Construction Materials

STEM Road Map for High School

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PART 2

CONSTRUCTION MATERIALS

STEM ROAD MAP MODULE

3

CONSTRUCTION MATERIALS MODULE OVERVIEW

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THEME: Innovation and Progress

LEAD DISCIPLINE: Science

MODULE SUMMARY

We use buildings every day but often take for granted how complex these structures are; this module gives students an in-depth look at the technologies and science necessary to understand these feats of engineering. In this module, students examine properties of construction materials, particularly those of high-rise buildings. Students first learn how high-rises are constructed, the influence these high-rises had on society, and how to communicate complex ideas clearly. Then, students examine the factors behind the collapse of the World Trade Center Twin Towers in New York, focusing on how engineers use failure to learn more about the designed world. Finally, students examine innovations in construction to propose new ways to construct high-rises (adapted from Peters-Burton et al. 2015). (*Note:* Teachers should consider their students' sensitivity to subjects such as the events of September 11, 2001, and terrorism before beginning this lesson. This module may spark emotional reactions, but arguably great learning can happen when people care about the topic.)

ESTABLISHED GOALS AND OBJECTIVES

The first lesson in this module examines the building of high-rises. In science class, students learn about the materials, such as concrete and rebar, used to build high-rises and the forces that must be in place to hold up such structures. In mathematics, students explore the geometry of construction, such as the methods used to place the foundation exactly at right angles. In English language arts (ELA), students learn strategies to gather complex ideas, analyze these ideas, and synthesize them to be communicated clearly. In social studies, students examine the influence that the invention of high-rises has had on societies around the world.

The second lesson focuses on the collapse of the World Trade Center Twin Towers. In science class, students look at the physics and chemistry behind the interactions that led to the collapse, and in mathematics, students concurrently learn about vectors for the purposes of analysis. In ELA, students delve deeper into the concept of success through failure. In social studies, students consider the arguments and sources of those who believe the Twin Towers were brought down by controlled demolition and compare them with mainstream reports of the disaster.

In the third lesson, students look to the future. In science, they synthesize what they learned about current techniques and create innovations for future high-rises. In mathematics, students complete risk-benefit analyses for their innovation ideas, and in ELA, they use effective communication techniques to propose the innovations. In social studies, students conduct a round robin evaluation.

At the conclusion of this module, students will be able to do the following:

- Apply their understanding of the types of materials used to build tall towers and how they are geometrically assembled
- Communicate complex ideas clearly and completely
- Research and describe the reasons communities race to build the world's tallest towers
- Explain the physical analysis of the collapse of the World Trade Center Twin Towers based on published data
- Compare and contrast arguments for the collapse of the World Trade Center Twin Towers
- Synthesize what they learned about current techniques and create innovations for upcoming high-rises

The lessons in this module take into account that it may not be possible for a teacher to collaborate with teachers from other content areas or that teachers from two different subject areas may not have the same students, so teaching in an integrated way in each class may not make sense. Therefore, the lessons are written so that the science teacher can teach the science classes and only a little of each other content area. That is, a teacher who is teaching the module alone may choose to follow only the lead subject, offering enrichment activities in the other connecting subjects. Those who are teaching the modules by themselves may want to collaborate with their peers in the other subjects to get ideas for ways to incorporate the supporting connections seamlessly. Teachers who are able to teach an integrated curriculum can use the module as written for all four subjects in each of the Lesson Plan Components sections of the module.

CHALLENGE OR PROBLEM FOR STUDENTS TO SOLVE: NEW TECHNOLOGIES FOR HIGH-RISE BUILDINGS

Student teams are challenged to use knowledge of molecular-level structure to examine the collapse of the World Trade Center Twin Towers and develop a proposal for new or improved building materials or methods that could be incorporated into the design of future high-rise buildings in U.S. cities.

Driving Question: How can we use what we know about the collapse of the World Trade Center Twin Towers to propose new building materials or methods that could prevent the extent of damage caused by a disaster?

CONTENT STANDARDS ADDRESSED IN THIS STEM ROAD MAP MODULE

A full listing with descriptions of the standards this module addresses can be found in the appendix. Listings of the particular standards addressed within lessons are provided in a table for each lesson in Chapter 4.

