



Standard #: SC.912.N.2.4

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Explain that scientific knowledge is both durable and robust and open to change. Scientific knowledge can change because it is often examined and re-examined by new investigations and scientific argumentation. Because of these frequent examinations, scientific knowledge becomes stronger, leading to its durability.

General Information

Subject Area: Science

Grade: 912

Body of Knowledge: Nature of Science

Idea: Level 3: Strategic Thinking & Complex Reasoning

Standard: [The Characteristics of Scientific Knowledge](#) -

Date Adopted or Revised: 02/08

A: Scientific knowledge is based on empirical evidence, and is appropriate for understanding the natural world, but it provides only a limited understanding of the supernatural, aesthetic, or other ways of knowing, such as art, philosophy, or religion.

B: Scientific knowledge is durable and robust, but open to change.

C: Because science is based on empirical evidence it strives for objectivity, but as it is a human endeavor the processes, methods, and knowledge of science include subjectivity, as well as creativity and discovery.

Content Complexity Rating: [Level 3: Strategic Thinking & Complex Reasoning](#) - [More Information](#)

Date of Last Rating: 05/08

Status: State Board Approved

Related Courses

Course Number	Course Title
2001350:	Astronomy Solar/Galactic (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2020910:	Astronomy Solar/Galactic Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000320:	Biology 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000330:	Biology 2 Honors (Specifically in versions: 2014 - 2015, 2015 - 2018, 2018 - 2022 (current), 2022 and beyond)
2000370:	Botany (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003340:	Chemistry 1 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003350:	Chemistry 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003360:	Chemistry 2 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2001310:	Earth/Space Science (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2001320:	Earth/Space Science Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000380:	Ecology (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2001340:	Environmental Science (Specifically in versions: 2015 - 2022 (current), 2022 and beyond)
2002480:	Forensic Science 1 (Specifically in versions: 2014 - 2015, 2015 - 2017, 2017 - 2022 (current), 2022 and beyond)
2002490:	Forensic Sciences 2 (Specifically in versions: 2014 - 2015, 2015 - 2017, 2017 - 2022 (current), 2022 and beyond)
2002410:	Integrated Science 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002420:	Integrated Science 2 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002430:	Integrated Science 2 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002440:	Integrated Science 3 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002450:	Integrated Science 3 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000390:	Limnology (Specifically in versions: 2014 - 2015, 2015 - 2018 (course terminated))
2002500:	Marine Science 1 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002510:	Marine Science 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002520:	Marine Science 2 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002530:	Marine Science 2 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003400:	Nuclear Radiation (Specifically in versions: 2014 - 2015, 2015 - 2018 (course terminated))
2020710:	Nuclear Radiation Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003310:	Physical Science (Specifically in versions: 2015 - 2022 (current), 2022 and beyond)
2003320:	Physical Science Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003380:	Physics 1 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)

2003390:	Physics 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003410:	Physics 2 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003600:	Principles of Technology 1 (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003610:	Principles of Technology 2 (Specifically in versions: 2014 - 2015, 2015 - 2018 (course terminated))
2002540:	Solar Energy Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002550:	Solar Energy 2 Honors (Specifically in versions: 2014 - 2015, 2015 - 2018 (course terminated))
2002330:	Space Technology and Engineering (Specifically in versions: 2014 - 2015, 2015 - 2018 (course terminated))
2000410:	Zoology (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002340:	Experimental Science 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002350:	Experimental Science 2 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002360:	Experimental Science 3 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002370:	Experimental Science 4 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
7920011:	Access Chemistry 1 (Specifically in versions: 2014 - 2015, 2015 - 2018, 2018 and beyond (current))
7920020:	Access Earth/Space Science (Specifically in versions: 2014 - 2015, 2015 - 2018, 2018 and beyond (current))
2000500:	Bioscience 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000510:	Bioscience 2 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2000520:	Bioscience 3 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2002425:	Integrated Science 2 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 - 2020 (course terminated))
2002445:	Integrated Science 3 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 - 2020 (course terminated))
2003345:	Chemistry 1 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003385:	Physics 1 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 - 2020 (course terminated))
2003500:	Renewable Energy 1 Honors (Specifically in versions: 2014 - 2015, 2015 - 2022 (current), 2022 and beyond)
2003836:	Florida's Preinternational Baccalaureate Physics 1 (Specifically in versions: 2015 - 2022 (current), 2022 and beyond)
2003838:	Florida's Preinternational Baccalaureate Physics 2 (Specifically in versions: 2015 and beyond (current))
7920022:	Access Physical Science (Specifically in versions: 2016 - 2018, 2018 and beyond (current))
2001341:	Environmental Science Honors (Specifically in versions: 2016 - 2022 (current), 2022 and beyond)
2001330:	Meteorology Honors (Specifically in versions: 2016 - 2019, 2019 - 2022 (current), 2022 and beyond)

