This course supports the assessments for Applications of Science, Technology, and Society. The course covers 9 competencies and represents 3 competency units.

Introduction

This course prepares you to take the Fundamentals of Science, Technology, and Society objective assessment (exam). This same course prepares you to master the performance assessment (tasks) in the related assessment Applications of Science, Technology, and Society. Please study carefully through this course before taking the exam. If you have previously completed the performance assessment, you should have already completed the required study activities found in this course. In such a case, it is recommended that you review this course, but you are not required to repeat these activities.

Overview
This course engages current and future educators in the study of the nature, processes, and applications of science and technology. Inquiry-based and engineering design models can be applied to effectively guide your students to solve open-ended problems and use science to make well-informed decisions.

Scientific inquiry starts with a question and leads to increased general understanding; engineering design starts with a problem and leads to a solution.

Science is both a body of knowledge and a process for growing that knowledge. Science evolves and refines its models of physical reality and scientific phenomena under a set of guidelines and rules of testable scientific theories. Understanding the rules and limitations of science is a necessary ingredient when teaching science, especially in its application to technology.

The engineering process works along with the scientific process, explicitly seeking to apply scientific knowledge to solve problems for society. Helping students make that connection from science to engineering is another necessary component of successful science teaching.

This course for current and prospective science teachers arms you with the knowledge and skills to explain important aspects of science and their application and use in technology. You will study the historical evolution of scientific inquiry as well as how science and engineering are being used to inform decision making on current issues and solve societal problems.

This course will cover the following general information:

- the importance and proper use of observations and experimentation
- the nature, processes, and applications of science and technology
- the processes, creativity, and critical thinking skills needed for engineering
- historical and contemporary perspectives on science and technology
- knowledge, skills, and dispositions needed to analyze socio-scientific issues
- the use of inquiry, engineering, research, and investigation to solve open-ended

problems
- how to design, conduct, report, and evaluate investigations in science and engineering
- mathematics and technology necessary to process and report data from research

Watch the following video for an introduction to this course:

Note: To download this video, right-click the following link and choose "Save as...": download video.

Competencies
This course provides guidance to help you demonstrate the following 9 competencies:

- Competency 663.1.1: Common Themes in Science
  The graduate analyzes the relationships among themes that appear across multiple scientific ideas.
- Competency 663.1.2 : Nature of Science
  The graduate analyzes the nature of science, including how science distinguishes itself from other ways of knowing.
- Competency 663.1.3: Historical Development of Science
  The graduate analyzes the historical development of science, including how scientific knowledge evolves.
- Competency 663.1.4: Interrelationship of Science, Technology and Society
  The graduate analyzes the various ways in which science, technology, and society are interrelated.
- Competency 663.1.5: Analyzing Issues and Making Decisions
  The graduate analyzes socially relevant scientific issues to make informed decisions based on data and context.
- Competency 663.1.6: Investigations in Science
  The graduate analyzes the principles, processes, and assumptions of investigations in science to engage students in the nature of inquiry.
- Competency 663.1.7: Improving Investigations and Communication
  The graduate uses technology tools and mathematics to improve investigations and the communication of results.
- Competency 663.1.8: Hypotheses and Scientific Investigations
  The graduate formulates testable hypotheses for scientific investigations.
- Competency 663.1.9: Carrying Out Investigations in Science
  The graduate conducts investigations in science to solve open-ended problems using appropriate scientific methods.

Teaching Dispositions Statement
Please review the Statement of Teaching Dispositions.

You will complete the following assessments as you work through the course of study.

Course Instructor Assistance

As you prepare to successfully demonstrate competency in this subject, remember that course instructors stand ready to help you reach your educational goals. As subject matter experts, mentors enjoy and take pride in helping students become reflective learners, problem solvers, and critical thinkers. Course instructors are excited to hear from you and eager to work with you.

Successful students report that working with a course instructor is the key to their success. Course instructors are able to share tips on approaches, tools, and skills that can help you apply the content you're studying. They also provide guidance in assessment preparation strategies and troubleshoot areas of deficiency. Even if things don’t work out on your first try, course instructors act as a support system to guide you through the revision process. You should expect to work with course instructors for the duration of your coursework, so you are welcome to contact them as soon as you begin. Course instructors are fully committed to your success!

Preparing for Success

The information in this section is provided to detail the resources available for you to use as you complete this course.

Learning Resources

The learning resources listed in this section are required to complete the activities in this course. For many resources, WGU has provided automatic access through the course. However, you may need to manually enroll in or independently acquire other resources. Read the full instructions provided to ensure that you have access to all of your resources in a timely manner.

Automatically Enrolled Learning Resources

You will be automatically enrolled at the activity level for the following learning resources. Simply click on the links provided in the activities to access the learning materials.

Open Access E-Text

The following textbook is available to you as an e-text within this course of study. You will be directly linked to the specific readings required within the activities that follow. NOTE: The online e-reader for this text may not be optimal on your browser, but you will have the option to download a free PDF copy of the text from the linked website for your convenience.

- Committee on Conceptual Framework for the New K-12 Science Education Standards. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, D.C.: National Academies Press. ISBN: 9780309217422

Note: These e-texts are available to you as part of your program tuition and fees, but you may purchase hard copies at your own expense through a retailer of your choice. If you choose to do so, please use the ISBN listed to ensure that you receive the correct edition.

STEM: Student Research Handbook

This resource is written with science pedagogy in mind, but also covers the essential topics of defining what science is and how it is used, analyzed, and communicated. It does this by guiding you through the process of carrying out scientific investigations with the same rigor and under the same rules and guidelines used by the science community. It teaches the process of a student or group of students stepping through a STEM research project. This includes defining research, topic ideas, design, vocabulary, background research, hypothesis writing, proposal writing, note taking, descriptive measures, graphical representation, interpreting data, documentation, writing a paper, and presentation.

You be given access to a PDF copy of the following text in the activities that follow. You may wish to save the document to your computer to save time on repeated downloads.

- Harland, D.J. (2011). *STEM: Student research handbook*. Arlington: NSTA Press. ISBN: 9781936137244

Note: The resources you are using to master the competencies for this assessment will also be valuable as you as you prepare for future assessments and as you develop lesson plans to be used in your classroom in the future. Therefore, it is highly recommend that you complete each activity contained in this document.

Watch this short video about how to access and use the learning resources embedded in this course of study:

Other Learning Resources

You will use the following learning resources for this course of study.

Understanding Science: How Science Really Works
This online resource contains eight separate chapters with detailed subtopics. It has a concise yet extensive coverage of the content. Links to the required chapters will be provided at the activity level.

