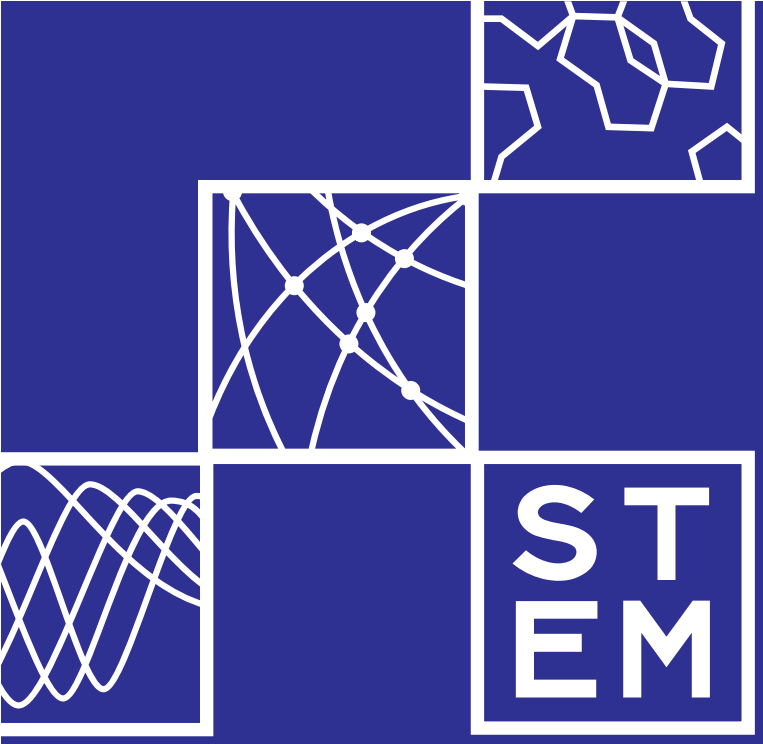


A BLUEPRINT FOR BUILDING A STEM PROGRAM

Integrate, Innovate, Inspire

REGION 13
EDUCATION SERVICE CENTER

TRANSFORMATION CENTRAL TEXAS STEM CENTER

Transformation Central Texas STEM Center (TSTEM) was established to help schools improve math and science achievement outcomes for all demographic groups as determined by state and national standards. Transformation Central accomplishes this objective by providing the highest quality professional development, curriculum, and outreach programs and emphasizing hands-on, problem-based learning to develop superior STEM students.

STEM FOUNDATIONS: A BLUEPRINT FOR BUILDING A STEM PROGRAM

AUTHORS:

Grant A. Kessler, Ph.D.
German Ramos, M.M.E
Stephanie Brierty
Benjamin Zink
Lyra Swinney, M.Ed
Jennifer Meyer, M.Ed

First Edition: August 2015

TABLE OF CONTENTS

Part 5: STEMify the Classroom (Resources)

References

INTRODUCTION

You have probably heard about STEM (science, technology, engineering, and math) and its ever-increasing importance in education. Your campus may even offer a STEM elective. You may even understand the big idea of STEM; you may have heard that STEM has its place in every classroom. But perhaps you've wondered: How do you accomplish this in such a way that it does not change teaching techniques, but rather encourages the incorporation of STEM best practices in order to STEMify the classroom?