Related Access Points

Access Points Number	Access Points Title
SC.912.N.2.In.3:	Recognize that scientific knowledge can be challenged or confirmed by new investigations and reexamination.
SC.912.N.2.Su.2:	Recognize that what is known about science can change based on new information.
SC.912.N.2.Pa.2:	Recognize a variety of cause-effect relationships related to science.

Related Resources

Lesson Plans

Name	Description
What's Your Type?:	In this lesson, students will analyze an informational text intended to support reading in the content area. The article explains the advancements that scientists have made in understanding blood types. By reading and synthesizing the text, students will explore a real-world example of how scientific knowledge becomes more robust and durable through investigations. This lesson includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric.
How Did Tuberculosis Reach the New World?:	This informational text is designed to support reading in the content area. The article from the National Science Foundation discusses research conducted on the origin of tuberculosis in the Americas. Scientists discovered tuberculosis in skeletons which pre-dated the arrival of Europeans to the New World. Through the analysis of tuberculosis DNA, it was discovered that the New World tuberculosis showed a clear relationship to lineages found in seals and sea lions, suggesting they carried the disease to the Americas pre-Columbus. The lesson plan includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric.
Termites to the Rescue!:	In this lesson, students will analyze an informational text from the National Science Foundation that discusses how termites in semi-arid ecosystems are preventing the process of desertification in these areas. The article also describes how and why scientific models are being used in this research. This lesson is designed to support reading in the content area. The lesson plan includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric.
Drama in the Deep:	In this lesson, students will analyze an informational text intended to support reading in the content area. The article describes the interactions between three different microorganisms and the implications on the food webs found in the oceans near Antarctica. Phytoplankton and bacteria are competing for food and resources in previously unknown ways. The lesson plan includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric. Numerous options to extend the lesson are also included.
Exploring the Heart of the Atom:	In this lesson, students will analyze an informational text intended to support reading in the content area. The article explains the strides scientists at Jefferson Lab are making toward revising our view of the atom via an upgrade to their CEBAF particle accelerator. The lesson plan includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric. Numerous options to extend the lesson are also included.
	In this lesson, students will analyze an informational text intended to support reading in the content area. The text

Phosphorus: Fertilizer of the Sea:	explains how scientists worked with the National Science Foundation (NSF) to try and better understand the phosphorus cycle in marine ecosystems. The author points out that although the phosphorus cycle has been studied in the past, the work chronicled in the article has greatly expanded that understanding. The lesson plan includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric. Numerous options to extend the lesson are also included.
Everyday Mysteries: Why Do We Yawn?:	In this lesson, students will analyze an informational text that seeks to answer the question "Why do we yawn?" Students will learn that while many claims regarding the social and physiological functions of yawning have been presented from Hippocrates, 17th and 18th century scientists, and experts today, scientists have yet to reach a consensus about the answer to the title question. All the while, this frequent challenge and re-examination of scientific claims helps to strengthen scientific knowledge. This lesson plan includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric, as well as options to extend the lesson.
Atomic Theory Stations - Eckert:	This is a set of 8 stations (each station lasts 15-20 minutes) that students may complete individually or in small groups. The stations focus on the development of the atomic theory and introduce students to the concept of the subatomic particles, how they were discovered, and where they are located within the atom. The stations can be grouped together and used as one lesson for 2-3 consecutive days, or they can be split into smaller increments and used over the course of several lessons.
MAP Gas Study:	This MEA presents data on modified atmospheric packaging (MAP) gas mixtures. Students are given standard data and asked to apply it to a new product.
Checks Lab:	Each team has an envelope containing a series of bank checks. A few are removed at a time, and the team attempts to construct a plausible scenario which involves those checks. With each subsequent removal of checks, appropriate revision of the scenario is done. Final scenarios are compared by the class. Class discussion is designed to show how human values and biases influence observation and interpretation, even in science. This is one of the few nature-of-science lessons which have a biological connection.
Invasive or Not?:	In this lesson, students will analyze an informational text that discusses new evidence regarding the status of the Arctic ground squirrel. The species was previously thought to be an invasive species on Chirikof Island off the coast of Alaska, but new evidence calls this belief into question. The lesson plan includes a vocabulary note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric.

