Aquatic Science

Subject: Science
Grade: 12
Num Expectations: 54
Num Breakouts: 188

(a) Introduction.

(1) Aquatic Science. In Aquatic Science, students study the interactions of biotic and abiotic components in aquatic environments, including natural and human impacts on aquatic systems. Investigations and field work in this course may emphasize fresh water or marine aspects of aquatic science depending primarily upon the natural resources available for study near the school. Students who successfully complete Aquatic Science acquire knowledge about how the properties of water and fluid dynamics affect aquatic ecosystems and acquire knowledge about a variety of aquatic systems. Students who successfully complete Aquatic Science conduct investigations and observations of aquatic environments, work collaboratively with peers, and develop critical-thinking and problem- solving skills.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.

(3) Scientific hypotheses and theories. Students are expected to know that:

(A) hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and

(B) scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed.

(4) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

(A) Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

(B) Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.

(5) Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).

(6) Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and provide tools for understanding the ideas presented. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(7) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(b) Knowledge and Skills Statements

(1) Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to explain phenomena or design solutions using appropriate tools and models. The student is expected to:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

Breakouts

(i) ask questions based on observations or information from text, phenomena, models, or investigations

(ii) define problems based on observations or information from text, phenomena, models, or investigations

(B) apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

Breakouts

(i) apply scientific practices to plan descriptive investigations

(ii) apply scientific practices to plan comparative investigations

(iii) apply scientific practices to plan experimental investigations

(iv) apply scientific practices to conduct descriptive investigations

(v) apply scientific practices to conduct comparative investigations

(vi) apply scientific practices to conduct experimental investigations

(vii) use engineering practices to design solutions to problems

(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

Breakouts

(i) use appropriate safety equipment during laboratory investigations as outlined in Texas Education Agency-approved safety standards

(ii) use appropriate safety equipment during classroom investigations as outlined in Texas Education Agency-approved safety standards

(iii) use appropriate safety equipment during field investigations as outlined in Texas Education Agency-approved safety standards

(iv) use appropriate safety practices during laboratory investigations as outlined in Texas Education Agency-approved safety standards

(v) use appropriate safety practices during classroom investigations as outlined in Texas Education Agency-approved safety standards

(vi) use appropriate safety practices during field investigations as outlined in Texas Education Agency-approved safety standards

(D) use appropriate tools such as Global Positioning System (GPS), Geographic Information System (GIS), weather balloons, buoys, water testing kits, meter sticks, metric rulers, pipettes, graduated cylinders, standard laboratory glassware, balances, timing devices, pH meters or probes, various data collecting probes, thermometers, calculators, computers, internet access, turbidity testing devices, hand magnifiers, work and disposable gloves, compasses, first aid kits, field guides, water quality test kits or probes, 30-meter tape measures, tarps, ripple tanks, trowels, screens, buckets, sediment samples equipment, cameras, flow meters, cast nets, kick nets, seines, computer models, spectrophotometers, stereomicroscopes, compound microscopes, clinometers, and field journals, various prepared slides, hand lenses, hot plates, Petri dishes, sampling nets, waders, leveling grade rods (Jason sticks), protractors, inclination and height distance calculators, samples of biological specimens or structures, core sampling equipment, fish tanks and associated supplies, and hydrometers;

Breakouts

(i) use appropriate tools

(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence;

Breakouts

(i) collect quantitative data using the International System of Units (SI)

(ii) collect qualitative data as evidence

(F) organize quantitative and qualitative data using probeware, spreadsheets, lab notebooks or journals, models, diagrams, graphs paper, computers, or cellphone applications;

Breakouts

(i) organize quantitative data using probeware, spreadsheets, lab notebooks or journals, models, diagrams, graphs paper, computers, or cellphone applications

(ii) organize qualitative data using probeware, spreadsheets, lab notebooks or journals, models, diagrams, graphs paper, computers, or cellphone applications

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

Breakouts

(i) develop models to represent phenomena, systems, processes, or solutions to engineering problems

(ii) use models to represent phenomena, systems, processes, or solutions to engineering problems

(H) distinguish between scientific hypotheses, theories, and laws.