You can access this resource using the following link, and in the activities that follow:

- Understanding Science: How Science Really Works

The Principal Elements of the Nature of Science: Dispelling the Myths
This resource is a collection of "what science is" myth busters. It is done within the framework of both how science really works as well as how it doesn't. The brief resource covers a wide spectrum of topics.

You can access this resource using the following link, and in the activities that follow:

- The Principal Elements of the Nature of Science: Dispelling the Myths

Earth System Science Modules
This resource is a collection of Earth System Science modules. Each module includes

background information on the topic, hypotheses to be explored, findings so far, and additional resources. This builds an understanding of science in action by investigating through a real-life science project. There are also sample investigations that you can use for science projects in your classroom. These projects include science content standards that are helpful in guiding you to age-appropriate projects and coverage in your own school curriculum.

You can access this resource using the following link, and in the activities that follow:

- Earth System Science Modules by Title

The following Learning Resource Navigation video will show you how to access the learning resources embedded in this Course of Study.

Note: To download this video, right-click the following link and choose "Save as...": download video.

Pacing Guide

The pacing guide suggests a weekly structure to pace your completion of learning activities. It is provided as a suggestion and does not represent a mandatory schedule. Follow the pacing guide carefully to complete the course in the suggested timeframe.

- Pacing Guide: Applications of Science, Technology, and Society

Note: This pacing guide does not replace the course. Please continue to refer to the course for a comprehensive list of the resources and activities

Additional Preparation

There are many different learning tools available to you within your course of study in addition to the learning resources already discussed. Take the time to familiarize yourself with them and determine how best to fit them into your learning process.

Message Boards, FAQs, Note-Taking Tool

Message boards, FAQs, and a note-taking tool are available in every course of study.

Use the "Additional Learning Tools" page to review these tools.

Other Preparations

Graphing Calculator

Acquire a graphing calculator and familiarize yourself with how to use it. Refer to the WGU Calculator and Scratch Paper Guidelines document for calculators permitted on WGU exams. If you are in a secondary mathematics program, refer to the WGU Calculator Recommendations for Secondary Math and Science Programs document for calculator suggestions for your degree program.

Nature of Science

There is a big difference between knowing isolated facts and understanding concepts. Much of scientific knowledge is in understanding the mechanism of how something works. Science can often explain the processes of natural phenomena and predict what is expected to happen, but sometimes the underlying reasons or mechanisms are not so easy to explain.

Nature of Scientific Knowledge

This section provides a broad foundation for understanding scientific knowledge and inquiry. It includes the language, tools, and processes commonly accepted to establish and advance the body of scientific knowledge.

This topic highlights the following key concepts:

- appropriate descriptions of scientific terms and concepts
- the ongoing nature of science
- the importance of testing ideas in science
- characteristics of scientific knowledge
- science, non-science, and poor science
- determining if a question can be answered by science
- reasonable definition of science

Journal Keeping As a Learning Aid

The growth of scientific knowledge depends on detailed recording of observations. In scientific investigations, the recording is often kept in laboratory notebooks. For this course, you will modify the concept of a laboratory notebook and keep an organized journal. The journal may include

- a record of your progress through the course,
- the activities and projects that you do to enhance learning,
- your reactions or reflections on the activities, and
- information or notes on topics that you want to remember and refer back to for the course assessments or your future teaching activities.

Your journal may be a paper notebook or electronic file. Just keep it handy to record as you learn.

Create your journal or notebook for this course. The following web page may be helpful to get you started:

- Keeping a Research Journal

Nature of Science Introduction and Vocabulary

Read the following chapter in *Understanding Science: How Science Really Works*:

- chapter I ("Understanding Science 101: An Overview")

Click some of the highlighted text terms and review the pop-up glossary definitions.

Record in your journal any terms whose definitions were different than you expected.

Nature of Science Foundation

Read the following chapter in *Understanding Science: How Science Really Works*:

- chapter II ("What is Science?")

As you read, keep in mind the following science concepts. Record thoughts in your journal as needed.

- Terms and Concepts: Understanding the meaning of scientific terms will help in using them appropriately in the proper context. For example, what is the difference between a theory and a law, and what are the limitations of each?
- Testing Ideas: Science is not limited to just testing a hypothesis (a prediction). Not all scientific ideas are formulated or tested this way. There are several different routes for scientific knowledge to be accumulated.
- Science, Non-Science, and Poor Science: Science involves induction from empirical observation. Science has no place in such subjects as religion. Poor science occurs where explanations are off-base, such as the earth-centric planetary system.
- Determining What Science Can and Cannot Answer: Is there a God? What new energy sources are the best candidates for future development? These are just a couple of examples of what science cannot answer. Others are not so easy to distinguish.
- Examples of What Science Is and Isn’t: Science is not the answer to many social issues. It may be able to determine an efficient and safe method of storing nuclear waste, for example, but science cannot determine if nuclear energy is the right thing for society.

Using Learning Resources Effectively

Recall the chapters that you read previously in Understanding Science: How Science Really Works.

Follow several of the sidebar links in chapter II ("What is Science?").

Record in your notebook the details of this search. Do not record the content that you learned, just the process and your thoughts. You might include answers to the following questions:

- Why did you select certain paths?
- What was your process in the search (e.g., did you follow all links on the page, or delve deeper into certain topics)?
- Did your search lead you to sites beyond the original website?
- Did the links lead you to different modes of understanding the information (e.g., videos, examples, etc.)?
- Which path categories were more helpful than others (e.g., Snapshot, Misconceptions, Take a Side Trip, Science in Action, etc.)?
- Do these types of searches enhance your understanding of the topics, or are they a distraction from the main content?

Myths About the Scientific Process

Read the following sections in "*The Principal Elements of the Nature of Science: Dispelling the Myths*":

- Introduction
- Myth 1: Hypotheses Become Theories That In Turn Become Laws
- Myth 3: A Hypothesis is an Educated Guess

Access Understanding Science: How Science Really Works. Select the tab "For Teachers" and the sidebar link "Correcting misconceptions."

Read the explanation for the following item:

- "If evidence supports a hypothesis, it is upgraded to a theory. If the theory then garners even more support, it may be upgraded to a law."

Compare the clarifications of "hypothesis," "theory," and "law" in the following two resources:

- Myth 1 and Myth 3 in "The Principal Elements of the Nature of Science: Dispelling the Myths"
- Misconception: If evidence supports a hypothesis, it is upgraded to a theory. If the theory then garners even more support, it may be upgraded to a law.