STEM RESEARCH NOTEBOOK

Each student should maintain a STEM Research Notebook, which will serve as a place for students to organize their work throughout this module (see p. 12 for more general discussion on setup and use of this notebook). All written work in the module should be included in the notebook, including records of students' thoughts and ideas, fictional accounts based on the concepts in the module, and records of student progress through the EDP. The notebooks may be maintained across subject areas, giving students the opportunity to see that although their classes may be separated during the school day, the knowledge they gain is connected.

Each lesson in this module includes student handouts that should be kept in the STEM Research Notebooks after completion, as well as a prompt to which students should respond in their notebooks. You may also wish to have students include the STEM Research Notebook Guidelines student handout on page 26 in their notebooks.

Emphasize to students the importance of organizing all information in a Research Notebook. Explain to them that scientists and other researchers maintain detailed Research Notebooks in their work. These notebooks, which are crucial to researchers' work because they contain critical information and track the researchers' progress, are often considered legal documents for scientists who are pursuing patents or wish to provide proof of their discovery process.

STUDENT HANDOUT

STEM RESEARCH NOTEBOOK GUIDELINES

STEM professionals record their ideas, inventions, experiments, questions, observations, and other work details in notebooks so that they can use these notebooks to help them think about their projects and the problems they are trying to solve. You will each keep a STEM Research Notebook during this module that is like the notebooks that STEM professionals use. In this notebook, you will include all your work and notes about ideas you have. The notebook will help you connect your daily work with the big problem or challenge you are working to solve.

It is important that you organize your notebook entries under the following headings:

1. **Chapter Topic or Title of Problem or Challenge:** You will start a new chapter in your STEM Research Notebook for each new module. This heading is the topic or title of the big problem or challenge that your team is working to solve in this module.
2. **Date and Topic of Lesson Activity for the Day:** Each day, you will begin your daily entry by writing the date and the day's lesson topic at the top of a new page. Write the page number both on the page and in the table of contents.
3. **Information Gathered From Research:** This is information you find from outside resources such as websites or books.
4. **Information Gained From Class or Discussions With Team Members:** This information includes any notes you take in class and notes about things your team discusses. You can include drawings of your ideas here, too.
5. **New Data Collected From Investigations:** This includes data gathered from experiments, investigations, and activities in class.
6. **Documents:** These are handouts and other resources you may receive in class that will help you solve your big problem or challenge. Paste or staple these documents in your STEM Research Notebook for safekeeping and easy access later.
7. **Personal Reflections:** Here, you record your own thoughts and ideas on what you are learning.
8. **Lesson Prompts:** These are questions or statements that your teacher assigns you within each lesson to help you solve your big problem or challenge. You will respond to the prompts in your notebook.
9. **Other Items:** This section includes any other items your teacher gives you or other ideas or questions you may have.

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MODULE LAUNCH

Explain to students the following ideas: Humans make use of buildings daily, usually without giving any thought to the work and ingenuity that created them, and they tend to take the structural integrity of buildings for granted. There also seems to be some status that comes with the building of tall towers, and it is speculated that the attack was made on the World Trade Center Twin Towers because they represented a powerful center in the United States. Post the following thought-provoking statement to engage students in purposeful exploration of the topic: Having the best technologies, such as the tallest building in the world, makes a country powerful. Have students discuss their positions on this statement, the extent to which they agree or disagree, and why. Compile their ideas on the board or in a computer document.

PREREQUISITE SKILLS FOR THE MODULE

Students enter this module with a wide range of preexisting skills, information, and knowledge. Table 3.1 (p. 28) provides an overview of prerequisite skills and knowledge that students are expected to apply in this module, along with examples of how they apply this knowledge throughout the module. Differentiation strategies are also provided for students who may need additional support in acquiring or applying this knowledge.

Table 3.1. Prerequisite Key Knowledge and Examples of Applications and Differentiation Strategies

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Knowledge
Chemical bonding and inorganic chemical reactions	Understand how atoms bond and what inorganic chemicals will react and in what way to be able to understand the composition of concrete and cement.	Review chemical bonding: *www.pbslearningmedia.org/resource/lsps07.sci.phys.matter.chembonds/chemical-bonds* Review chemical reactions: *www.chemtutor.com/react.htm*
Mathematical functions	Understand the role of variables in a function to be able to understand the loads (forces) in constructing static objects.	Review the role of mathematical functions: *www.mathsisfun.com/sets/function.html*
Basic geometry	Understand definitions for and be able to identify a line, plane, and angle so that they can interpret the geometry of tall towers.	Review concepts regarding lines, planes, and angles: *www.virtualnerd.com/pre-algebra/geometry/points-lines-planes-angles*
Molecular structure	Understand how molecules are structured and the macro properties that are a result of this structure. (Different carbon structures such as graphite and diamond are good examples of how the same elements can be arranged differently to produce different properties of the substance.)	Review the shapes of molecules and ions: *www.chembio.uoguelph.ca/educmat/chm19104/shapes_of_molecules_and_ions.htm*