Breakouts

(i) distinguish between scientific hypotheses, theories, and laws

(2) Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A) identify advantages and limitations of models such as their size, scale, properties, and materials;

Breakouts

(i) identify advantages of models

(ii) identify limitations of models

(B) analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

Breakouts

(i) analyze data by identifying significant statistical features

(ii) analyze data by identifying patterns

(iii) analyze data by identifying sources of error

(iv) analyze data by identifying limitations

(C) use mathematical calculations to assess quantitative relationships in data; and

Breakouts

(i) use mathematical calculations to assess quantitative relationships in data

(D) evaluate experimental and engineering designs.

Breakouts

(i) evaluate experimental designs

(ii) evaluate engineering designs

(3) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A) develop explanations and propose solutions supported by data and models consistent with scientific ideas, principles, and theories;

Breakouts

(i) develop explanations supported by data consistent with scientific ideas

(ii) develop explanations supported by data consistent with scientific principles

(iii) develop explanations supported by data consistent with scientific theories

(iv) develop explanations supported by models consistent with scientific ideas

(v) develop explanations supported by models consistent with scientific principles

(vi) develop explanations supported by models consistent with scientific theories

(vii) propose solutions supported by data consistent with scientific ideas

(viii) propose solutions supported by data consistent with scientific principles

(ix) propose solutions supported by data consistent with scientific theories

(x) propose solutions supported by models consistent with scientific ideas

(xi) propose solutions supported by models consistent with scientific principles

(xii) propose solutions supported by models consistent with scientific theories

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

Breakouts

(i) communicate explanations individually in a variety of settings

(ii) communicate explanations individually in a variety of formats

(iii) communicate explanations collaboratively in a variety of settings

(iv) communicate explanations collaboratively in a variety of formats

(v) communicate solutions individually in a variety of settings

(vi) communicate solutions individually in a variety of formats

(vii) communicate solutions collaboratively in a variety of settings

(viii) communicate solutions collaboratively in a variety of formats

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

Breakouts

(i) engage respectfully in scientific argumentation using applied scientific explanations

(ii) engage respectfully in scientific argumentation using empirical evidence

(4) Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:

(A) analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;

Breakouts

(i) analyze scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(ii) analyze scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(iii) analyze scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(iv) analyze scientific explanations and solutions by using observational testing so as to encourage critical thinking by the student

(v) evaluate scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(vi) evaluate scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(vii) evaluate scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(viii) evaluate scientific explanations and solutions by using observational testing so as to encourage critical thinking by the student

(ix) critique scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(x) critique scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(xi) critique scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(xii) critique scientific explanations and solutions by using observational testing so as to encourage critical thinking by the student

(B) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists as related to the content; and

Breakouts

(i) relate the impact of past research on scientific thought, including research methodology

(ii) relate the impact of past research on scientific thought, including cost-benefit analysis

(iii) relate the impact of past research on scientific thought, including contributions of diverse scientists as related to the content

(iv) relate the impact of past research on society, including research methodology

(v) relate the impact of past research on society, including cost-benefit analysis

(vi) relate the impact of past research on society, including contributions of diverse scientists as related to the content

(vii) relate the impact of current research on scientific thought, including research methodology

(viii) relate the impact of current research on scientific thought, including cost-benefit analysis

(ix) relate the impact of current research on scientific thought, including contributions of diverse scientists as related to the content

(x) relate the impact of current research on society, including research methodology

(xi) relate the impact of current research on society, including cost-benefit analysis

(xii) relate the impact of current research on society, including contributions of diverse scientists as related to the content

(C) research and explore resources such as museums, planetariums, observatories, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field in order to investigate STEM careers.