Reflect on these two explanations and record your thoughts in your journal. Consider the following questions:

- Which explanation was easier to understand?
- Do the different explanations enhance your understanding of this concept?
- How will these explanations affect the way you will use the terms "hypothesis," "theory," and "law?"

Nature of Science Integration Activity

What topics can and what topics cannot be investigated scientifically? In your journal, write a very brief explanation about how science is related to each of the following topics:

- power of prayer
- effectiveness of a new drug
- whether society should ban genetically modified food
- life after death
- the placebo effect
- the best genre of music
- the size of the universe

Compare your thoughts with the following document:

- Nature of Science Integration Activity Answers

Science as a Humanistic and Social Endeavor

All scientific knowledge begins with careful observations of natural phenomena and detailed records, then expands through sharing clear communication. All of this is affected by cultural views and expectations. The collaboration with people from different academic fields as well as different cultural backgrounds can help refine and advance scientific understanding.

This topic highlights the following key concepts:

- social aspects of working in science
- diverse and global science community
- ethical tradition in science
- the different types of people and groups that conduct scientific work
- the role of legitimate skepticism in scientific inquiry
- the relationships among key human qualities that lead to scientific discoveries
- how scientists are influenced by societal, cultural, and personal beliefs
- how communication among scientists helps advance a specific science theory

Science As a Humanistic and Social Endeavor

Read the following chapter in *Understanding Science: How Science Really Works*:

- chapter V ("The Social Side of Science: A Human and Community Endeavor")

As you read, keep in mind the following science concepts. Record thoughts in your journal as needed.

- Important Social Aspects of Science: One important aspect of scientific discovery is its impact on society. For example, scientists may wish to un-invent a weapon. While a weapon may be a controversial subject, scientific advances in medicine and creature comforts also create unexpected consequences to society.
- Ethical Traditions in Science: Truth in science is important, as human lives and well-being are often at stake. Consider why ethical traditions have evolved and continue to evolve as new issues arrive hand in hand with new scientific discoveries.
- Healthy Skepticism, Checks, and Balances: Because of the possible falsification of scientific knowledge, checks and balances are appropriately and sometimes inappropriately applied. Healthy skepticism should be encouraged, even though it may rattle a few dearly held paradigms. For those curious about how far this can go, see the Eotvos Experiment article.

Working Alone Is Not How Science Is Done

Read the following sections in "The Principal Elements of the Nature of Science: Dispelling the Myths":

- Myth 9: Scientists Are Particularly Objective
- Myth 15: Science Is a Solitary Pursuit

Revisit and possibly revise your previous responses in your journal to the following two items from the previous activity:

- Important Social Aspects of Science: One important aspect of scientific discovery is its impact on society. For example, scientists may wish to un-invent a weapon. While a weapon may be a controversial subject, scientific advances in medicine and creature comforts also create unexpected consequences to society.
- Ethical Traditions in Science: Truth in science is important, as human lives and well-being are often at stake. Consider why ethical traditions have evolved and continue to evolve as new issues arrive hand in hand with new scientific discoveries.

The Scientific Method Is Not All There Is to Science

Read the following chapter in *Understanding Science: How Science Really Works*:

- chapter III ("How Science Works")

Look in your journal at how you previously responded to the following reflection prompt:

- Healthy Skepticism, Checks, and Balances: Because of the possible falsification of scientific knowledge, checks and balances are appropriately and sometimes inappropriately applied. Healthy skepticism should be encouraged, even though it may rattle a few dearly held paradigms. For those curious about how far this can go, examine the Eotvos Experiment article.

Record another situation where further scientific research has upset or overturned a previously believed paradigm.

Science As a Humanistic Endeavor Integration Activity

Scientific growth is not a smooth, continuous process. Do you think the early pioneers of the automobile would have anticipated the impact on society, both good and bad?

What social impacts do you think would come from the following new discoveries? List a few ideas for each, and be creative.

- making cold fusion work
- the ability to change climate
- a cure for cancer
- selecting the characteristics of your offspring

Note: Check out the "Take a Side Trip" links throughout chapters III and V of Understanding Science: How Science Really Works.

Compare your thoughts with the following document:

- Science as a Humanistic Endeavor Integration Activity Answers

Common Themes in Science

As a science teacher, you need more than a firm understanding of subject matter. You will also need knowledge of how students learn, and a wide spectrum of approaches and activities to stimulate that learning.

This topic illustrates how some of the foundation concepts and common themes of science relate to each other and how they can be taught in innovative ways.

Common Themes in Science

This section will help you consider how to bridge the gap between learning science content to considering the “big picture” and the interrelationships of fields and practices of science. You will also consider how to help your future students gain an appreciation for and a comprehensive and useful knowledge of science.

This topic highlights the following key concepts:

- common themes in science and technology
- experiments do not prove cause-and-effect relationships
- observation and measurement, and their fundamental role in science
- feedback mechanisms
- conserved quantities
- structure, function, and observed patterns
- accurate vs. precise measurements

The Framework of K?12 Science Education Document

Read the following sections in *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*:

- Summary
- chapter 3 ("Dimension 1: Scientific and Engineering Practices")

Highlight in the text, or copy to your journal, concepts and text that are key points or summary statements. This will help you relocate that information when you complete the subsequent activities.

Consider the following questions:

- Look at the topics in the course. How do you think these topics reflect the principles proposed in *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*?
- How does the phrase "engineering practices" have a different meaning in *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* from the word "technology" in this course?

Translating the Framework Concepts to Classroom Practices

Recall your reading and the main concepts of chapter 3 ("Dimension 1: Scientific and Engineering Practices") in *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*.

Think carefully about the following topics, both their content as well as ways they may be taught for firm understanding.

How would you explain the following concepts to a 6th or 7th grade student?

- Cause and Effect: Scientific explanations are often about a relationship between variables, or, in other words, recognizing examples of cause and effect. Flipping a switch and the light coming on is not a scientific explanation of cause and effect. A scientific explanation must include electrical circuits, the flow of electricity, the heating of a filament wire, among other elements.
- Experiments: While an experiment may illustrate a cause-and-effect relationship, it does not necessarily prove a specific cause-and-effect relationship. Previous scholars thought that heavier objects fell faster due to gravity, which is not a surprising explanation if the experiment compared the fall rates of a rock and a feather. The explanation of cause and effect needed to be investigated further, expanding the knowledge of falling bodies, before a more reasonable explanation could be deduced.

Common Themes in Science

Read the following chapter in *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*:

- chapter 4 ("Dimension 2: Crosscutting Concepts")

Read the following section in *Understanding Science: How Science Really Works*:

- Frequently Asked Questions About How Science Works

Think carefully about the following topics, both their content as well as ways they may be taught for firm understanding.