PURPOSE

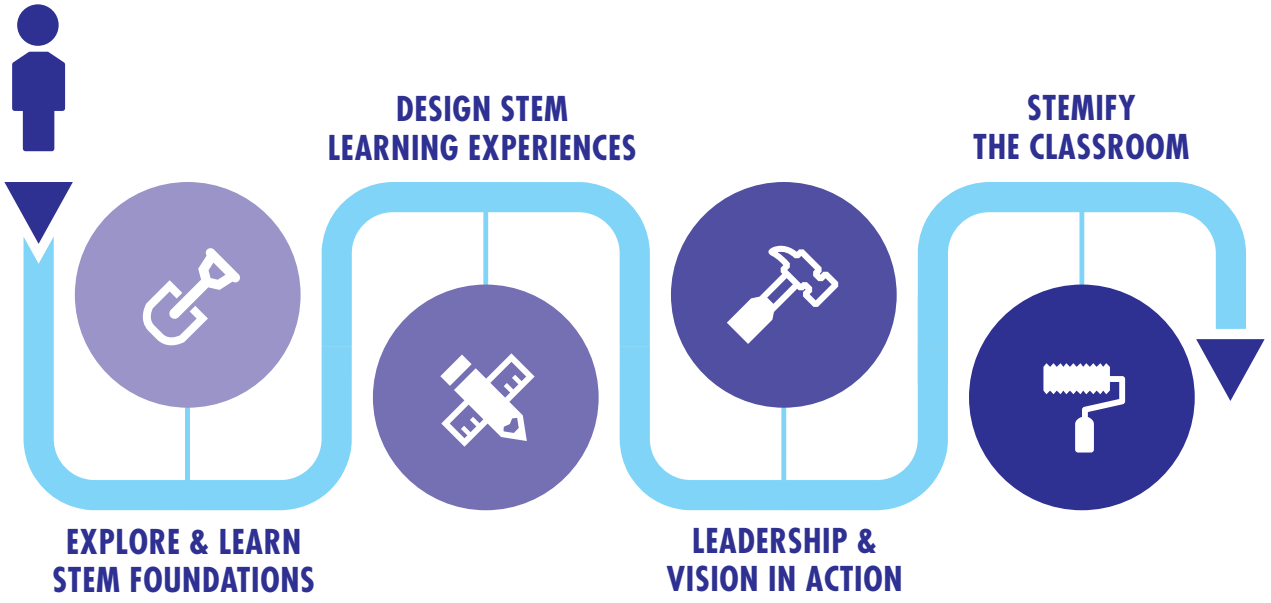
The purpose of this STEM Foundations resource is to provide practical and strategic processes for STEMifying students' learning experiences. This content is intended for teachers, administrators, and other stakeholders in student learning. The STEM Foundations Road Map included in this resource serves as a basis for establishing a common language, vision, and pathway toward strategic implementation of a STEM program and STEMified learning.

AUDIENCE

This resource is for all teachers, administrators, parents, and stakeholders who want to STEMify student learning. Administrators can use this guide from a leadership point of view to foster a STEM culture; the principles laid out in this book provide a foundation for ongoing teacher support, staff development, classroom observations, as well as a professional learning community focus. For instance, administrators may find it useful to use the material in Section One to lead discussions with colleagues and senior staff. Additionally, Section Four provides a framework for administrators to implement STEM initiatives district- or campus-wide.

Teachers may use this resource as a tool to implement or enhance STEM best practices and learning experiences, helping students to develop content-area understanding and the skills to succeed in this global economy.

STEM ROAD MAP



At the beginning of the road map, you will explore and learn the foundations of STEM education. Taking the second step, you will develop the student learning experiences that integrate STEM Essentials into specific content-area skills.

The third step will help you to create a strategic plan to STEMify learning across your campus. The fourth step provides resources to prepare you to implement, revise, and sustain a quality STEM program.

KEY FOR USING THIS RESOURCE

This book is intended as a practical guide for implementing STEM learning. It is designed to be interactive and allow you to track your progress throughout your journey on the STEM Road Map. The following symbols will appear throughout the book to highlight the processes you will use to learn about STEM.