Breakouts

(i) research STEM careers

(ii) explore resources in order to investigate STEM careers

(5) The student understands how the properties of water build the foundation of aquatic ecosystems. The student is expected to:

(A) describe how the shape and polarity of the water molecule make it a "universal solvent" in aquatic systems;

Breakouts

(i) describe how the shape of the water molecule make it a "universal solvent" in aquatic systems

(ii) describe how the polarity of the water molecule make it a "universal solvent" in aquatic systems

(B) identify how aquatic ecosystems are affected by water's properties of adhesion, cohesion, surface tension, heat capacity, and thermal conductivity; and

Breakouts

(i) identify how aquatic ecosystems are affected by water's properties of adhesion

(ii) identify how aquatic ecosystems are affected by water's properties of cohesion

(iii) identify how aquatic ecosystems are affected by water's properties of surface tension

(iv) identify how aquatic ecosystems are affected by water's properties of heat capacity

(v) identify how aquatic ecosystems are affected by water's properties of thermal conductivity

(C) explain how the density of water is critical for organisms in cold environments.

Breakouts

(i) explain how the density of water is critical for organisms in cold environments

(6) Students know that aquatic environments are the product of interactions among Earth systems. The student is expected to:

(A) identify key features and characteristics of atmospheric, geological, hydrological, and biological systems as they relate to aquatic environments;

Breakouts

(i) identify key features of atmospheric systems as they relate to aquatic environments

(ii) identify key features of geological systems as they relate to aquatic environments

(iii) identify key features of hydrological systems as they relate to aquatic environments

(iv) identify key features of biological systems as they relate to aquatic environments

(v) identify key characteristics of atmospheric systems as they relate to aquatic environments

(vi) identify key characteristics of geological systems as they relate to aquatic environments

(vii) identify key characteristics of hydrological systems as they relate to aquatic environments

(viii) identify key characteristics of biological systems as they relate to aquatic environments

(B) describe the interrelatedness of atmospheric, geological, hydrological, and biological systems in aquatic ecosystems, including positive and negative feedback loops; and

Breakouts

(i) describe the interrelatedness of atmospheric, geological, hydrological, and biological systems in aquatic ecosystems, including positive feedback loops

(ii) describe the interrelatedness of atmospheric, geological, hydrological, and biological systems in aquatic ecosystems, including negative feedback loops

(C) evaluate environmental data using technology such as maps, visualizations, satellite data, Global Positioning System (GPS), Geographic Information System (GIS), weather balloons, and buoys to model the interactions that affect aquatic ecosystems.

Breakouts

(i) evaluate environmental data using technology to model the interactions that affect aquatic ecosystems

(7) The student knows about the interdependence and interactions that occur in aquatic environments. The student is expected to:

(A) identify how energy flows and matter cycles through both freshwater and marine aquatic systems, including food webs, chains, and pyramids;

Breakouts

(i) identify how energy flows through freshwater aquatic systems, including food webs

(ii) identify how energy flows through freshwater aquatic systems, including chains

(iii) identify how energy flows through freshwater aquatic systems, including pyramids

(iv) identify how energy flows through marine aquatic systems, including food webs

(v) identify how energy flows through marine aquatic systems, including chains

(vi) identify how energy flows through marine aquatic systems, including pyramids

(vii) identify how matter cycles through freshwater aquatic systems, including food webs

(viii) identify how matter cycles through freshwater aquatic systems, including chains

(ix) identify how matter cycles through freshwater aquatic systems, including pyramids

(x) identify how matter cycles through marine aquatic systems, including food webs

(xi) identify how matter cycles through marine aquatic systems, including chains

(xii) identify how matter cycles through marine aquatic systems, including pyramids

(B) identify biological, chemical, geological, and physical components of an aquatic life zone as they relate to the organisms in it;

Breakouts

(i) identify biological components of an aquatic life zone as they relate to the organisms in it

(ii) identify chemical components of an aquatic life zone as they relate to the organisms in it

(iii) identify geological components of an aquatic life zone as they relate to the organisms in it

(iv) identify physical components of an aquatic life zone as they relate to the organisms in it

(C) identify variables that affect the solubility of carbon dioxide and oxygen in water;

Breakouts

(i) identify variables that affect the solubility of carbon dioxide in water

(ii) identify variables that affect the solubility of oxygen in water

(D) evaluate factors affecting aquatic population cycles such as lunar cycles, temperature variations, hours of daylight, and predator-prey relationships; and

Breakouts

(i) evaluate factors affecting aquatic population cycles

(E) identify the interdependence of organisms in an aquatic environment such as in a pond, a river, a lake, an ocean, or an aquifer and the biosphere.