Choose one of the following topics and explain how it could be taught differently in 1st grade, 4th grade, 7th grade, high school Biology, and high school Geology.

- Patterns in Investigations: How do scientists use patterns to direct their investigations? A new piece of scientific knowledge rarely, if ever, results from a single investigation. It is usually the result of many investigations spanning a large time period and carried out by several different investigating teams. In engineering, the data from patterns of product failures are used to instigate design improvements.
- Measurements: Scale is an important concept in science and technology, especially in measuring things like the width of an atom versus the width of a galaxy. Accuracy and precision of measurements are factors when evaluating data.
- Limitations of Science: Science uses models to simplify the understanding of behaviors

of certain phenomena. A model may only use data obtained over a limited time frame. What are the limitations of such models? Why should you question the use of a model that extrapolates a prediction of events from limited data?

Cause/Effect/Experimentation Integration Activity

Recall your reading of chapters 3 and 4 in *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*.

Which of the following scenarios are good scientific explanations of the specified cause and effect? Categorize them as good science, non-science, or poor science, and explain why you chose each category.

- Flip a switch and the light comes on: You have paid your utility bill, so the power is still on.
- A car coming towards you makes a higher-pitched noise than a car going away from you: Sound waves are compressed; therefore, they have a higher frequency and higher pitch as the car comes towards you, and they are stretched and have a lower frequency and lower pitch as the car moves away.
- The speed of light from a distant star is the same when the earth moves towards the star as when it moves away from the star: The speed of light is measured relative to the stationary space and not a moving object.
- Both your parents have brown eyes, but your eyes are blue: Both parents have one blue and one brown gene; brown is dominant, and you inherited one blue gene from each parent.
- Noble gases rarely react with other elements: Oxygen is the only gas that readily reacts with other elements.

Compare your thoughts with the following document:

- Cause/ Effect/Experimentation Integration Activity Answers

Historical Development of Science

Some scientific advancements cause major shifts in the way people think and behave. These advancements and understandings also have impacts that ripple through society, and sometimes whole new branches of investigation are invented. The importance of these advancements can only be determined in a historical perspective.

Historical Development of Science

People all over the world have made careful observations of cause-and-effect relationships. Now that communication is easy, scientific knowledge can be shared and enhanced from many different academic fields and cultural perspectives.

One example of how science evolves is the scientific understanding of gravity. Newton’s model of gravity as a force and Newton’s Laws of Motion are more than adequate at predicting the behavior of moving bodies at low velocity. But at higher velocities, a more inclusive, relativistic theory is needed to model gravity as a curvature of space. The relativistic correction of the orbiting GPS satellites is an example of an application of further refinement of this scientific knowledge.

This topic highlights the following key concepts:

- iterative nature of science
- historical development of important scientific theories

Historical Development of Science

Review the following chapter in *Understanding Science: How Science Really Works*:

- chapter III ("How Science Works") (21pp.)

Follow links within the text or from the right-hand side bar to find information about the following topics. In your journal, write brief synopses of what you find.

- Important Advances in Science Impacting Society: Health and medicine, transportation, communication, etc; what discoveries have changed society into what it is today?
- Science Contributions from Diverse Cultures: Match scientists and their contributions from Marconi to Einstein, Eratosthenes to Galileo, and others that you learn about.
- Historical Development of Scientific Theories: What are some significant leaps in science's understanding of the solar system, the universe, atomic structure, medicine, chemistry, evolution, etc., as it has evolved over many centuries?

What Science Has Done for You Lately

Read the following chapter in *Understanding Science: How Science Really Works*:

- chapter VII ("What has Science Done for You Lately?") (7 pp.)

Choose one of the topics detailed in this chapter, or another of your choice, and draw a concept map of the significant developments in this scientific field. You might include the following elements:

- a timeline
- important researchers
- false paths (beliefs that were later disproven or significantly revised)
- significant side branches that developed in this field

Note: For information on concept maps, review the "Concept Map" web page.

Search the Internet for recent publications about the status of research or knowledge in this field. You may consider some of the following sources:

- science magazines written for the consumer (e.g., *Science Magazine*, *Discover Magazine*, *National Geographic*, *Smithsonian Magazine*)
- government or research agencies who publish for general consumer information

(e.g., NASA, NOAA, PBS Nova, Centers for Disease Control, Nobel Foundation)
- research journals that publish peer-reviewed articles of current research (e.g., The Public Library of Science where all articles are free, The Proceedings of the National Academy of Sciences where articles more than six months old are available for free, The Directory of Open Access Journals where you can find free journals on many different topics)

Compare how these different types of sources write about the topic.
Historical Development of Science Integration Activity

Read the following article:

- Modern Science: What's Changing?

List as many events as you can that have altered the understanding of the universe, starting with the flat earth hypothesis.

What technologies are currently changing scientific understanding?

Compare your thoughts with the following document:

- Historical Development of Science Integration Activity Answers

Interrelationship of Science, Technology, and Society

Technology strives to use science appropriately to help solve societal issues. Science can aid technological advancement, but it cannot determine solutions to many of the social issues these advancements may create.

Scientific observations are influenced by cultural expectations. This may include views on what is acceptable to investigate, explanations that may contradict cultural beliefs, or ideas about how new technologies should be used in society. The interrelationships are a continuous source of tension as science, technology, and society evolve.

Interrelationship of Science, Technology, and Society

Science enhances understanding to create technologies that change society. Society pushes technology to provide solutions, which in turn creates more problems. Technology provides new ways to explore for scientific knowledge. In this topic, you will examine some of these interrelationships and how each of these segments function.

This topic highlights the following key concepts:

- science in society
- applications of science to health, safety, and the environment
- characteristics of science and technology, and their relationship

Interrelationships of Science, Technology, and Society

Read the following chapter in *Understanding Science: How Science Really Works*:

- chapter VI ("Science and Society") (5 pp.)

Read the following chapters in *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*:

- Summary
- chapter 6 ("Dimension 3: Disciplinary Core Ideas—Life Sciences")
- chapter 7 ("Dimension 3: Disciplinary Core Ideas—Earth and Space Sciences")

Make a two-column table to compare and contrast how science and technology address their common characteristics. For example, you might include how they approach the following issues differently:

- seeking knowledge
- testing hypotheses
- accumulating data
- interpreting results
- drawing conclusions
- distributing or using their end results
- any other characteristics you find in your search

Science Advancing Technology and Technology Advancing Science

Consider the readings and notes you completed for chapters VI and VII of *Understanding Science: How Science Really Works*. Think about the role of science in society. Is it to advance human knowledge of the world and the surrounding universe, or is it to advance technology to improve the human condition?

