

Influencing Environmental Policy with Real Data

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Overview

Humans are the inspiration for robots. All humans fit the basic criteria, since a robot is simply a computer (brain) with the ability to take in information (see) and act on that information (do). The beauty and curse of robots – in fact – is that they are so much like humans in all of their successes and failures. We all make mistakes, and sometimes our errors are unintentional but have far-reaching and long-lasting effects. A robot can be programmed with minimum and maximum thresholds – limits of acceptability. While it may sound harsh, the humans who programmed those limits are always using arbitrary interpretation of data based on their flawed experience of life; humans do not live in a vacuum or a sterile lab environment. Thusly, the synapses of the robot's brain are routed to respond to and act within our own limitations.

In history, all men are not created equal. Some humans hold much higher offices than others and their decisions affect the lives of countless other humans. Some are elected, some appointed, some conferred with degrees based on education, and some are in the right place at the right time. We trust that the limits set by these special humans – and their judicious interpretation of the data at hand – are helping all other humans to live life to the fullest. Sometimes that trust is well placed. Many times it is not questioned.

In the case of environmental policy in the United States, many of the special humans have relied on trial and error to come to decisions that affect the health and well-being of other humans. Scientists, lobbyists, and politicians have all thrown their hats into the ring when it comes time to draft legislation that will regulate the manufacture and consumption of man-made materials. Taking light bulbs as an example, legislation was passed in 2007 to take effect in 2014 making incandescent light bulbs illegal at minimum thresholds of luminous efficacy. The implementation of this venture has since been

pushed back because of the difficulty of rollout and, arguably, the reliability of the data surrounding the decisions made in the legislation.

In this unit, learners will take the real-world problem of energy efficiency and test it. They will compile their own data and set their own minimum and maximum limits of luminous efficacy for light bulbs. They will analyze the Energy Independence and Security Act of 2007 and draft their own rebuttals to the legislation based on the analysis of their data. Lastly, they will use their human-robot capacity to determine the long-range effects of their revisions to the legislation and prepare themselves for their roles as future policymakers and global citizens.

This unit is designed to be used in an 11th grade Advanced Placement United States History course. It may be modified or appropriate as-is for an honors or regular United States History course. Additionally, the unit will take about 5-7 in-class days. The placement of the unit will be within discussions of Progressivism and the turn of the 20th century.

Rationale

Problem-based learning is a buzzword in education today. The purest examples in schools that implement the model hold that learners will create a new problem each year to study and that all courses throughout the day will provide different lenses for solving that problem. For the learner, the model provides constant and consistent interest because the problem is one they own. For the educator, it creates an opportunity to guide learners in their individual quests for knowledge as well as work with highly motivated and interested clients throughout the year. In theory, it is the silver-bullet for creating engaged and active citizens for future generations in America.

In practice, problem-based learning is difficult to manage and maneuver for many educators, both within a school year and from year to year. The task of scaffolding the problem-solving technique to last 180 or more days and to support and guide up to 30 projects a year is daunting. Add to that the styles of different educators intersecting on one learner's problem statement, and pedagogical or managerial issues unfold. Finally, problems without a clear or actionable solution can be frustrating and may cause interest in school to wane or disappear completely if not placed in the correct context of learning from one's failures.

Choosing to construct a unit on problem-based learning, then, is a risk for both educators and learners. This unit takes advantage of a problem that has seemingly already been solved by the United States federal government and places it under the microscope of a layman's scrutiny. Asking learners whether or not our government has made a good choice or based its decisions on solid research is a high-interest way to build a problem-based approach into an otherwise traditional classroom. By breaking down a pre-existing

solution to a problem that seemingly still exists, learners are forced to examine all elements of conceiving, drafting, and implementing legislation. Additionally, there is room for investigating the validity of data produced by scientific research funded through the taxes of all Americans. Finally, by running their own independent experiments and creating their own legislation, learners are engaging with the democratic process from a scientific angle – presumably allowing learners with varied interests to become more interested in the process of active citizenship.

The 2007 Energy Independence and Security Act was created in a time of heightened awareness with the best of intentions. The legislation itself is massive and encompasses many facets of energy use by individuals, corporations, and the government. The self-stated goal of the act was “to move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government...” With such lofty aims, it is easy to see why it was enacted and also why parts have fallen short.