Breakouts

(i) identify the interdependence of organisms in an aquatic environment

(8) The student conducts short-term and long-term studies on local aquatic environments. Local natural environments are to be preferred over artificial or virtual environments. The student is expected to:

(A) evaluate data over a period of time from an established aquatic environment documenting seasonal changes and the behavior of organisms;

Breakouts

(i) evaluate data over a period of time from an established aquatic environment documenting seasonal changes

(ii) evaluate data over a period of time from an established aquatic environment documenting the behavior of organisms

(B) collect and analyze pH, salinity, temperature, mineral content, nitrogen compounds, dissolved oxygen, and turbidity data periodically, starting with baseline measurements; and

Breakouts

(i) collect pH data periodically, starting with baseline measurements

(ii) collect salinity data periodically, starting with baseline measurements

(iii) collect temperature data periodically, starting with baseline measurements

(iv) collect mineral content data periodically, starting with baseline measurements

(v) collect nitrogen compounds data periodically, starting with baseline measurements

(vi) collect dissolved oxygen data periodically, starting with baseline measurements

(vii) collect turbidity data periodically, starting with baseline measurements

(viii) analyze pH data periodically, starting with baseline measurements

(ix) analyze salinity data periodically, starting with baseline measurements

(x) analyze temperature data periodically, starting with baseline measurements

(xi) analyze mineral content data periodically, starting with baseline measurements

(xii) analyze nitrogen compounds data periodically, starting with baseline measurements

(xiii) analyze dissolved oxygen data periodically, starting with baseline measurements

(xiv) analyze turbidity data periodically, starting with baseline measurements

(C) use data from short-term or long-term studies to analyze interrelationships between producers, consumers, and decomposers in aquatic ecosystems.

Breakouts

(i) use data from short-term or long-term studies to analyze interrelationships between producers, consumers, and decomposers in aquatic ecosystems

(9) The student knows the role of cycles in an aquatic environment. The student is expected to:

(A) identify the role of carbon, nitrogen, water, and nutrient cycles in an aquatic environment, including upwellings and turnovers;

Breakouts

(i) identify the role of carbon cycles in an aquatic environment, including upwellings

(ii) identify the role of carbon cycles in an aquatic environment, including turnovers

(iii) identify the role of nitrogen cycles in an aquatic environment, including upwellings

(iv) identify the role of nitrogen cycles in an aquatic environment, including turnovers

(v) identify the role of water cycles in an aquatic environment, including upwellings

(vi) identify the role of water cycles in an aquatic environment, including turnovers

(vii) identify the role of nutrient cycles in an aquatic environment, including upwellings

(viii) identify the role of nutrient cycles in an aquatic environment, including turnovers

(B) examine the interrelationships between aquatic systems and climate and weather, including El Niño and La Niña, currents, and hurricanes; and

Breakouts

(i) examine the interrelationships between aquatic systems and climate and weather, including El Niño

(ii) examine the interrelationships between aquatic systems and climate and weather, including La Niña

(iii) examine the interrelationships between aquatic systems and climate and weather, including currents

(iv) examine the interrelationships between aquatic systems and climate and weather, including hurricanes

(C) explain how tidal cycles influence intertidal ecology.

Breakouts

(i) explain how tidal cycles influence intertidal ecology

(10) The student knows the origin and potential uses of fresh water. The student is expected to:

(A) identify sources of water in a watershed, including rainfall, groundwater, and surface water;

Breakouts

(i) identify sources of water in a watershed, including rainfall

(ii) identify sources of water in a watershed, including groundwater

(iii) identify sources of water in a watershed, including surface water

(B) identify factors that contribute to how water flows through a watershed;

Breakouts

(i) identify factors that contribute to how water flows through a watershed

(C) analyze water quantity and quality in a local watershed or aquifer; and

(D) Breakouts

(i) analyze water quantity in a local watershed or aquifer

(ii) analyze water quality in a local watershed or aquifer

(E) describe human uses of fresh water and how human freshwater use competes with that of other organisms.