Lesson Study Resource Kit

Name	Description
Exploring Diversity and Evolution: A Lesson Study Resource Kit for grades 9-12:	This lesson study resource kit is designed to support lesson study teams in developing a unit of instruction for students in grades 9-12 on the topic of diversity and evolution.

Text Resources

Name	Description
The Invasive Squirrel That Wasn't:	This informational text resource is designed to support reading in the content area. This article describes the discovery of evidence that contradicts the notion that a specific species of squirrel was introduced to an Alaskan ecosystem. It further discusses the implication of the new evidence and challenges the current meaning of invasive species.
The Mystery of Human Blood Types:	This informational text resource is intended to support reading in the content area. Blood types such as the ABO group have been inherited for at least 20 million years. Despite how ancient blood groups are, scientists are still unclear as to their purpose. The ABO blood group, the most well-known of the blood groups, has enabled scientists to understand a link between blood groups and the immune system; discoveries over the last century suggest a link between blood groups and disease. Even with these findings, scientists are still unclear as to why such blood antigens evolved in the first place.
Dirt Mounds Made by Termites in Africa, South America, Asia Could Prevent Spread of Deserts:	This informational text resource is designed to support reading in the content area. The article discusses the impact termite mounds are having on semi-arid ecosystems and the surprising realization that scientists have come to in regards to the effects of these termite mounds. The text also describes the importance of scientific modeling to predict plant growth while having termite mounds present.
Research Spotlights a Previously Unknown Microbial 'Drama' Playing in the Southern Ocean:	This informational text resource is intended to support reading in the content area. The article discusses the relationship between phytoplankton and different bacteria in the Southern Ocean. The text goes on to describe the results and how they changed previous ideas and assumptions about the needs of phytoplankton.
Exploring the Heart of Matter:	This informational text resource is intended to support reading in the content area. Under the direction of the Department of Energy, the Jefferson Laboratory is making strides in its development of a new high-speed particle accelerator. This accelerator promises to operate at double the maximum speed of existing accelerators, and it will reveal more details about the forces which bind subatomic particles inside an atom, as well as the very nature of those particles. These discoveries will help us refine our ideas about atoms and nuclei.
Revealing the Ocean's Hidden Fertilizer:	This informational text resource is designed to support reading in the content area. The text explains how scientists are working with the National Science Foundation (NSF) to explore the role of phosphorus, and specifically the phosphorus cycle, in marine ecosystems. The author explains what is known about the topic, what research was done, what conclusions were drawn, and the importance of the scientists' findings.
Why Do We Yawn?:	This informational text resource is designed to support reading in the content area. The article seeks to answer the question, "Why do we yawn?" Scientists have yet to reach consensus about the function of yawning. Social and physiological claims about why we yawn are presented from Hippocrates, 17th and 18th century scientists, and scientists today.
	This informational text resource is designed to support reading in the content area. The article is about a woman,