Within a history classroom, it can be valuable to study the history of energy use and abuse in this country, beginning with the landing of Europeans on the continent for the purpose of gaining unlimited access to natural resources and spanning efforts by individuals and organized governments to regulate, monitor, and criminalize behaviors that affect our environment. Within a science classroom, labs and demonstrations of energy consumption and conservation captivate learners because of the applicability of the experiments to their own environment. As with so many things in life, the 2007 federal legislation combines the social studies and science of energy use and efficiency and applies it to our lives today and our future behaviors.

We take for granted that scientists have the best interests of humanity in mind when they conduct and analyze experiments. After all, there is a widely held belief that nature is unable to be bent to the will of man and that science is untouched by manipulators and lobbyists; hard numbers and facts cannot lie. While it may be true that scientists go in to experiments with the intention of testing theories and that even debunking data is considered in the final analysis, the temptations of humanity are too great. When Oppenheimer and his colleagues realized their work could decimate humanity, it surely gave them pause but ultimately did not reverse their research. Human nature’s great thirst for knowledge and understanding is sometimes a great flaw.

While not suggesting that light bulb efficiency is the atomic bomb of our generation, it is interesting to note that all advancements in light bulb technology have co-existed with the incandescent light bulb instead of replacing it. Unlike the vinyl album, the eight-track, the cassette tape, or the laser disk, incandescent light bulbs have held up in popularity against major competitors like light emitting diodes, halogens, and compact fluorescents.

The cost differences could account for this maintenance in the marketplace, but compact disc players were wildly expensive in their youth and still outpaced all other media players in a very small window of time.

What, then, accounts for the continued popularity of incandescent light bulbs when so many other, more efficient sources of light are available to consumers? A better question for our purposes might be: why would the government want to phase out the manufacture, sale, and use of incandescent light bulbs when consumers seem to prefer them and manufacturers have been working toward increasing their efficiency? Herein lays the reason to study this problem with young people – scandal.

This is not to suggest that there is a huge government conspiracy against incandescent light bulbs or their manufacturers. Instead, learners should consider who gains from the outlaw of such devices, and what link those gains have to do with energy consumption, environmental safety, consumer costs, and manufacturer profits. Not all legislators are working to keep the bad out and bring the good in. In the same vein, not all scientists will validate data that suggests outcomes with only the purest of intentions.

Learners who are intrigued by this introduction will relish the opportunity to get themselves into the lab and see the pros and cons of different sources of light. They will have to consider their own biases when analyzing the data and determine what levels meet the arbitrary criteria for luminous efficacy. They will need to look at costs of manufacture and sale, research the investment in different technologies, and find out which corporations (or large private investors) are funding development for each of the alternate light bulbs. In short, they will have to consider that humans cannot be just scientists or just politicians or even just businesspersons, but must be all of these at once in order to successfully lobby for their interests.

It is possible that discussions around the analysis of the data gathered can breed more cynical citizens rather than activist citizens within the classroom. It is popular to suggest that idealist lessons are better incubators for vigorous change makers. I hazard to say that the later a learner meets with the harshness and convoluted nature of reality, the less likely she is to rebound and use the lesson as a positive stepping stone toward better decision making. Coupling the good with the bad, the sinister with the idyllic – so long as it is done in an environment of support and actualization – creates real-world scenarios that require real-world solutions.

Objectives

For this unit, educators will be able to achieve three goals. Utilizing a real-world problem – the energy efficiency of light bulbs – allows educators to engage learners in reading, analyzing, and critiquing current federal legislation. Additionally, educators can run the data gathering labs that demonstrate proper parameters for measuring data. Lastly, they

will instruct learners in proper methods of analyzing data to establish acceptable luminous efficacy thresholds.

In response, this unit will allow learners to set a problem and map out a workable solution based on data they have gathered. At different times in the unit, learners will: measure the luminous efficacy of different light bulbs; chart that data of different measurements of energy efficiency and analyze that data to establish thresholds of effectiveness; solve problems using data they have generated through the labs; write energy policy based on their collected data; and finally analyze and discuss current energy efficiency legislation.