Breakouts

(i) describe human uses of fresh water

(ii) describe how human freshwater use competes with that of other organisms

(11) The student knows that geological phenomena and fluid dynamics affect aquatic systems. The student is expected to:

(A) examine basic principles of fluid dynamics, including hydrostatic pressure, density as a result of salinity, and buoyancy;

Breakouts

(i) examine basic principles of fluid dynamics, including hydrostatic pressure

(ii) examine basic principles of fluid dynamics, including density as a result of salinity

(iii) examine basic principles of fluid dynamics, including buoyancy

(B) identify interrelationships between ocean currents, climates, and geologic features such as continental margins, active and passive margins, abyssal plains, island atolls, peninsulas, barrier islands, and hydrothermal vents;

Breakouts

(i) identify interrelationships between ocean currents, climates, and geologic features

(C) explain how fluid dynamics causes upwelling and lake turnover; and

Breakouts

(i) explain how fluid dynamics causes upwelling

(ii) explain how fluid dynamics causes lake turnover

(D) describe how erosion and deposition in river systems lead to formation of geologic features.

Breakouts

(i) describe how erosion in river systems lead[s] to formation of geologic features

(ii) describe how deposition in river systems lead[s] to formation of geologic features

(12) The student understands the types of aquatic ecosystems. The student is expected to:

(A) differentiate among freshwater, brackish, and marine ecosystems; and

Breakouts

(i) differentiate among freshwater, brackish, and marine ecosystems

(B) identify the major properties and components of different marine and freshwater life zones.

Breakouts

(i) identify the major properties of different marine life zones

(ii) identify the major properties of different freshwater life zones

(iii) identify the major components of different mariner life zones

(iv) identify the major components of different freshwater life zones

(13) The student knows environmental adaptations of aquatic organisms. The student is expected to:

(A) compare different traits in aquatic organisms using tools such as dichotomous keys;

Breakouts

(i) compare different traits in aquatic organisms using tools

(B) describe how adaptations allow an organism to exist within an aquatic environment; and

Breakouts

(i) describe how adaptations allow an organism to exist within an aquatic environment

(C) compare adaptations of freshwater and marine organisms.

Breakouts

(i) compare adaptations of freshwater and marine organisms

(14) The student understands how human activities impact aquatic environments. The student is expected to:

(A) analyze the cumulative impact of human population growth on an aquatic ecosystem;

Breakouts

(i) analyze the cumulative impact of human population growth on an aquatic ecosystem

(B) predict effects of chemical, organic, physical, and thermal changes due to humans on the living and nonliving components of an aquatic ecosystem;

Breakouts

(i) predict effects of chemical changes due to humans on the living components of an aquatic ecosystem

(ii) predict effects of organic changes due to humans on the living components of an aquatic ecosystem

(iii) predict effects of physical changes due to humans on the living components of an aquatic ecosystem

(iv) predict effects of thermal changes due to humans on the living components of an aquatic ecosystem

(v) predict effects of chemical changes due to humans on the nonliving components of an aquatic ecosystem

(vi) predict effects of organic changes due to humans on the nonliving components of an aquatic ecosystem

(vii) predict effects of physical changes due to humans on the nonliving components of an aquatic ecosystem

(viii) predict effects of thermal changes due to humans on the nonliving components of an aquatic ecosystem

(C) investigate the role of humans in unbalanced systems involving phenomena such as invasive species, fish farming, cultural eutrophication, or red tides;

Breakouts

(i) investigate the role of humans in unbalanced systems involving phenomena

(D) analyze and discuss how human activities such as fishing, transportation, dams, and recreation influence aquatic environments;

Breakouts

(i) analyze how human activities influence aquatic environments

(ii) discuss how human activities influence aquatic environments

(E) describe the impact such as costs and benefits of various laws and policies such as The Endangered Species Act, right of capture laws, or Clean Water Act on aquatic systems; and

Breakouts

(i) describe the impact of various laws and policies

(F) analyze the purpose and effectiveness of human efforts to restore aquatic ecosystems affected by human activities.

Breakouts

(i) analyze the purpose of human efforts to restore aquatic ecosystems affected by human activities

(ii) analyze the effectiveness of human efforts to restore aquatic ecosystems affected by human activities