Zanzibar's Malaria Hunter:	Habiba, who uses a motorbike to travel to families in the villages of Zanzibar to track, test, and treat malaria patients. After receiving a text message about the location of a malaria patient, she travels to the patient and tests the patient's family to see if other family members have malaria. Then, she treats any infected family members with medicine, giving them extra medicine and insecticide-treated mosquito nets, while educating them about prevention of the disease and its transmission.
Ammonium Dichromate:	This article explains the uses and properties of ammonium dichromate, an "explosive" compound once common in children's chemistry sets, and the reasons why society has gradually moved away from using this compound.
Phrenology-History of a Science and Pseudoscience:	This informational text resource is intended to support reading in the content area. This article discusses phrenology, which is a pseudoscience that claims to be able to use bumps on human skulls to make inferences about personality traits. The article details why phrenology is not a true science, and reviews the history of phrenology, the role of phrenology in the debate about the organization of the brain, how phrenology came under scientific criticism, and modern iterations of the technique.
Debate Tests Accuracy of Tree Ring Data :	This informational text resource is intended to support reading in the content area. The article explains the controversy surrounding the research of scientists Mann, Fuentes, and Rutherford, whose work suggests that tree rings may not be as accurate a record of past climate changes as once thought. The author explains how the reliance on one type or source of data is a limitation in science and discusses the other information available to reconstruct climates of the past.
Evolution Made Ridiculous Flightless Birds Over and Over:	This informational text resource is intended to support reading in the content area. This article focuses on the evolution of ratites—large, flightless birds like the ostrich—and how they evolved to become flightless birds. New research shows that ratites evolved from common flying ancestors and that the evolutionary process occurred over and over again.
Antimatter:	This informational text is intended to support reading in the content area. The article describes the history of the study of antimatter in language that is easier to understand than most technical texts.
Some Ducks Let Young Be Raised by Relatives:	This informational text resource is intended to support reading in the content area. This text is a news article describing three reproductive strategies of goldeneye ducks. The text provides evidence regarding the reasons for such behaviors and also notes how the hypotheses regarding them have changed over time.
Scientists Now Uncertain About Heisenberg's Uncertainty Principle:	This informational text resource is intended to support reading in the content area. This article reports on scientists' findings that refute an aspect of Heisenberg's uncertainty principle. The article describes the principle and what the new results mean for its future.
"The Riddle of the Human Species," a New York Times Opinionator blog by biologist E. O. Wilson :	This informational text resource is intended to support reading in the content area. This New York Times Opinionator blog by one of the world's leading biologists is an explanation of the important role that "eusociality" has played in human evolution.
"What Do Scientific Studies Show?" an Opinionator Blog from The New York Times:	This informational text resource is intended to support reading in the content area. It includes an explanation from a philosophy professor of what is wrong when the media reports on scientific results that are later called into question.

Unit/Lesson Sequence

Name	Description
Modeling for Understanding Natural Selection:	This series of lessons introduces students to evolutionary reasoning and to the explanatory power of the Darwinian model of natural selection. Students read three evolutionary scientists' (Paley, Lamarck and Darwin) original work and compare their thinking, proposed mechanism of evolution, use of evidence, and explanatory power of their theory. They apply the three scientists thinking to another scenario to refine their understanding of the explanations.

Video/Audio/Animations

Name	Description
AIDS: Evolution of an Epidemic:	This Howard Hughes Medical Institute Holiday Lecture Series video includes 6, 60-minute lectures on the history of the AIDS epidemic. The talk covers AIDS/HIV history in the United States from the 1980's through 2007 (when the lecture was taped) and also some basics on the biology of HIV and AIDS, including transmission, viral replication and the human immune system. The video offers a useful perspective on an example of the evolution of scientific thinking and research, as researchers discuss the development of scientific theories about HIV/AIDS as well as treatments. Several related resources, such as animations and video clips, can be found on the main page.
Inquiry and Ocean Exploration:	Ocean explorer Robert Ballard gives a TED Talk relating to the mysteries of the ocean, and the importance of its continued exploration.

Student Resources

Video/Audio/Animation

Name	Description
Inquiry and Ocean Exploration:	Ocean explorer Robert Ballard gives a TED Talk relating to the mysteries of the ocean, and the importance of its continued exploration.