Learning Outcomes

Guides your learning throughout each section

Read

Research supporting STEM and guides for STEMifying

Explore

Supplemental information and interactive resources

Action

Create plans to STEMify learning for all students

Discuss

Share your insights and ideas with fellow educators

Reflect

Activities to reinforce content and processes

3 DESIGN STEM LEARNING EXPERIENCES

LEARNING OUTCOMES

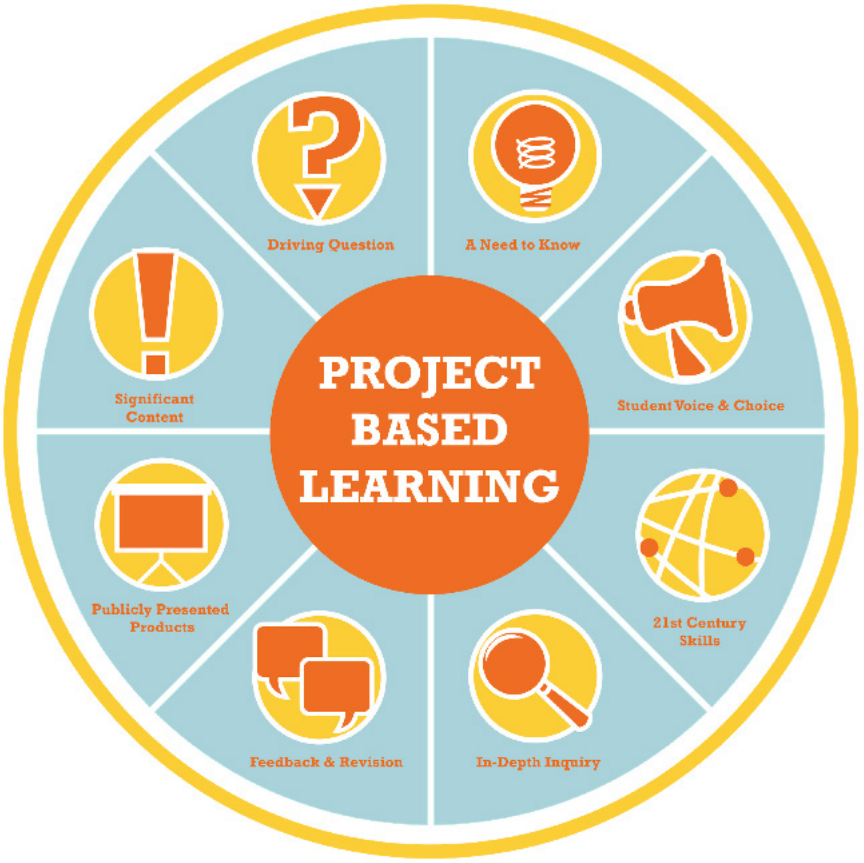
- Explore methods to STEMify student learning
- Create a STEMified lesson using the STEM lesson design process
- Identify ways to incorporate the STEM Essentials into all learning experiences
- Identify effective methods for student success in STEM learning experiences

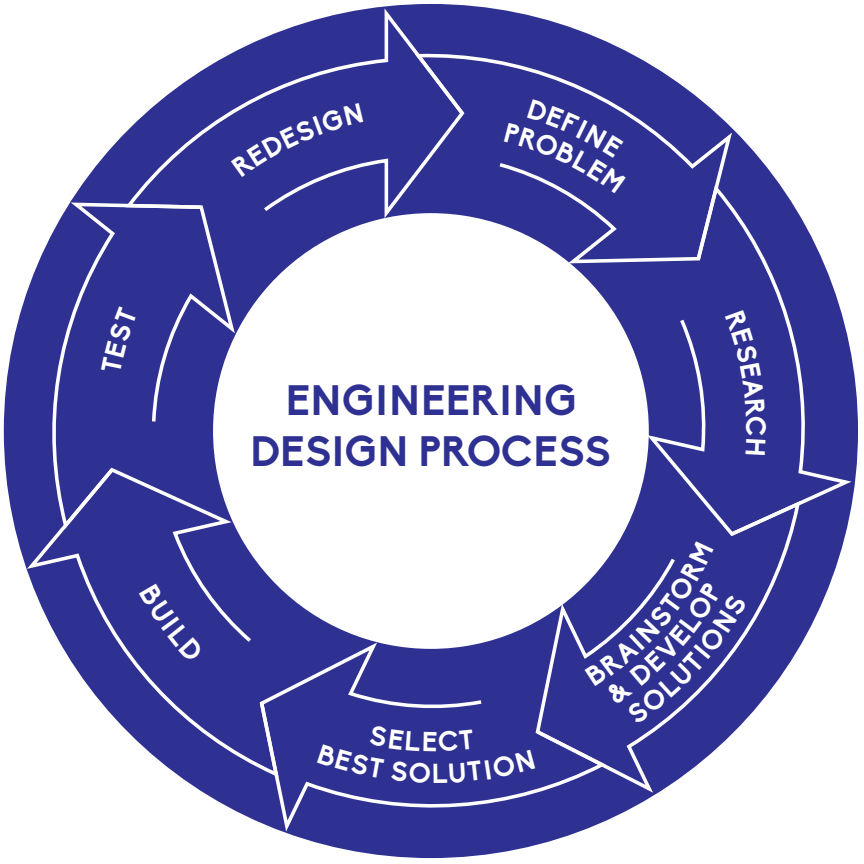
The Texas STEM Center (T-Central) has developed a straightforward and practical process for educators to efficiently STEMify learning for all students. This method of STEM lesson design is appropriate for planning new learning experiences within and across content areas and grade levels. It may also be used to redesign and STEMify existing lessons.