POTENTIAL STEM MISCONCEPTIONS

Students enter the classroom with a wide variety of prior knowledge and ideas, so it is important to be alert to misconceptions, or inappropriate understandings of foundational knowledge. These misconceptions can be classified as one of several types: "preconceived notions," opinions based on popular beliefs or understandings; "nonscientific beliefs," knowledge students have gained about science from sources outside the scientific community; "conceptual misunderstandings," incorrect conceptual models based on incomplete understanding of concepts; "vernacular misconceptions," misunderstandings of words based on their common use versus their scientific use; and "factual misconceptions," incorrect or imprecise knowledge learned in early life that remains unchallenged (NRC 1997, p. 28). Misconceptions must be addressed and dismantled in order for students to reconstruct their knowledge, and therefore teachers should be prepared to take the following steps:

- *Identify students' misconceptions.*
- *Provide a forum for students to confront their misconceptions.*
- *Help students reconstruct and internalize their knowledge, based on scientific models. (NRC 1997, p. 29)*

Keeley and Harrington (2010) recommend using diagnostic tools such as probes and formative assessment to identify and confront student misconceptions and begin the process of reconstructing student knowledge. Keeley and Harrington's *Uncovering Student Ideas in Science* series contains probes targeted toward uncovering student misconceptions in a variety of areas. In particular, Volumes 1 and 2 of *Uncovering Student Ideas in Physical Science* (Keeley and Harrington 2010, 2014), about force/motion and electricity/magnetism, may be useful resources for addressing student misconceptions in this module.

Some commonly held misconceptions specific to lesson content are provided with each lesson so that you can be alert for student misunderstanding of the science concepts presented and used during this module. The American Association for the Advancement of Science has also identified misconceptions that students frequently hold regarding various science concepts (see the links at *http://assessment.aaas.org/topics*).

Students will have various types of prior knowledge about the concepts introduced in this lesson. Table 3.2 (p. 30) outlines some common misconceptions students may have concerning these concepts. Because of the breadth of students' experiences, it is not possible to anticipate every misconception that students may bring as they approach this lesson. Incorrect or inaccurate prior understanding of concepts can influence student learning in the future, however, so it is important to be alert to misconceptions such as those presented in the table.

Table 3.2. Common Misconceptions About the Concepts in This Module

Topic	Student Misconception	Explanation
Engineering design process (EDP)	Engineers use only the scientific process to solve problems in their work.	The scientific method is used to test predictions and explanations about the world. The EDP, on the other hand, is used to create a solution to a problem. In reality, engineers use both processes. (See Teacher Background Information section on p.47 for a discussion of this topic.)
Vectors	Adding the magnitude of vectors gives the resultant vector.	If vectors are located in more than one direction, they need to be translated to the *x*- and *y*-axes separately, then added and resolved into one vector.
Design and building materials	Synthetic chemicals are dangerous.	Many chemicals that are synthesized in laboratories are the same as those produced by nature.
	Vertical loads are the safest structures.	Particularly with tall tower construction, there is a bending momentum, so lateral stability is just as important as vertical stability.

SRL PROCESS COMPONENTS

Table 3.3 illustrates some of the activities in the Construction Materials module and how they align to the SRL process before, during, and after learning.