Reflect upon the effects of space exploration on science, technology, and society. Answer the following questions:

- Were there societal pressures to pursue or stop space exploration?
- What scientific knowledge was needed to advance the exploration?
- What technology had to be built?
- Was new science knowledge needed to create the technologies?
- How were the new knowledge and technologies used by society in different ways than their original purpose?

Interrelationship of Science and Technology Integration Activity

Identify a technological application of the following scientific discoveries:

- the photoelectric effect
- relativity
- fission
- silicon

- DNA
- thermal expansion
- carbon 14

Compare your thoughts with the following document:

- Interrelationship of Science and Technology Integration Activity Answers

Analyzing Issues and Making Decisions

Communication technologies make science knowledge available to more people. This knowledge is accessed and relied upon when making policy decisions and directing actions of nations, states, communities, companies, families, and individuals.

This section covers how to search for reliable and relevant sources and apply what you learn to a decision or action. It will help you evaluate the quality of information and make judgments when sources disagree. You will also consider how to instill these thoughtful behaviors in students.

Analysis of Socio-Scientific Issues

Problems and events far from you can affect your life, even if you are not aware of it. Because many people may be affected, these far-reaching consequences must be considered when scientific knowledge or technologies are put into action. In this topic, you will research and evaluate some of the many interlocking impacts of world events.

This topic highlights the following key concepts:

- social issues in various fields of science study
- complexity of solutions to said social issues

Analysis of Socio-Scientific Issues

Read the following chapters in *Understanding Science: How Science Really Works*:

- chapter IV ("The Core of Science: Relating Evidence and Ideas") (5 pp.)
- chapter VI (Science and Society") (5 pp.)

Review your notes in your journal or the pages and sidebar links in these chapters. Write an analysis of the social issues related to science and technology regarding medical research. Consider the following issues:

- Prioritizing funding research versus hospice care for patients with a terminal illness. On the one hand, the search for a cure would benefit a lot of potential future suffers. But, accepting that funds are limited, should this be at the expense of those who currently have the disease?
- How are decisions made about which diseases to research?
- What about safety of the patients who will be used the research?
- What about humane treatment of animals used in research?

Complexity of Socio-Scientific Issues

Read "Inquiry Strategies to Use in Your Classroom" for an overview of a problem-based learning approach to inquiry-based learning.

Choose one of the following modules from the Earth Systems Science site that interests you. Note: these resources are freely available to teachers and can form valuable assets in building inquiry-based lessons. Read the web page, and think carefully about the complexity of the issues involved:

- "Gulf of Mexico Dead Zone"
- "California Wildfires"
- "Global Climate Change"

As you read your chosen scenario, think carefully about the complexity of the issues involved.

Most social issues for which science is asked to provide data or guidance are extremely complex. Usually this is because of social, economic, and political considerations. For example, the fuel crisis and the search for more fuel efficient transportation is rife with societal issues of transportation safety, fuel price wars, emissions concerns, the economy, international politics, and foreign trade.

These issues may seem like they are geographically distant from you, but they do impact you. Write about how these issues directly affect your life. What actions do you engage in that impact this issue? Where can you go to find additional reliable information? As a scientist, how does this knowledge affect the choices you make?

Integration Activity of Socio-Scientific Issues

A scientific investigation into mass transportation has concluded that the most efficient form of mass transport modes for commuters is a light rail system.

Outline some of the social issues that would need to be addressed before building a light rail system for commuters working in the city center. What additional information do you need to make a clear decision?

What issues would be most relevant to the following individuals?

- the state governor
- the city mayor
- a transportation engineer
- a city homeowner
- a suburban homeowner

Compare your thoughts with the following document:

- Socio-scientific Issues Integration Activity Answers

Task 3 Performance Task

You are now ready to complete Task 3 in Taskstream.

For details about this performance assessment, see the "Assessment" tab in this course.

Investigations in Science

Science encompasses much more than just lab experiments. Different fields of study have evolved standard practices and types of investigations. For example, medical studies include studies of characteristics of populations that have a particular medical issue. They also include pure chemical tests and biology lab experiments.

Then there are the ethical issues of testing on animals, and more complex issues when testing on people. There are even medical investigations that primarily use data from patient records and mathematical models to test procedures quite thoroughly to advance the knowledge long before any interface with patients. This topic will present some of those scientific investigation practices.

Methods of Investigation

Science and technology encompass many different fields. The methods of investigation range from observational studies to qualitative surveys and quantitative experimental research. Science advances because each generation builds on previous knowledge. Scientific concepts are the foundation for technological advances, and technology enables more advanced scientific research. Each field has standards and procedures to ensure quality, ethical work.

This topic highlights the following key concepts:

- methods of investigation commonly associated with different fields in science
- role of observation in scientific investigations
- methods of investigation
- reasons for conducting investigations

Methods of Investigation

Read the following article:

- Fair Tests: A Do-It-Yourself Guide (4 pp.)

Think carefully about the following topics:

- Analyzing Evidence: Evidence can be in the form of results of one or many experiments, surveys, observational studies, etc. Analysis of the evidence can result in a change in the understanding of a scientific phenomena or a confirmation of what is already known. It can also be inconclusive and lead to a further investigations.
- Complex Scientific Investigations: Is recent global warming a long-term trend? If so, what should be done to counter its negative impact? What methods of investigation would be used to answer these questions?

Review your journal notes for your reading of chapters II, III, and IV in *Understanding Science: How Science Really Works*.

Compare how your journal notes are different from a scientific lab notebook. Consider the following questions:

- What steps or processes are you missing?
- How could your journal be improved as a study resource by adding more detail or organizational rigor?
- How could your journal be useful in a study group with another student studying this topic?
- How might your journal contribute to creating lesson plans for teaching science?

Read the following section in "*The Principal Elements of the Nature of Science: Dispelling the Myths*":

- Myth 4: A General and Universal Scientific Method Exists

List at least three methods of investigation that are used in scientific investigation besides a laboratory experiment.

Note: You may want to consult the Fair Tests: A Do-It-Yourself Guide article.

Explain how the other methods you listed in your journal meet the criteria for fair tests.

Observation in Scientific Investigation

Science includes empirical observation modeled by self-consistent predictive mathematical models. Science cannot be proven, but it can be disproven with a single counter-example. Further observations can lead to refinement, so the result is a growing body of ever-improving knowledge.

