3. What are some of your most successful student assessments – the kind that helped you adjust your lesson and improve student learning? How could you adapt one or more of those assessments to use with STEM lessons? Please share your assessment ideas on the book website at http://wp.me/p7Gw3Q-H.

4. What data and information could you gather by using each of these five Design Tools at the end of Chapter 9?
   Design Tool 9.1: Criteria Rubric
   Design Tool 9.2: 60-Second Teamwork Check-In
   Design Tool 9.3: What Must Team Members Be Able to Do?
   Design Tool 9.4: Teamwork Quick Check
   Design Tool 9.5: Sample EDP Assessment?

Chapter 10: Coordinating CTE and STEM

Some say that Career and Technical Education (CTE) is the same thing as STEM. Others see similarities but also point to differences. This chapter can help you sort out the connections between CTE and STEM.

1. What do you know about Career and Technical Education (CTE?) You might take a quick online search to investigate the program, and discuss (or journal) what you discover.

Does your school offer CTE? If so, what type of program is it? (Check out the examples on page 129.)

2. How can CTE at your school match up with your STEM program? (If your school doesn't have a CTE program, locate the CTE curriculum of a nearby middle school to explore. The curriculum information is often online at the school district website.) The section of Chapter 10 titled, *How Do CTE and STEM Match Up for Partnership at the Middle Level?* can help you think about specific aspects of the CTE program that coordinate with STEM programs.

3. Discuss the possibilities for collaboration with the CTE teacher, if possible. *Design Tool 10.1: Partnership Possibilities* and *Design Tool 10.2: Partnership Building* can guide your discussion and collaborative efforts.

4. What is your thinking about the place of CTE in STEM? Could CTE and STEM form a valuable and useful partnership? Please share your opinion on the book website at http://wp.me/p7Gw3Q-H.

Chapter 11: Teaching STEM After School

After school programs undoubtedly have value. But what about teaching STEM after school? Is after- school STEM a stand-alone STEM program? Is it better used to enhance learning for some students in an already existing in-school STEM program?

1. What do you perceive as the value of after-school programs in general? Specifically, how do you think that a STEM after-school program could be of value?

2. Consider the suggestions in Chapter 11 about the types of curriculum that might be offered in an after-school program. How do these suggestions match the STEM curriculum that would typically be offered during the school day to all students? If you see differences, why do you think the curriculum offerings would not be identical?

3. Check out *Design Tool 11.1: After-School Assessment Checklist.* Do you think this checklist differs from the needs of in-school STEM classes? Given your context, what else would you add to this checklist for an after-school STEM program?

4. Suppose that you have the task of designing an after-school STEM program. What major components will you include? What possible cautions will you flag? Please post your responses on the book website at http://wp.me/p7Gw3Q-H.

Chapter 12: Including Girls in STEM Class

You've probably heard about the lack of girls in STEM classes and STEM fields. What's the problem? This chapter is designed to give you some insight into this dilemma and to suggest possible solutions.

1. Chapter 12 opens with a section titled *What's the Problem with Girls, Women, and STEM?* What's your opinion of the suggested obstacles preventing girls from going into STEM fields? Are these the right ones? In your area, are there different obstacles, or barriers that might discourage girls from pursuing STEM careers.

2. Discuss (or journal) the barriers that you think might prevent girls from going into STEM work in your situation. Do the suggested solutions on pages 149-151 address those? If not, what solutions can you come up with to address each obstacle?

3. What different ethnicities and special needs students do you teach? These are also STEM high-needs areas. Look again pages 149-151 and substitute an ethnicity or area of student need for the word "girls." Which of these suggested solutions would work for those students?

4. I'm curious about your ideas for working with all students who make up the underrepresented groups in STEM fields. Would you share some of your thinking on the book website at http://wp.me/p7Gw3Q-H?