Strategies

Flow Charts: Outlining the Problem-Solution Pipeline

As with all robots, the brain must be programmed to follow directions and actuate different outcomes based on the varied input of data. Creating flow charts for learners provides a visual program that they can follow while solving problems. The intention is for learners to realize that all problems do not have obvious solutions and that the process for solving problems usually entails many roadblocks.

Starting with a verbal prompt that becomes a visual flow chart, educators can open learners up to the possibilities inherent in the problem-solution pipeline. Problem-based learning requires failures to be effective and allowing learners to see their mistakes as they take shape is crucial to the learning process. The importance of different stages in problem solving is only evident as they are named; in some cases, learners will overlook vital steps in solving a problem in their haste to reach a solution, only to see their error as their solution cannot be properly implemented without that step.

Flow charts should be created for each new problem encountered in the classroom. While it is acceptable to build on previous problem's charts, it is essential that learner understand that prefabricated solutions or roads to solutions may lull them into a false sense of security and cause them to overlook unique solutions or steps. Building on prior knowledge is encouraged, but blinding oneself to the special aspects of each new problem is a mistake that will not serve them well in the real-world.

Using a Multi Meter, Temperature Probe, and Light Probe to Measure Energy Efficiency

A multi meter is a tool that measures voltage at different points on a circuit. A temperature probe (as the name suggests) measures the temperature of an object. A light probe measures lumens. In order to utilize them for our experiments and data gathering, it is important to know what we are measuring and where in the circuit and on the object

we must measure. Our goal is to create a data chart that captures real numbers that we may then interpret based on our needs and ideas.

Multi meters can measure amps and volts separately within the circuit. By multiplying amps and volts, the wattage of the circuit can be determined. For our purposes, this is useful for determining the luminous efficacy of different types of light bulbs because wattage is an indication of energy use. The temperature probe measures the amount of heat generated by the bulb once it is in use. The relationship between heat and energy is another way to determine efficiency. Lastly, light probes measure lumens – the amount of light produced by a source. Luminous efficacy can be determined by comparing and analyzing all of this data. Direct comparisons are useful for rating light bulbs as poor or excellent in efficiency in all of the categories.

Data Analysis: How Do You “Know” What You “Know”?

Analysis is the synthesis of gathering information and applying it. In the current legislation written for energy efficiency in America, scientists have set thresholds of minimum luminous efficacy for light bulbs and legislators have taken this expert opinion and enacted legislation as a result. There is a lot of guessing in analysis, and a lot of context necessary to hit closer to the truth or heart of the data presented. How can we expect learners to make significant conclusions in fields where they are not experts?

The first step to effective analysis is to go back to the problem-solving flow chart and decide what elements of the problem you are going to tackle with the data collected. Instead of working from the desired solution backwards (as many educators probably practice in their pedagogy, designing method around expected outcomes), it is important to determine what you want to know before you look at data in aggregate. Going back to a problem statement and isolating what things are important and what things are superficial is helpful in determining what your data will say. For example, if a key part of calculating luminous efficacy is knowing how often you’ll have to replace bulbs, a key part of your data collection may be determining cost over time or cost per year of use so that all the tested light bulbs are being measured in the same unit. Saying that one light bulb costs \$1.25 and another costs \$23 is not as illuminating as knowing that the cheaper light bulb lasts less than a year whereas the more expensive light bulb lasts 20 or more years. No data analysis works without context and purpose.

In the same vein, analysis can be skewed by bias. Going back to the problem-solving flow chart again, learners must keep in mind all of the players participating in creating both the data and the resulting policy. A manufacturer will perhaps prioritize different measures of luminous efficacy than a consumer or an investor or a conservationist. Each individual tinges their analysis with prejudice, and no one dissection of the data is to be valued over other’s without consideration of all of the viewpoints as a whole. The largest problem with analysis is demonizing or idealizing the origin of bias without

contemplating the motivation behind it. Also, not all bias is bad and sometimes different viewpoints will reach the same conclusion for vastly different reasons; that does not necessarily make the conclusion foregone or correct, however.

Teaching effective methods of data analysis is difficult and cannot be given proper treatment in this unit. However, it can and must be mentioned that the element of bias and the instruction of starting with a problem rather than a solution is paramount to counteracting the normal human tendency of bending data to fit a solution instead of finding a solution through analysis of data. So long as learners are instructed to focus on their intentions rather than their outcomes, the problem-solving process will yield long-ranging lessons in life.