We recognize the challenges educators will face as they implement STEM in their classrooms: constraints on time, budgets, access to technology, class sizes, levels of background knowledge, and expertise. The processes outlined in this section are designed to ensure that all students have access to STEM learning experiences.

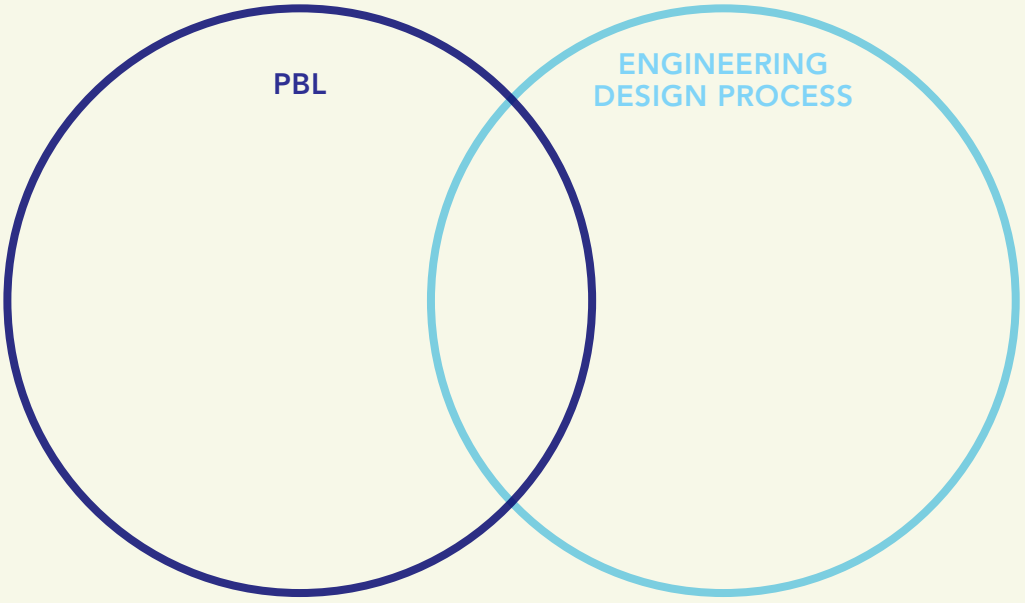
The STEM lesson design process is teacher friendly. We'll go through the five steps to design a fully STEMified student learning experience with methods for modifying lessons to align with your campus's needs and resources. We have provided some real-world scenarios to demonstrate how the STEM lesson design process can be incorporated into a variety of student learning experiences depending on the availability of time and resources. The final portion of the section will address how to manage and facilitate STEM learning in your classroom.

The STEM lesson design process is built upon successful, research-based strategies for 21st century learners and incorporates both the engineering design process and a project-based learning model. Take a moment to compare and contrast these instructional models.





Use the Venn diagram below to compare and contrast the PBL and the Engineering Design Process.



3.1 STEM LESSON DESIGN PROCESS OVERVIEW

The STEM lesson design process contains five steps. Although you will practice going through the process in sequential order, it is designed to be fluid. Teachers may map out one or more of the steps based on their intuition and experience before fully designing a STEM learning experience. The flexibility of this model allows for creativity and innovation, giving it the potential to inspire future lessons.

INCORPORATE STEM LESSONS & TECHNOLOGY

1. Select content-area learning objectives
2. Select a relevant real-world challenge and plan launch
3. Define deliverables, constraints, and success criteria
4. Set project timeline and allocate resources
5. Outline student learning through the engineering design process

STEP 1:

SELECT CONTENT-AREA LEARNING OBJECTIVES

Because our objective is to teach students the state standards, an obvious place to start planning is with development of content learning objectives. When making the shift from a traditional learning context to STEM, subtle adjustments can make a big difference. In addition to content standards, STEMified lessons incorporate 21st century skills (4C model) and College and Career Readiness Standards (CCRS). These additional standards may be selected during your initial planning or added and/or edited as you work through the lesson design process.