Read the following section in "*The Principal Elements of the Nature of Science: Dispelling the Myths*":

- Myth 5: Evidence Accumulated Carefully Will Result in Sure Knowledge

Describe how observations and mathematical models have been used to advance the science of weather prediction. Consider the following questions:

- What were some very early hypotheses?
- What hypotheses have been tested by observation?
- When have hypotheses been disproven by contradicting observations?
- What mathematical models have been used to predict weather outcomes?

Common Reasons for Investigation

Read the following section in "*The Principal Elements of the Nature of Science: Dispelling the*

Myths":

- Myth 8: Science and its Methods can Answer All Questions

Explain why science cannot answer every question.

In *Understanding Science: How Science Really Works*, read at least three of the investigations in the following section of the Resource Library:

- Science in Action

Science and technology often have different reasons for an investigation. Science is driven more by the need to know, whereas technology is driven more by the need to solve a particular problem, improve an existing product, or invent a new product.

Analyze whether the investigations you read about were motivated more by a pure scientific search for knowledge or by a search for a technological solution to a problem. Give examples of some technologies that have grown from each of these investigations.
Methods of Investigation Integration Activity

Write the processes you would use to investigate the following topics. What testing, research, or search would you perform?

- a new metal alloy
- finding new planets
- the nature of gravity
- climate change
- pollution
- curing world hunger

Compare your thoughts with those found in the following document:

- Methods of Investigation Integration Activity Answers

Explanation and Communication in Science

There are many reasons for effectively communicating scientific investigations. Even to gain funding, researchers must communicate the importance of the investigation; later, they must communicate status updates. An interpretation of results is likely to be more accurate if the results are debated and a consensus is reached. That is not to say that reality is based on a majority vote, but an airing of all interpretations with all possible objections addressed is a far better, transparent process for determining a sound explanation. Peer review is an example of this important process.

This topic highlights the following key concepts:

- common criteria that scientific explanations must follow

- models and criteria of scientific explanation
- resolutions in the science world

Explanation and Communication in Science

Read the following chapter in *Understanding Science: How Science Really Works*:

- chapter VIII ("A Scientific Approach to Life: A Science Toolkit") (9 pp.)

As you read, think carefully about the following topics:

- Important Criteria for Scientific Investigation: purpose, funding, resources, implications, etc. All of these are important considerations best reviewed before a scientific investigation is commenced. In most cases, important criteria for an investigation will need to be met as a condition for the investigation to commence.
- Replicating the Result of Scientific Investigations: one of the characteristics of a scientific law or theory is that replicating the investigation that determined it, within specified bounds, will return the same result. If it does not, the theory or law is ripe for being overturned or modified.
- Models as Scientific Explanations: Someone once said that science was a mathematical model of reality. Models are a convenient way of capturing a scientific law or theory. Science and technology use models of varying sophistication to understand the behavior of complex systems. The weather, finite element analysis, and population growth are a few examples.

Visit the sidebar links on the following web page:

- "Publish or Perish"

Answer the Reading Guide questions at the end of the following web page:

- "Bone Changes in Rock Climbers"

Communication I?What Is the Investigation About?

Outline the important topics you would cover in your communication or publication following an investigation of the following topic:

- You believe that a serious terminal disease is inherited from one parent, and if the gene were identified, it could be tested for during early term pregnancy. The result could then be shared with the prospective parents. How would you go about communicating your investigation, with funding in mind, where you are competing for limited resources?

Compare your thoughts with the following document:

- Communication I—What is the Investigation About? Answers

Improving Investigations and Communication

Technology is useful in recording, analyzing, and presenting data from scientific investigations. Certain computer programs and hand-held graphing calculators can record and analyze data of incredible sophistication. These programs have the mathematical capability of analyzing data and presenting a final test statistic in a matter of seconds, accomplishing quickly that which could take several days by hand calculation. Graphical representations of the results as bar charts, histograms, and pie charts can also be produced by computer programs to present the results more clearly.

Role of Mathematics and Technology

Different technologies are used throughout the process of scientific investigations. Some, like microscopes, improve observation capabilities. Automatic timers for periodic photography can aid data collection. In this topic, you will learn to use some statistical functions to quickly analyze data from a scientific investigation.

This topic highlights the following key concept:

- appropriate technology tools for gathering, analyzing, and presenting scientific data

Role of Mathematics and Technology

Skim the following chapters in the STEM: Student Research Handbook:

- chapter 2
- chapter 8
- chapter 9

List the technologies that you have used for scientific investigations. Classify when these technologies were used:

- data gathering
- recording
- analyzing data
- presenting results

Technology Enables Leaps in Science Knowledge

Investigate technologies that have enabled significant leaps in knowledge of astronomy. How have these technologies been used to advance the science?

Include at least the following technologies:

- observations from ancient civilizations
- archeological sites with astronomical observatories
- various telescopes
- technologies required to repair the Hubble telescope

You may want to consult the following websites:

- NASA
- Chronology of Space Exploration
- HubbleSite

Record an organized list in your journal.
Using Mathematics and Technology for Analysis

Use your calculator to run a statistical test for the following situation:

- A test for the effectiveness of a new drug in reducing back pain collected data on two 100-person samples. One sample of 100 individuals was given the new drug; 64 individuals had a significant reduction in pain. The other sample of 100 individuals was given a current pain killer; 52 individuals had a significant reduction in pain. Conduct a Z test for the difference in proportions of the two samples to see if there is an improvement in the effectiveness of the new drug at the 0.05 level of significance.

Use these steps to perform the calculation:

- Run test # 6 under STAT/TESTS on your TI Calculator.

Instructions:

- STAT/TESTS/Arrow down #6/Enter

Enter data:

- x1 = 64
- n1 = 100
- x2 = 52
- n2 = 100
- pi > p2
- Calculate/Enter

Compare the p value with the 0.05 level of significance. What conclusion can you draw? Compare your thoughts with the following document:

- Using Mathematics and Technology for Analysis Answers

Hypotheses and Scientific Investigations

Well-written hypotheses are one way that scientists direct what they study. A hypothesis helps to organize thinking and categorize observations. Hypotheses can range from an educated guess to making a prediction. Understanding the context of a scientific investigation will help in determining the appropriate hypothesis.

Hypotheses and Scientific Investigations

Hypotheses guide scientific investigations. They should inform the investigation, and determine whether an idea is testable. If the results of the investigation are inconclusive, it does not mean that the hypothesis is not testable, but rather, that another investigation or approach may be necessary.

