Solution Tree | Press

Designing the Future: How Engineering Builds Creative Critical Thinkers in the Classroom

By Ann Kaiser

Study Guide

This study guide is a companion to the book *Designing the Future: How Engineering Builds Creative Critical Thinkers in the Classroom* by Ann Kaiser. *Designing the Future* explores the engineering design process (EDP) and provides teachers with a framework for developing and adapting engineering activities and projects into the classroom.

This guide is arranged by chapter, enabling readers to either work their way through the entire book or focus on the specific topics addressed in a particular chapter. It can be used by individuals, small groups, or an entire team to identify key points, raise questions for consideration, assess conditions in a particular school or district, and suggest steps that might be taken to promote a healthy school culture.

We thank you for your interest in this book, and we hope this guide is a useful tool in your efforts to create a healthy culture in your school or district.

Chapter 1

Building an Engineering Design Culture

---

1. Consider your classroom culture. Do you and your students embrace an engineering mindset or are you simply collecting dots? What is your evidence for your choice?

2. List the three steps you can use to begin creating a creative problem-solving culture.

3. What are some ways you can introduce your students to the impact engineering has on their lives and to the roles of engineers? List the five engineering design hallmarks.

4. What does *failing forward* mean? Why is failing a powerful learning tool? How can you establish a culture that supports failing forward?

5. How can you limit the negative impact of trial and error in the classroom? List some questions that help students avoid trial and error and that promote robust learning experiences.

6. Design an activity that demonstrates to students the idea of multiple solutions to a scenario or problem. What are the constraints and criteria of the activity?

7. How does engineering design transcend traditional disciplinary boundaries? How might you collaborate and build an activity with a different subject teacher to promote transdisciplinary skills?

8. Why does including opportunities for student voice and choice encourage student engagement? List the three elements that help create opportunities for student voice and choice.

Chapter 2

Deconstructing the Engineering Design Process

1. Why is it important to think flow and not script when implementing the engineering design process (EDP) in your classroom? List and describe the three phases of the EDP.

2. What are the three steps of phase 1? How can teachers help students have a clear understanding of the design challenge? What is the students' first job when faced with an ill-defined problem?

3. Why do many educators and students struggle with managing the EDP? Define *constraints* and *criteria*. How are they similar and different?

4. What are the two steps of phase 2? Which step will most likely be the most challenging in the EDP? What are the teacher's responsibilities as guide and leader during this step?

5. What are the four steps of phase 3? What is the students' role in this phase? What is the teacher's role in this phase?

6. Describe the actions students can take to decide on their prototype. What are the main reasons for creating prototypes?

7. Why is it important to practice modifications in the EDP? If you do not have time for meaningful modifications, what steps can you take to maximize learning?

8. Consider the ways you have students share their work in your classroom. How can you incorporate one of the communication approaches outlined at the end of this chapter in your classroom?

Chapter 3

Designing Projects

---

1. What are the characteristics of a good design challenge? Consider figure 3.1 (page 61), and summarize why the option B statements are the better challenge statements.

2. List the three components all projects should have. What are the three steps you can take to ensure your projects contain these components?

3. What are *quick builds*? How do these challenges enhance student learning?

4. What is the ideal size for groups? What are some guidelines you should follow when assembling teams? Why should team members have different jobs?

5. Why does the author identify the engineering notebook as the cornerstone of all her projects? How might you remind students daily that the project is all about the process and not the final product?

6. What are concept maps? How can you use concept maps throughout a project? What would this process look like?

7. What are the two traps you can fall into if your assessments only focus on the final product?

8. Do you currently include peer assessments after projects and tasks? Why is it important to incorporate a peer assessment at the end of each project?

Chapter 4

Starting With Activities That Support Engineering Thinking and Skills

1. Consider the activities introduced in this chapter. How do these activities differ from projects?

2. Reiterate the advantages of learning from failure. Do you currently use any activities that help students internalize the concept that failure is always an option?

3. After studying the Learn From Failure activities, how might you modify one of these activities to fit your classroom? What do students learn about the EDP by completing this activity?

4. Why is it important to define a problem as clearly as possible? Which of the Know Your Problem activities would you like to try with your students?

5. Why do teachers find the know-your-options phase challenging? When is the best time to utilize the activities outlined in the Know Your Options section in your classroom?

6. Consider the SCAMPER This! Activity (page 114). What does the acronym *SCAMPER* stand for? What four things should you remind students of before they begin brainstorming?

7. What is a *prototyping station*? What can students do if building an actual prototype is too complex?

8. In what ways does the LEGO Person Activity (page 122) support communication and collaboration?

Chapter 5

Introducing Projects for Elementary School

---

1. What three things should your design challenges help grades K–2 students do? Define *reverse engineering*.

2. How does using a book or story for an engineering design challenge enhance student learning?

3. Consider the Engineering Happily Ever After project (page 131), and list some potential books or stories you can use for this project. In what ways does this project create an engaged learning experience?

4. What are the two main goals of the Building a Better Box project (page 135)? How might you tie in other subjects, such as environmental science and visual arts, into this project?

5. What does the acronym *STEAM* stand for? Every Graph Tells a Story (page 139) focuses on several ideas. What are they?

6. What principles do good engineering and nature share? What is *biomimicry*?

7. What modifications would you make to the Hidden in Plain Sight Project—Biomimicry (page 142)? Use table 5.2 on pages 143–144 to plan your project.

8. What would the No Words Activity (page 146) look like in your classroom? What skills do students develop by creating pictorial instructions?

Chapter 6

Introducing Projects for Middle and High School

1. Why is starting with smaller activities and projects especially important in grades 6–12?

2. What are some steps you can take to involve colleagues from other departments in your planning and projects?

3. Why do many students who identify as being creative lose interest in STEM fields during high school?

4. Why is board game design the ultimate STEAM project? How can you adapt the Engineering a Board Game project (page 152) to relate to your content area?

5. What are the three main ingredients for creating real-world global projects? How do real-world global projects differ from the projects discussed earlier in the chapter?

6. Why is it important to know your end user? Define *appropriate technology* in your own words.

7. Reflect on the two engineering enablement projects shared in this chapter. How might you incorporate one of these projects into your classroom? Can you think of or find a different engineering enablement project that you can use in your classroom?

8. Consider the In the Classroom feature box on page 180. Why is it important to have students reflect on their work after completing a project? How often do you ask your students to reflect on their work?

Chapter 7

Reflecting On, Revising, and Optimizing Your Curriculum

1. Do you make time for reflecting on your teaching practice? If so, when do you reflect and how often? Do you use any tools or checklists when reflecting?

2. What is the key to effective reflection? What is the goal of reflection?

3. If you currently use a teacher post-project reflection checklist, how might you modify it after studying figure 7.1 (page 185) and figure 7.2 (page 186). If you do not utilize any teacher reflection tools, are there any elements you might want to include to this sample checklist?

4. What are some questions you should ask yourself before tackling your reflection checklist?

5. Consider figure 7.3 (pages 188–189), and reflect on projects you have used with your students. Can you think of some other things not listed in figure 7.3 that can go wrong? What are some possible revisions for next time?

6. List the actions you should take to re-engineer how you teach.

7. What are some ways you can receive feedback from students regarding your implementation of the EDP? What are some statements that indicate students are moving toward real-world thinking in the classroom?

8. Study the In the Classroom feature box on page 192, and summarize how the EDP has enhanced student learning for each individual.