Table 3.3. SRL Process Components

Learning Process Components	Example From Construction Materials Module	Lesson Number
BEFORE LEARNING		
Motivates students	Students view videos on why there is a race to build the world's tallest tower.	Lesson 1
Evokes prior learning	While viewing the videos on the race for the tallest tower, students record any information they already know about forces.	Lesson 1
DURING LEARNING		
Focuses on important features	Students present their scientific explanations of the Twin Towers collapse for peer review.	Lesson 2
Helps students monitor their progress	Students find connections between the materials they found in Lesson 1 and the reports of the collapse of the Twin Towers.	Lesson 2
AFTER LEARNING		
Evaluates learning	Students present their ideas for innovations in a *Shark Tank* format, sharing condensed ideas in a round robin for feedback.	Lesson 3
Takes account of what worked and what did not work	Students write reflections in their STEM Research Notebooks on the peer review of their challenge presentation.	Lesson 3

STRATEGIES FOR DIFFERENTIATING INSTRUCTION WITHIN THIS MODULE

For the purposes of this curriculum module, differentiated instruction is conceptualized as a way to tailor instruction—including process, content, and product—to various student needs in your class. A number of differentiation strategies are integrated into lessons across the module. The problem- and project-based learning approach used in the lessons is designed to address students' multiple intelligences by providing a variety of entry points and methods to investigate the key concepts in the module (for example, investigating the development of tall tower technologies throughout history). Differentiation strategies for students needing support in prerequisite knowledge can be found in Table 3.1, (p. 28). You are encouraged to use information gained about student prior knowledge during introductory activities and discussions to inform your instructional differentiation. Strategies incorporated into this lesson include flexible grouping, varied environmental learning contexts, assessments, compacting, and tiered assignments and scaffolding.

Flexible Grouping. Students work collaboratively in a variety of activities throughout this module. Grouping strategies you might employ include student-led grouping, grouping students according to ability level, grouping students randomly, or grouping them so that students in each group have complementary strengths (for instance, one student might be strong in mathematics, another in art, and another in writing). You may also choose to group students based on their prior knowledge about the topics of this module. For Lesson 2, you may choose to maintain the same student groupings as in Lesson 1, since students will be adding to their knowledge based on the lists of molecular-level structures of construction materials or regroup students according to another of the strategies described here. You may therefore wish to consider grouping students in Lesson 2 into design teams on which they will remain throughout the remainder of the module.

Varied Environmental Learning Contexts. Students have the opportunity to learn in various contexts throughout the module, including alone, in groups, in quiet reading and research-oriented activities, and in active learning through inquiry and design activities. In addition, students learn in a variety of ways, including through doing inquiry activities, journaling, reading fiction and nonfiction texts, watching videos, participating in class discussion, and conducting web-based research.

Assessments. Students are assessed in a variety of ways throughout the module, including individual and collaborative formative and summative assessments. Students have the opportunity to produce work via written text, oral and media presentations, and modeling. You may choose to provide students with additional choices of media for their products (for example, PowerPoint presentations, posters, or student-created websites or blogs).

Compacting. Based on student prior knowledge you may wish to adjust instructional activities for students who exhibit prior mastery of a learning objective. For instance, if some students exhibit mastery of vectors in mathematics in Lesson 1, you may wish to limit the amount of time they spend practicing these skills and instead introduce ELA or social studies connections with associated activities.

Tiered Assignments and Scaffolding. Based on your awareness of student ability, understanding of concepts, and mastery of skills, you may wish to provide students with variations on activities by adding complexity to assignments or providing more or fewer learning supports for activities throughout the module. For instance, some students may need additional support in identifying key search words and phrases for web-based research or may benefit from cloze sentence handouts to enhance vocabulary understanding. Other students may benefit from expanded reading selections and additional reflective writing or from working with manipulatives and other visual representations of mathematical concepts. You may also work with your school librarian to compile a set of topical resources at a variety of reading levels.

STRATEGIES FOR ENGLISH LANGUAGE LEARNERS

Students who are developing proficiency in English language skills require additional supports to simultaneously learn academic content and the specialized language associated with specific content areas. WIDA has created a framework for providing support to these students and makes available rubrics and guidance on differentiating instructional materials for English language learners (ELLs) (see *www.wida.us/get.aspx?id=7*). In particular, ELL students may benefit from additional sensory supports such as images, physical modeling, and graphic representations of module content, as well as interactive support through collaborative work. This module incorporates a variety of sensory supports and offers ongoing opportunities for ELL students to work with collaboratively. The focus in this module is on high-rise buildings, particularly in Lesson 1, which explores how different cultures around the world are racing to build the tallest tower. This focus affords opportunities to access the culturally diverse experiences of ELL students in the classroom.