This topic highlights the following key concepts:

- hypotheses
- connections between the hypothesis and design of a scientific experiment

Hypotheses and Scientific Investigations

Skim the following section of "*The Principal Elements of the Nature of Science: Dispelling the Myths*":

- Myth 3: A Hypothesis is an Educated Guess

Read the following chapter in the STEM: Student Research Handbook:

- chapter 4

As you read the learning resources above, think carefully about the following topic:

- Testability of a Hypothesis: There are some things that can be tested scientifically and some things that cannot. Faith based phenomena such as the existence of God cannot be tested. On the other hand, it is possible to test to see if a new drug treatment is more effective. The former is not scientifically testable, but the latter is.

In your journal, answer the chapter questions and chapter applications and complete the Student Handout #4 located on the following page of the STEM: Student Research Handbook:

- page 63

To learn more about this topic, view the following Teachscape videos:

- "View Video Introduction" in the Learning About Generating and Testing Hypotheses section of the lesson
- "View Grades 9–12 Examples (Science)" in the Seeing the Strategies in Action section of the lesson

Hypotheses and Scientific Investigations Creation Activity

Refer to the following section of "*The Principal Elements of the Nature of Science: Dispelling the Myths*":

- Myth 3: A Hypothesis is an Educated Guess

Review the following chapter in the STEM: Student Research Handbook:

- chapter 4

Write an appropriate hypothesis or hypotheses for the following investigations:

- a new medical treatment
- climate change
- possibility of an asteroid strike
- mortality rates
- average adult body weight
- the effectiveness of a new medicine

Compare your thoughts with the following document:

- Hypotheses and Scientific Investigations Creation Activity Answers

Task 1 Performance Task

You are now ready to complete Task 1 in Taskstream . In this task, you will be analyzing and tracing the historical development of a theory of your choice. Many scientific theories are appropriate for this task, but avoid selecting a very *new* theory (one for which there is little historical development) or a very *obscure* theory (one for which there is little documented discourse available). Examples of theories that are appropriate include, but are not limited to, the following:

- light speed theory
- geocentric theory
- theory of relativity
- multiverse theory
- plate tectonics theory
- atomic theory
- heliocentric theory
- big bang theory
- theory of evolution
- cell theory
- germ theory of disease

For details about this performance assessment, see the "Assessment" tab in this course.

Designing and Conducting Investigations

Well-designed scientific investigations involve numerous details or characteristics. Careful attention to all of the requirements is important to providing valid data, drawing useful conclusions, and making sound decisions based on the investigation.

Designing and Conducting Investigations

One of several considerations for a well-designed investigation is eliminating bias and collecting objective data. There are several controls that help ensure this fair and useful outcome.

This topic highlights the following key concepts:

- well-designed scientific investigations
- scientific process skills
- independent, dependent, and control variables
- data to support or disprove a given prediction.

Designing and Conducting Investigations

Read the following section of "*The Principal Elements of the Nature of Science: Dispelling the Myths*":

- Myth 9: Scientists are Particularly Objective

Review the following chapter in the STEM: Student Research Handbook:

- chapter 2

As you read the recommended sections of these learning resources, think carefully about the following topic:

- Variables and Controls: Many scientific investigations involve a relationship between variables. A control can be assigned as a basis for comparison. Investigating whether a new product is more effective than the current product involves variables. The products are one variable, and the outcome is another variable. The control is the current product, and its outcome is used to compare the outcome of the new product. It does not matter if you are considering the effectiveness of a new detergent or the efficiency of a new rocket fuel, variables and controls must be assigned or identified in a similar manner.

In your journal, answer the chapter questions and chapter applications and complete the Student Handout #2 located on the following page of the STEM: Student Research Handbook:

- page 33

Fair Tests

Read the following website:

- Fair Tests: A Do-It-Yourself Guide (4 pp.)

Follow the sidebar links, read the information in the "Snapshot" sections, and read about other sample tests.

Think carefully about the characteristics that allow for a fair test, that is, a fair scientific investigation.

Evaluate what was unique in these investigations that ensured they were fair tests.

Well-Designed Experiment

Consider the following scenario: Professor Fudge is asked to run a scientific study to see if a new energy drink actually provides more energy for exercising cyclists. Professor Fudge owns stock in the company that produces the energy drink, and so does his son, who will be one of the cyclists in the study.

Outline the details of the study to determine if the drink actually does provide more energy to cyclists so that neither Professor Fudge nor his son will bias the results.

Compare your thoughts with the following document:

- Well-Designed Experiment Answers

Formulating Explanations and Communicating Results

Describing what happened in a scientific investigation is different than explaining why it happened. Of course, a clear explanation is the first requirement, but the explanation needs a lot of evidence to back-up the conclusion. Clear communication—whether in a conference paper and presentation, a peer-reviewed journal, or in collaborative work with colleagues—will add to the body of scientific knowledge.

This topic highlights the following key concepts:

- benefits of accurate and effective communication
- descriptions and explanations
- evidence and logic
- procedure, explanation, and recommendation of a scientific investigation

Formulating Explanations and Communicating Results

Skim the following chapters in STEM: Student Research Handbook:

- chapter 10
- chapter 11
- chapter 12

As you read the recommended sections of STEM: Student Research Handbook, think carefully about the following topics:

- The Benefits of Communication in Scientific Investigation: Important aspects of the interrelationship of science and technology include clear communication of methods, results, implications of the investigation, and how this research may be extended further.
- Descriptions versus Explanations: There is a difference between what happened and how or why it happened. Often, science can predict what will happen, but not why it will happen. A large proportion of scientific investigation is involved in uncovering underlying mechanisms and understanding how something happens. For example, recent global warming is an undeniable fact; a scientific explanation for it is a little harder to pin down.

Formulating Explanations and Communicating Results- 2

As you read the following sections of the learning resources, compare your notes and learning with the STEM information recorded in your journal.

Review the following chapters in *Understanding Science: How Science Really Works*:

- chapter III ("How Science Works") (especially pp. 10–21)
- chapter V ("The Social Side of Science: A Human and Community Endeavor") (8 pp.)

Read the following article:

- Cells Within Cells: An Extraordinary Claim With Extraordinary Evidence (13 pp.)

Read the following section of "*Misconceptions about Science*":

- Misconception: Investigations That Don't Reach a Firm Conclusion are Useless and Unpublishable

Read the following article from Visionlearning:

- Scientific Communication: Understanding Scientific Journals and Articles

How can you use each of these levels of scientific communication to investigate an issue? How can you direct students to conduct investigations and to evaluate the validity of a resource they may find?