Reading and Writing Legislation: Legalese for Dummies

Laws are intended to be followed. They are written – however – so that politicians, lawyers, and judges can support, sell, defend, interpret, and overturn them. In the democratic republic that is the United States of America, laws fit into every branch of government at every level and help to shore up the morality of the humans that inhabit the country. If all Americans are expected to abide by the law and if all Americans are supposedly capable of proposing the laws under which they function, then why is legal language and syntax so difficult to comprehend?

Legalese is not a real language in the literal sense, but it surely exists as it has been used to draft all legislation and litigation since the birth of the nation. If we wish for learners to engage with the legislation, we must demystify the language in which it is written and teach our learners how to replicate and use it correctly.

In our robotics seminar, YouTube and Wikipedia were both acceptable means of gathering information and self-educating for our labs and discussions. To engineers, it makes no sense to use 10 words when one will do nicely and it makes even less sense to waste time reading or watching when true education lies in the doing. That is not to say that engineers do not have wonderful vocabularies or are not well-read; instead, they are quite efficient managers of time and resources and should be recognized as such.

Conversely, as a social studies educator, it has always been imperative to have learners read and to build their vocabularies during direct instruction. It is arguably difficult to “do” history, although the point can be made that active citizens are just that – active in their communities. More often than not, however, our classes have resorted to reading primary sources, slogging through dense material, and reading the book even though there was an enticing movie that just came to video on the same topic.

Marrying the two mindsets of efficiency and due diligence is a surprisingly simple solution and fits nicely into the method of understanding and writing legislation. Reading

synopses of pieces of legislation is not undermining the intricacies of the language is multiple treatments are read from different published sources across a variety of biases. Additionally, just as in writing code when programming robots, it is acceptable for learners to write in their own language what they wish to accomplish with their legislation and then to translate their notations line by line into the legalese with the help of their educator. Instead of becoming bogged down in the mire of dense language and imposing syntax, learners can grapple with the intentions and implications of the law at their own level and then spend time learning how to “switch codes” by translating between plain English and legal jargon.

Classroom Activities

Lesson One: Introduce the Problem and Map the Road to a Solution

The objective of this lesson is to introduce the concept of energy efficiency in the United States in the context of progressivism at the turn of the 20th century. The lesson will be split over two days and will be divided into two parts. In the first, learners will be able to identify the areas in which the federal government heightened regulation of energy issues. The idea of the Department of the Interior and the Environmental Protection Agency will be addressed as well as early efforts toward conservation and protection of resources. Different government agencies and bureaus will be compared and contrasted, starting with early organizations that may have evolved into current groups.

In the second part of the lesson, the advent of electronic technology will be discussed. Learners will be able to link the evolution of technologies that rely on electricity to the regulations identified in the previous part of the lesson. They will compare the level of regulation to the growth of companies around certain technologies. Monopoly, research & development, and patents will be addressed in the context of legislation around those topics. Finally, learners will decide if light bulb energy efficiency standards are over- or under-regulated and begin to identify the problem with regulation of incandescent light bulb manufacture, sale, and use.

The lesson will begin with a short lecture on the ideals of progressivism at the turn of the 20th century. The lecture will be accompanied by a power point presentation that asserts the fact that environmental and conservation problems were not new to the time period, but that the regulation of new technologies was floundering because of the geometric growth of technology in the period. After the lecture, learners will be provided with a chart where they will identify the problems that different United States government agencies were charged to solve over the course of American history and their methods for solving and/or monitoring those problems (Worksheet One). Learners will be encouraged to use pre-printed materials for the completion of the chart. They will work in jigsaw groups to identify the information for their assigned agency (4 groups in total) and will share out their information with classmates to complete the chart.

Part two of the lesson will begin with a review of the information from the previous class. Once the agencies have been refreshed in learners' minds, this lesson will continue with discussing light bulbs and their invention and integration into the American lifestyle. Learners will complete a chart on the surface pros and cons of different types of light bulbs (Worksheet Two) in preparation for the lab in the next lesson which gathers hard data. Once the chart is completed and discussed in class to identify problems with incandescent light bulbs, learners will begin drafting a flow chart to list steps to solve their problem.