Teachers differentiating instruction for ELL students should carefully consider the needs of these students as they introduce and use academic language in various language domains (listening, speaking, reading, and writing) throughout this module. To adequately differentiate instruction for ELL students, teachers should have an understanding of the proficiency level of each student. The following five overarching K–12 WIDA learning standards are relevant to this module:

- Standard 1: Social and Instructional language. Focus on social behavior in group work and class discussions.
- Standard 2: The language of Language Arts. Focus on forms of print, elements of text, picture books, comprehension strategies, main ideas and details, persuasive language, creation of informational text, and editing and revision.
- Standard 3: The language of Mathematics. Focus on numbers and operations, patterns, number sense, measurement, and strategies for problem solving.
- Standard 4: The language of Science. Focus on safety practices, magnetism, energy sources, scientific process, and scientific inquiry.
- Standard 5: The language of Social Studies. Focus on change from past to present, historical events, resources, transportation, map reading, and location of objects and places.

SAFETY CONSIDERATIONS FOR THE ACTIVITIES IN THIS MODULE

For the activities in this module, all laboratory occupants must wear personal protective equipment consisting of indirectly vented chemical splash goggles, particulate respirator (face mask), nonlatex gloves, and aprons during all phases of inquiry activities (setup, hands-on investigation, and takedown). For more general safety guidelines, see the "Safety in STEM" section in Chapter 2 (p. 18).

DESIRED OUTCOMES AND MONITORING SUCCESS

The student outcomes begin with small tasks and build to create more complex thinking about construction materials. First, students get a basic understanding of the materials used in buildings and the molecular compositions of the construction materials. Then, building on this basic knowledge, students make connections to vector forces and geometry of creating tall towers. While students are learning to connect these complex ideas, they are also learning how to synthesize information and communicate the result effectively. Once students master the materials and processes of building tall towers, they investigate the symbolism of tall towers and the historical and social aspects of their influence on humans. The theme of the module now turns from constructing to the collapse of the Twin Towers and how engineers use failure to learn and create better innovations. Students investigate and evaluate the arguments of citizens who claim there was a conspiracy that led to the collapse and compare those claims with those of scientists and engineers. Armed with this knowledge, students model from past lessons learned and look at the current problems of tall towers, posing solutions through innovations in their final presentation. The desired outcomes for this module are outlined in Table 3.4, along with suggested ways to gather evidence to monitor student success. For more specific details on desired outcomes, see the Established Goals and Objectives sections for the module and individual lessons.

Table 3.4. Desired Outcomes and Evidence of Success in Achieving Identified Outcomes

Desired Outcome	Evidence of Success	
	Performance Tasks	Other Measures
Students synthesize the characteristics of the materials and the processes of building necessary for engineering tall towers.	Students use the list that they made about the materials used and investigate their molecular level structures. Students develop warrants about the principles that make an effective synthesis of complex information. Students present their ideas about how the geometry and materials work together to create buildings, using the principles of communication they agreed to the previous day.	Communication clarity is assessed on the rubrics for the products.
Students determine the major factors that caused the collapse of the World Trade Center Twin Towers	Students present their scientific explanations for the collapse of the Twin Towers for peer review.	Students interpret what it means for engineers to achieve success through failure and produce webcasts explaining their position. They each listen to two other students' webcasts and make connections among them.
Students develop innovations to address current problems caused by building and maintaining tall towers.	Student teams present their proposals for their innovations related to high-rises and conduct a peer review.	

ASSESSMENT PLAN OVERVIEW AND MAP

The assessment plan for this module can be conceptualized in three segments: how tall towers are built, the causes of the collapse of the Twin Towers, and innovations to improve current problems in tall tower construction and maintenance. Each of these segments has several formative assessments leading to a summative assessment. Some of the assessments are individual and some are group projects. The assessments have different approaches, including infographics, a round robin of condensed presentations, webcasts, peer reviews, and a formal proposal presentation. Table 3.5 (p. 36) provides an overview of the major group and individual *products* and *deliverables* that constitute the assessment for this module. See Table 3.6 (p. 36) for a full assessment map of formative and summative assessments in this module.