Evaluating Scientific Reporting

Choose a scientific topic that interests you. Read articles or view reports on this topic from several different sources, including newspaper articles or blogs, popular science periodicals, educational materials from science institutions, commercial news releases, peer-reviewed professional journals, etc. Here are a few potential sources and example articles to get you started:

- PBS *Nova*
- *Discover Magazine*
- *Smithsonian Magazine*
- *National Geographic*
- NASA
- *Scientific American*
- *Science Magazine*
- Public Library of Science (all articles are available for free)
- Proceedings of the National Academy of Sciences (articles more than six months old are available for free)
- Directory of Open Access Journals (journals on many different topics are available for free)

In your journal, record your topic; your search process; questions that came up in your research;

how your knowledge, beliefs, or opinions of the topic changed through your research; your impressions of the communication medium or validity of the source; etc.
Results of an Investigation

Select one of the scientific journals that interest you:

- Public Library of Science (all articles are available for free)
- Proceedings of the National Academy of Sciences (articles more than six months old are available for free)
- Directory of Open Access Journals (journals on many different topics are available for free)

Read one research article completely. Outline the way you would write an article for a popular magazine that presents this research.

Write a sample newspaper article or radio report that disseminates this information in a 5–10 minute segment to a general audience.
Communication II?Reporting an Investigation

Imagine an investigation you led to find a disease-causing gene has been successful, and you have isolated the gene. How would you communicate your result to a medical organization capable of developing a method to test for this gene in an early-term pregnancy? Outline the important topics you would include in your communication.

Compare your thoughts with the following document:

- Communication II—Reporting an Investigation Answers

The Engineering Design Process

The Next Generation Science Standards call for explicit instruction and incorporation of the engineering design process, alongside the scientific method. While there exists different terminology for the steps of the design process, at its core is starting with a real-world problem or need, and working toward a working solution.

The Engineering Design Process Compared to the Scientific Method

Engineering methods are used to generate new and working solutions to real societal issues. Whereas the goal of the scientific method is to expand knowledge and understanding, engineering's goal is to apply such knowledge in finding and implementing solutions to challenges facing people.

This topic highlights the following key concepts:

- engineering method
- similarities and differences between engineering methods and the scientific method

Watch the following video for pointers about the engineering project you will complete in Task 2:

Note: To download this video, right-click the following link and choose "Save as...": download video.

Why Address Engineering?

Read Why Engineering Problem Solving? from the Dartmouth Project for Teaching Engineering Problem Solving.

Read pp. 201-204 in Chapter 8 ("Dimension 3: Disciplinary Core Ideas—Engineering, Technology, and Applications of Science") from *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*.

As you read the learning resources above, think carefully about the following topic:

- Reasons for teaching engineering: students, educators, and schools all benefit from clear, explicit instruction in the engineering process and the conceptual link between scientific knowledge and problem-solving for the betterment of society.

In your journal, summarize the best arguments that you have seen for covering engineering within the science classroom. Reflect: are you convinced? What are the trade-offs that come along with dedicating classroom time and resources to engineering instruction?

Comparing Methods

Read Comparing the Engineering Design Process and the Scientific Method from Science Buddies.

As you read the learning resource above, think carefully about the following topic:

- Methods and processes: the engineering design process and the scientific method have both been developed over time, with input and modifications from practitioners to refine each into best practices for their respective goals.

In your journal, reflect on how the different goals of science and engineering lead to different processes. Identify the major differences in these processes, and try to explain why these differences exist. Note any questions that you have to help refine your understanding of these methods and why they differ. Some of these questions will be answered in the next topic, "The Steps of the Engineering Design Process." If you have other questions, you might ask your course instructor or other members of your learning community

The Steps of the Engineering Design Process

Just as the scientific method includes clear, iterative steps leading toward its goal of enhancing knowledge, so too the engineering design process includes clear, iterative steps leading toward its goal of meeting needs.

This topic highlights the following key concepts:

- engineering design process
- defining and delimiting an engineering problem
- developing possible solutions
- optimizing the design solution

Engineering Design Process

Watch "EiE Spotlight—The Engineering Design Process in Action" from Engineering is Elementary..

Read pp. 204-214 in Chapter 8 ("Dimension 3: Disciplinary Core Ideas—Engineering, Technology, and Applications of Science") from *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*.

Brainstorm problems that seem appropriate to the engineering design process, and note your ideas in your journal.

Compare your ideas to the Grand Challenges for Engineering from the National Academy of Engineering and the Science Related Model Problems from the Dartmouth Project for Teaching Engineering Problem Solving .

Tip: your ideas from this activity and those from your subject area in Science Related Model Problems from the Dartmouth Project for Teaching Engineering Problem Solving might form an ideal basis for the problem you will solve in Task 2 of your assessment. Select a problem that seems within reach based on your current knowledge. Remember, too, that you will need to actually test your solution?so pick a project that you can test safely using the resources available to you. It would be fantastic if you solved one of the NAE's Grand Challenges, but you also might be biting off a bit too much for this course!

Defining and delimiting an engineering problem

Read Defining the Problem from Science Buddies, and explore their Examples.

Developing Possible Solutions

Once an engineer has defined the problem, the next step is developing solutions: brainstorming, evaluating solutions, and implementing a prototype solution. Chapter 5 of *Teaching Engineering* is a great resource for developing and optimizing solutions. Carefully explore the following sections and consider reading the full chapter and bookmarking it for future reference. Consider the differences between novice and expert problem solvers, how you can help your students become expert problem solvers, and the steps you can take to hone your own problem-solving abilities.

Read the following sections from Chapter 5 of *Teaching Engineering*:

- Table 5-1 ("Comparison of Novice and Expert Problem Solvers"), pp. 69–70
- Section 5.3 ("Problem-Solving Strategies"), pp. 70–72
- Section 5.4 ("Getting Started or Getting Unstuck"), pp. 73–75
- Section 5.6 ("Creativity"), pp. 79–84

Note: make use of the skills and tips presented in this section as you work on your engineering project in Task 2.

Optimizing the Design Solution

The final stages of the engineering design process include analyzing alternatives, selecting the most viable alternative, and iterating the cycle until you find a solution to the defined problem. Evaluate your alternatives and measure their tradeoffs using a decision matrix. Read and explore The "Problem-Solving Matrix" and "Iteration" sections of What is Engineering Problem Solving? for a detailed example of how to use a decision matrix.

Task 2 Performance Task

You are now ready to complete Task 2 in Taskstream.

You may use the Problem-Solving Matrix Template , based on the one from the Dartmouth project for Teaching Engineering Problem Solving, to demonstrate how you evaluated alternative ideas during the engineering design process.

For details about this performance assessment, see the "Assessment" tab in this course.

Final Steps

Congratulations on completing the activities in this course! This course has prepared you to complete the assessments associated with this course. If you have not already been directed to complete the assessments, schedule and complete your assessments now.