Lesson Two: Create the Data (Testing the Bulbs, Creating a Data Chart for Comparison)

The objective of this lesson is to test each type of light bulb and create a data chart (Worksheet Three). The data chart will then be used to make decisions on luminous efficacy thresholds and recommending legislation. Learners will be able to identify the parts of a light bulb circuit, identify different tools used to make the measurements for the data chart, and correctly conduct the experiments within the lab.

First, learners will review the pros and cons listed and discussed in Worksheet Two. Then, the educator will demonstrate how the light bulb circuits will be constructed for the lab. One circuit must be constructed for each lab station as the receptor is universal for all of the light bulbs tested. The educator will use either a document camera or a power point to identify the parts of the circuit and demonstrate the steps of assembly. Then, learners will reproduce the steps and construct the circuit they will use for the lab. They will screw in a light bulb and test the circuit to make sure it works when the switch is pulled.

When the measurement tools are introduced in the lab, the basic units of measurement such as volt, amp, watt, degree Fahrenheit, candela, and lumen will be reviewed. Next, the educator will show where on the circuit the multi meter should be placed to get correct readings of amps and volts. Then, the educator will display the formula – $\text{amps} \times \text{volts} = \text{watts}$ – for future use. The educator will demonstrate the two times to measure the temperature of the light bulbs with the temperature probe and the acceptable method to use for the lab (whether a water method or a direct contact method, depending on the type of probe used). Lastly, the educator will demonstrate how to use the light probe (or photo receptor) to measure the lumens of each light bulb. Once all of the demonstrations and instructions have been completed, the educator will list the proper order of steps to be used in the lab and the lab may begin.

During the lab, learners will be working with their partners to complete the measurements for each type of light bulb and to accurately record their findings in the data chart. This lab does not provide parameters for measuring the cost of the light bulbs or the life of the light bulbs, so those measurements should be provided at the beginning or end of the lab by the educator. Alternately, one learner in the group could be charged

with researching this information from three different sources (on the internet) and using the averages as their measurements for the chart.

At the end of the lab, all materials should be returned safely to their original places within the laboratory. All data charts should be filled out completely (except for the last column, which will be filled out in the analysis lesson) by each lab group. If there is enough time, groups should compare their data with other groups; this is not for the purpose of changing data, but instead to see if some groups produced results that were extreme outliers of the aggregate measurements. In the case of outlier data, the class average for a measurement should be taken and used in its place. The finished data chart will be used in another lesson on analyzing the data and setting thresholds for the acceptable limits of luminous efficacy.

Lesson Three: Write a Policy Proposal Based on Data

Once learners have decided on their acceptable thresholds for luminous efficacy using their data, and once they have read through the Energy Independence and Security Act of 2007, they need to decide if they will challenge the federal government's legislation or modify it to reflect their data.

The objective of this lesson is to write an environmental policy proposal based on the learners' findings in their light bulb lab experiment. Learners will be able to use their data chart and analysis to decide whether to write a rebuttal to federal policy outlawing incandescent light bulbs or to modify that policy in any number of ways. Then, they will write out step by step what they want to see done. Finally, they will translate it into appropriate legal language. Suggestions for modification include subsidizing other types of light bulb manufacture, outlawing other types of light bulbs instead of incandescent, or creating media campaigns to encourage or discourage the use of incandescent light bulbs. There is no option to leave the legislation as-is because it has already been proven ineffective in that the measures outlawing incandescent light bulbs which were to take effect in January of 2014 were not followed.

First, the class as a whole should decide if they will be writing new legislation or modifying the existing 2007 law. This decision should take into consideration the analysis of the data from the lab experiment and the setting of acceptable limits for luminous efficacy as a result of the lab. Since the entire class will be writing the policy together, it might be helpful to employ a democratic process such as voting by blind ballot or debating the merits of the choices. Either way, once the decision has been made, the entire class will be writing the same policy.

The policy will be drafted from the "layman's" sentences that the learners use to describe the changes they wish to make to the existing policy (or the complete revision). The lesson should be done in front of the class on some type of digital white board and

then the learners can either fill in the information as it is written (on their own Worksheet Four) or the educator can print out a version to be completed individually in class or at home.

