Science Georgia Standards of Excellence

SCIENCE - Oceanography

The Science Georgia Standards of Excellence are designed to provide foundational knowledge and skills for all students to develop proficiency in science. The Project 2061's *Benchmarks for Science Literacy* and the follow up work, *A Framework for K-12 Science Education* were used as the core of the standards to determine appropriate content and process skills for students. The Science Georgia Standards of Excellence focus on a limited number of core disciplinary ideas and crosscutting concepts which build from Kindergarten to high school. The standards are written with the core knowledge to be mastered integrated with the science and engineering practices needed to engage in scientific inquiry and engineering design. Crosscutting concepts are used to make connections across different science disciplines.

The Science Georgia Standards of Excellence drive instruction. Hands-on, student-centered, and inquiry-based approaches should be the emphasis of instruction. The standards are a required minimum set of expectations that show proficiency in science. However, instruction can extend beyond these minimum expectations to meet student needs.

Science consists of a way of thinking and investigating, as well a growing body of knowledge about the natural world. To become literate in science, students need to possess sufficient understanding of fundamental science content knowledge, the ability to engage in the science and engineering practices, and to use scientific and technological information correctly. Technology should be infused into the curriculum and the safety of the student should always be foremost in instruction.

The oceanography course is designed to emphasize the interconnectedness of multiple science disciplines. Students will recognize that the ocean is a dynamic system reflecting interactions among organisms, ecosystems, chemical cycles, and physical and geological processes, on land, in air, and in the oceans. Students will investigate oceanography concepts through experience in laboratories and fieldwork using the processes of inquiry.

SO1. Obtain, evaluate, and communicate information about how and why humans explore our ocean.

a. Obtain, evaluate, and communicate information that compares historical and modern motivations for ocean exploration and methods of exploration.
b. Define problems and challenges associated with oceanographic research and exploration. (*Clarification statement*: Emphasis should be on using technology to address issues such as seawater corrosiveness, deep sea temperatures and pressure, water depth, distance from land, and wave action.)

SO2. Obtain, evaluate, and communicate information about the characteristics, physical features, and boundaries of the oceans.

a. Analyze and interpret geologic data to describe how the Earth's ocean basins, ocean and atmosphere were formed.
b. Construct an argument from evidence to support the role of plate tectonics in shaping the physical features of the ocean and continents.
c. Analyze and interpret data to understand how the dynamic events at plate boundaries influence the physical features of oceans and continents.
(*Clarification statement*: Events such as tsunamis and earthquakes should be included in this element.)
d. Develop and use models to investigate geological features from the continental margins to the deep ocean basins.
(Clarification statement: Models should provide scale information about the features being represented.)
e. Ask questions to classify the sources of different types of marine sediments.

SO3. Obtain, evaluate, and communicate information to model the flow of energy in the ocean.

a. Construct an explanation to support the claim that some of the earliest life forms originated in the ocean.
b. Ask questions to compare and contrast the relative role of photosynthesis and chemosynthesis in oceanic biologic productivity and describe the oceanic realms in which each mode of primary production occurs.
(*Clarification statement*: Distinguish between photosynthesis and chemosynthesis in ocean organisms.)
c. Develop and use models to analyze the flow of energy and cycling of matter in marine ecosystems.
(*Clarification statement*: This includes food webs and trophic levels.)
d. Ask questions to investigate relationships between biotic and abiotic factors in marine ecosystems including estuaries, coral reefs, kelp forests, the open ocean, and the deep ocean.

SO4. Obtain, evaluate, and communicate information that describes the complex relationships between weather, climate and the oceans.

a. Develop a model to explain the effects of tilt of the earth, solar energy inputs, and heat capacity of land and oceans on the resulting patterns of weather and climate.
b. Ask questions to investigate and provide explanations about the influence of the Coriolis Effect on winds, ocean currents, and climate.
c. Analyze and interpret data to develop models for global patterns of atmospheric and oceanic circulation.
   (*Clarification statement:* Include the role of deep water currents in oceanic circulation.)
d. Construct an explanation for variations in global weather patterns such as El Nino, hurricanes, and monsoons and design solutions to minimize the impact of these systems on human populations.
e. Use mathematics and computational thinking to explain how climate change influences the ocean.
   (*Clarification statement*: Emphasis is on sea level rise and ocean acidification.)

SO5. Obtain, evaluate, and communicate information on how waves and tides are created and their influence on coastal processes.

a. Develop and use models to demonstrate how ocean waves are generated.
   (*Clarification statement:* Consideration should be given to the type of waves formed by wind, atmospheric pressure gradients, gravitation, earthquakes, storms, and surface tension forces.)
b. Use mathematics and computational thinking to analyze the properties of ocean waves and how they change as they interact with the seafloor.
c. Construct an argument based on evidence from tide tables and lunar calendars to explain the role of the moon and sun in the formation of tides and tidal patterns.
d. Construct an explanation for the effects of waves and tides on coastlines, including how they interact with sandy shorelines to transport sediments, influence barrier islands, and affect the marine organisms that live there.

SO6. Obtain, evaluate, and communicate information on the physical and chemical properties of seawater and how they influence the structure of the ocean.

a. Develop and use a model to demonstrate how the ocean and land are connected by the hydrologic and other biogeochemical cycles.
b. Plan and carry out an investigation to discover the unique properties of seawater when compared to fresh water.
(*Clarification statement*: Water quality monitoring could be used to address this element.)
c. Ask questions to investigate how the water column is structured based upon the physical properties of seawater (temperature, salinity, density).
d. Develop an argument based on evidence to support the claim that the physical properties of sea water influence the evolution, adaptations and distributions of marine organisms.
(*Clarification statement:* This should include addressing how invertebrate and vertebrate organisms are differently impacted by sea water properties.)

SO7. Obtain, evaluate, and communicate information about how humans use the ocean as a resource and the need for responsible stewardship.

a. Construct an argument based on evidence about the impact that extraction of physical, geological, chemical, and biological resources from the oceans has on marine ecosystems.
b. Design, evaluate, and refine solutions on how to use the ocean as a source of alternative energy.
c. Construct an explanation based on evidence on how recreation and transportation impact marine ecosystems.
d. Analyze and interpret data to investigate the causes of ocean acidification, biomagnification of pollutants, ocean deoxygenation, and eutrophication.
e. Construct an argument based on evidence to examine policies and laws related to responsible stewardship of the oceans.
f. Design and evaluate a sustainability plan that includes conservation efforts to reduce human impact on the ocean.
(*Clarification statement:* Human impact should include the role of individuals living inland.)