Table 3.5. Major Products and Deliverables in Lead Disciplines for Groups and Individuals

Lesson	Major Group Products and Deliverables	Major Individual Products and Deliverables
1	• Teams' creation of infographics explaining how high-rises have influenced society	• Presentation of ideas about how the geometry and materials work together to create buildings, using the principles of communication they agreed to the previous day
2	• Teams' evaluation of scientific arguments presented about collapse of the Twin Towers	• Presentation of scientific explanations for the collapse of the Twin towers for peer review • STEM Research Notebook prompts
3	• Teams' presentations of ideas for innovations in a round robin *Shark Tank* format • Teams' presentation of proposals for the innovation related to high-rises • Peer review	• Interpretation of what it means for engineers to achieve success through failure and production of webcasts explaining their position • Listening to two other students' webcasts and making connections among them • STEM Research Notebook prompt

Table 3.6. Assessment Map for Construction Materials Module

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
1	STEM Research Notebook *prompts*	Group/ individual	Formative	• Explain the geometry of building high-rises and tall towers. • Explain the makeup of the construction materials and how they are used to build high-rises.
1	Poster on Mathematical Connections to High-Rise Construction *rubric*	Group	Formative	• Explain the geometry of building high-rises and tall towers. • Synthesize ideas to communicate complex and connected information effectively.

Table 3.6. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
1	Graphic Organizer for Materials and Processes of Building Tall Towers *handout*	Group	Formative	• Synthesize and expand on the makeup of the construction materials and how they are used to build high-rises.
1	Problems and Limitations of High-Rises *handout*	Group	Formative	• Describe problems and limitations of high-rises. • Develop potential solutions to high-rise problems and limitations.
1	Infographic *rubric*	Group	Formative	• Analyze the impacts of high-rises throughout history on human progress. • Synthesize ideas to communicate complex and connected information effectively.
1	Peer Review *handout*	Individual	Formative	• Reflect on feedback
2	STEM Research Notebook *prompts*	Group/ individual	Summative	• Synthesize learning from multiple sources related to the collapse of the Twin Towers.
2	Technical Report *rubric*	Individual	Summative	• Explain the major science and engineering principles associated with the collapse of the Twin Towers. • Interpret the idea of success through failure.
2	Evaluating a Debate *scoring sheet*	Group/ individual	Summative	• Describe the scientific arguments and the arguments posed by those who believe the Twin Towers were brought down by controlled demolition and explain which have more credible evidence. • Organize materials for presentation to minimize redundancy and hit all key points. • Use appropriate evidence to support argument. • Present logical argument addressing strengths of their position and weaknesses of opposing side. • Pose and respond to questions effectively. • Communicate clearly and respectfully while presenting argument.

Table 3.6. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
2	Graphic Organizer for Assessing Student Prior Knowledge *handout*	Individual	Formative	• Explain the major science and engineering principles associated with the collapse of the Twin Towers.
2	*Shark Tank rubric*	Group	Summative	• Effectively communicate ideas for innovations for high-rises.
3	STEM Research Notebook *prompts*	Group/ individual	Formative	• Document use of engineering design process to solve a STEM problem and accomplish a complex task.
3	Proposal Presentation *rubric*	Group	Summative	• Propose a new technology to address a current problem, either engineering or social, with building high-rises. • Support ideas with reliable evidence. • Conduct risk-benefit analysis for product using appropriate variables. • Communicate proposal effectively.
3	Graphic Organizer for Reflection on Learning Strategies Used in Module *handout*	Individual	Formative	• Understand which learning strategies are effective and ineffective for student.

MODULE TIMELINE

The module can be described as three segments of work: (1) research about the cultural value and structural designs of tall towers, (2) investigations involving factors of the collapse of the World Trade Center Twin Towers to inform ideas for innovations, and (3) development and communication of ideas for new or improved building materials or methods that could be used for construction and safety of future high-rise buildings in U.S. cities. Tables 3.7–3.11 (pp. 39–41) provide timelines for each week of the module.

Table 3.7. STEM Road Map Module Schedule for Week One

Day 1	Day 2	Day 3	Day 4	Day 5
Lesson 1 *The Race for Tall Towers* • Launch the module by having students begin to explore what they already know about high-rises, geometry of construction, influences of high-rises on society, and synthesizing complex ideas.	*Lesson 1* *The Race for Tall Towers* • Students conduct an internet search to investigate materials needed to construct a high-rise and watch videos about how high-rises are constructed.	*Lesson 1* *The Race for Tall Towers* • Students investigate the molecular-level structures of the materials on the list they made. • Students investigate the geometry and mathematical models involved in building a tall tower.	*Lesson 1* *The Race for Tall Towers* • Students present posters with their ideas about how the geometry and materials work together to create buildings.	*Lesson 1* *The Race for Tall Towers* • Students investigate the societal influences of high-rises. • Student teams create an infographic explaining how high-rises have influenced society.