The draft of the legislation should outline the problem statement, the method for collecting data, the analysis of the data and conclusions made based on this analysis, and finally the proposed solution of the class. For each point, the learners should be prompted by the educator as to what could possibly be written based on the journey undertaken for the unit. Modelling of possible answers could also be effective for struggling writers. However, each learner should be encouraged to write their own words in preparation for the conversion to legal language.

Once each part of the policy has been addressed, learners should either take their work home to edit the plain language into legalese, or work within the classroom to make the conversion. If the class is struggling with the conversion, it may be useful to extend this lesson into two classes where the second class is devoted solely to conversion and polishing the final legislation. At the end of the lesson (and the unit), all learners should have a draft of their energy efficiency legislation that is publishable and can either be displayed or sent to their congressperson in Washington, D.C.

Annotated Bibliography/Resources

Teacher Bibliography

"Energy Efficiency Lab Teacher Guide." Environmental Literacy and Inquiry Working Group at Lehigh University, 2010. Web. 20 May 2014.
<http://www.ei.lehigh.edu/eli/energy/resources/handouts/labs/efficiency_lab_teacher.pdf>.

This is a step by step procedure for conducting a lab that measures temperature and lumens of light bulbs. It provides set up directions and guiding elements for guiding learners to gather data for our luminous efficacy chart

"Environmental policy of the United States." *Wikipedia*. Wikimedia Foundation, 14 May 2014. Web. 22 May 2014.
<http://en.wikipedia.org/wiki/Environmental_policy_of_the_United_States>.

This article provides an overview of the different government agencies in charge of environmental policy in the United States. It also lists acts and legislation related to specific environmental issues and provides links to other articles on those topics.

United States. House of Representatives. *Energy Independence and Security Act of 2007*. Washington, DC: United States Government Printing Office, 2007. Web. <<http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf>>. *This is the law created by the US Government in 2007 to set limits on use of less energy efficient products. Title III, Subtitle B contains the specific reference to the manufacture of incandescent light bulbs. If classes choose to write policy outlawing incandescent light bulbs, they can model off of this; if not, they can use this to see what limits were actually set as efficacy thresholds.*

Student Bibliography

Aires, Benjamin. "How to Measure Amps or Watts With a Multimeter." *Tech Channel - Radio Shack*. Radio Shack Corporation, n.d. Web. 2 May 2014. <<http://techchannel.radioshack.com/measure-amps-watts-multimeter-1243.html>>. *This website gives step by step instructions on how to operate a multi meter for measuring amps and volts. It also gives instructions for converting those measurements into watts for use in a comparison chart of light bulb efficiency.*

McAlpin, Megan. "Making It Plain: In Love With Legalese?." *Welcome to the Oregon State Bar Online*. Oregon State Bar, 1 Jan. 2009. Web. 13 May 2014. <<https://www.osbar.org/publications/bulletin/09febmar/legalwriter.html>>. *This web article is meant for introductory law students and those who would learn the language of the law. It encourages more clear and precise language instead of legal jargon in the writing of modern law. It can be a useful article to employ when the learners get to writing their own legislation.*

Classroom Materials

Multi Meters – for measuring amps and volts in the circuits of different types of light bulbs; this will be useful for creating wattage measurements (amps multiplied by volts) for our comparison chart of light bulb efficiency.

Temperature Probes – for measuring the temperature of light bulbs before and after use; the difference in these two numbers will indicate the amount of heat generated by each type of bulb during use.

Light Probes – for measuring lumens of different types of light bulbs; lumens are a way to measure light emitted from a source and how effective a source is at illuminating a space.

Light Bulbs – incandescent, compact fluorescent lamp (CFL), light emitting diode (LED), high-intensity discharge lamp (HID)

Worksheet Four: Policy Outline

	In My Words	In Legal Terms
<i>Problem Statement</i>		
<i>Method for Collecting Data</i>		
<i>Results and Analysis of Data</i>		
<i>Conclusions Based on Analysis of Data</i>		
<i>Proposed Solution</i>		

Pennsylvania State Standards (Aligned with the Common Core)

CC.3.5.11-12.C. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CC.3.5.11-12.D. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

CC.3.5.11-12.G. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CC.3.5.11-12.H. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

CC.8.5.11-12.G. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

CC.8.5.11-12.I. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

CC.8.6.11-12.B. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

- Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
- Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
- Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

CC.8.6.11-12.C. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CC.8.6.11-12.F. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.