Several factors will determine which standards you select for your STEM lesson design. Learning objectives may be predetermined by a district scope and sequence, or they may address a particular standard with which your students have struggled. Once you have selected and written your learning objectives, you can begin planning how students will achieve the desired learning outcomes.

TEAM-WIDE STEM PLANNING

You may decide to work as a team (e.g., by department or grade level) to develop integrated, multi-class STEM experiences. The starting place for this collaboration is identifying and coordinating interdisciplinary standards. For instance, the Language Arts standards may fit naturally as students learn a variety of writing styles and language skills through research, product development, and product presentation.

Depending on the level of flexibility for each content area's scope and sequence, a team may have the freedom to align subject area standards prior to the school year and design overarching interdisciplinary units. Grade-level teachers may regularly meet to share standards and brainstorm ways to bridge and support students within their own content area.

Lesson Design Template

	Select and write down student learning outcomes using content area TEKS, 4C, and CCCR	
STEP 1: **LEARNING OBJECTIVES**	TEKS (i.e., 7.2A, 112.33C), 4C, CCCR Standards	The students will know . . . The students will be able to . . .

(see complete lesson design template on pages 52-54)

STEP 2:

SELECT A RELEVANT REAL-WORLD CHALLENGE & PLAN THE PROJECT LAUNCH

After selecting the learning objectives, the next step is to start thinking about a relevant challenge. This process often involves generating, editing, and revising in order to find a question that is engaging, open-ended, rigorous, and aligned with content standards.

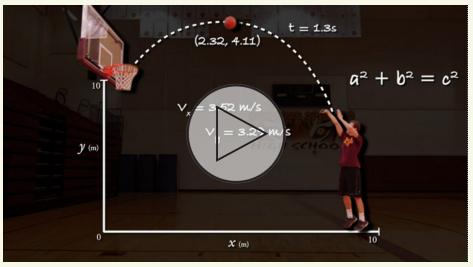
There are three main types of challenge statements to choose from, depending on the desired outcomes:

1. **Abstract, conceptual questions** ask students to consider and address an abstract idea through analysis and critical thinking.
2. **Problem-solving questions** ask students to come up with a reasonable solution to a problem.
3. **Design-problem questions** ask students to come up with a design that fits specific requirements and constraints.

STEM IN ACTION

The students in Ms. Cooper's physics class learned about kinematic equations (the learning objective) by analyzing the free throw shots of basketball players and helping them improve. As you watch this video, pay attention to the relevant challenge and the way Ms. Cooper introduced the project to students.

region13.wistia.com/medias/w2cwtvw5i5



RELEVANT CHALLENGE

1. Brainstorm a list of real-world problems or challenges that would invite students to initiate discussion and questions.
2. Select a challenge or problem that students will solve in order to apply and learn the content-area objectives.
3. Describe the requirements for the challenge. What must each team do to fully complete the challenge?

After you have selected the relevant challenge for students, it is time to plan for how to get students engaged and prepared to learn through the STEM experience; we call this process the STEM Project Launch. A successful launch can send your students off and running to solve problems, gain knowledge, and work together to master standards. This piece should not be rushed or taken lightly because it sets the entire project up for success (or on a bumpy road if students are not motivated or interested). The Project Launch has two key elements:

1. THE ENTRY EVENT

This hooks your students into the project, makes them owners of their learning, and directly connects to the driving question and standards.

2. KNOWS & NEED-TO-KNOWS

This is an outline to help students understand the gaps in their knowledge along the path to the final product. It shows the educator what teaching needs to occur during the project on all scales (from the whole-class to individual). While facilitating this exercise, keep in mind the standards that students must demonstrate so that you can ensure they are present in the need-to-knows column. Revisiting the knows and need-to-knows throughout the project will help keep all parties on task as well as show their progress.

Lesson Design Template

STEP 2:

PLAN THE PROJECT LAUNCH

ENTRY EVENT

What engaging scenario will define the context and build excitement for the challenge?

What resource(s) can you use for the entry event: video, article, guest speaker, webpage, or field trip?

KNOWS & NEED-TO-KNOWS

How will you facilitate a discussion and support students in generating a class list of "knows" and "need-to-knows" for this challenge?

How will students track their knowledge along the way? (e.g., a handwritten list, capacity matrix, or prepared template)

(see complete lesson design template on pages 52-54)