Table 3.8. STEM Road Map Module Schedule for Week Two

Day 6	Day 7	Day 8	Day 9	Day 10
Lesson 1 *The Race for Tall Towers* • Teams continue to work on their infographic explaining how high-rises have influenced society. • Then, students do a gallery walk of the completed infographics.	*Lesson 2* *Success Through Failure* • Students consider the symbolism in the attacks on the World Trade Center Twin Towers in New York. • Students investigate the science behind the collapse of the towers from reliable resources.	*Lesson 2* *Success Through Failure* • Continue investigation of the science behind the collapse of the towers. • Students present their scientific explanations of the collapse of the towers for peer review.	*Lesson 2* *Success Through Failure* • Students look for connections between the materials they listed at the beginning of the module and what they found from reliable resources. • Students identify mathematical models and force vectors used to explain phenomena about the collapse of the towers.	*Lesson 2* *Success Through Failure* • Students find examples of engineering mishaps that led to new innovations. • Students interpret what it means for engineers to achieve success through failure and produce webcasts explaining their position.

Table 3.9. STEM Road Map Module Schedule for Week Three

Day 11	Day 12	Day 13	Day 14	Day 15
Lesson 2 *Success Through Failure* • Students investigate and analyze the arguments of those who believe the Twin Towers were brought down by controlled demolition and compare them with arguments from reliable sources.	*Lesson 2* *Success Through Failure* • Continue analysis of the arguments made by both sides. • Then, student teams present a side-by-side analysis.	*Lesson 2* *Success Through Failure* • Students participate in a debate focusing on resolving this question: What were the major problems that caused the materials failure and ultimate collapse of the Twin Towers?	*Lesson 2* *Success Through Failure* • Students conduct research to find potential solutions for the problems identified in the debate.	*Lesson 2* *Success Through Failure* • Student teams present their ideas for innovations in a round robin *Shark Tank* format, sharing condensed presentations for feedback.

Table 3.10. STEM Road Map Module Schedule for Week Four

Day 16	Day 17	Day 18	Day 19	Day 20
Lesson 3 *New Technologies for High-Rise Buildings* • Launch the challenge. Student teams develop a proposal for new or improved building materials or methods that could be used for future high-rise buildings in U.S. cities.	*Lesson 3* *New Technologies for High-Rise Buildings* • Students research a current problem with high-rises and investigate possible solutions for presentations.	*Lesson 3* *New Technologies for High-Rise Buildings* • Students continue to research a current problem with high-rises and investigate possible solutions.	*Lesson 3* *New Technologies for High-Rise Buildings* • Students consider social implications of their technology and incorporate these into their presentations.	*Lesson 3* *New Technologies for High-Rise Buildings* • Students conduct risk-benefit analyses for their innovations and incorporate their analyses into the presentation.

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Table 3.11. STEM Road Map Module Schedule for Week Five

Day 21	Day 22	Day 23	Day 24	Day 25
Lesson 3 *New Technologies for High-Rise Buildings* • Students use communication best practices for proposal presentation learned in class to prepare proposals.	*Lesson 3* *New Technologies for High-Rise Buildings* • Students finalize presentations of proposals.	*Lesson 3* *New Technologies for High-Rise Buildings* • Student teams present their proposals for the innovation related to high-rises and conduct peer reviews.	*Lesson 3* *New Technologies for High-Rise Buildings* • Student teams continue to present their proposals and conduct peer reviews.	*Lesson 3* *New Technologies for High-Rise Buildings* • Student teams continue to present their proposals and conduct peer reviews. • Students write a brief reflection on the knowledge they gained in this module.

RESOURCES

Teachers have the option to coteach portions of this module and may want to combine classes for activities such as mathematical modeling, geometric investigations, discussing social influences, or conducting research. The media specialist can help teachers locate resources for students to view and read about construction materials, high-rises, examples of engineering mishaps, and the collapse of the Twin Towers. Special educators and reading specialists can help find supplemental sources for students needing extra support in reading and writing. Additional resources may be found online. Community resources for this module may include guest speakers on construction materials or high-rises, such as general contractors, masonry experts, small business owners, engineers, and architects. *The Team Handbook* (2003), by Peter R. Scholtes, Brian L. Joiner, and Barbara J. Streibel, is a good resource to learn more about the use of teaming in the classroom.

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