Section 4. Science

I. OVERALL OBJECTIVES

Aim to develop students' competencies necessary to conduct scientific inquiry into natural objects and phenomena, through experiencing natural objects and phenomena, using discipline-based epistemological approaches of science, and conducting observations and experiments with a comprehensive vision. Specifically, ensure that students:

(1) Deepen knowledge and understanding of natural objects and phenomena, and acquire fundamental skills for observations, experiments, and other scientific activities necessary to conduct scientific inquiry.

(2) Develop abilities to conduct scientific inquiry through conducting observations, experiments, and other scientific activities.

(3) Develop attitudes toward conducting scientific inquiry through actively experiencing natural objects and phenomena.

II. OBJECTIVES AND CONTENT FOR EACH FIELD

[Field One (Physical Science)]

1. Objectives

Aim to develop students' competencies necessary to conduct scientific inquiry into natural objects and phenomena related to matter and energy in the following ways.

(1) Through conducting observations, experiments, and other scientific activities regarding objects and phenomena related to matter and energy, understand "Familiar physical phenomena", "Electric currents and their uses", "Motion and energy", "Familiar substances", "Chemical changes, atoms and molecules", and "Chemical changes and ions", and at the same time deepen recognition regarding the relationship between human life and the development of Science & Technology. In addition, acquire fundamental skills for observations, experiments, and other scientific activities necessary to conduct scientific inquiry into the topics mentioned above.

(2) Through experiencing objects and phenomena related to matter and energy, develop abilities to discover regularities and to solve problems by conducting scientific inquiry activities that include generating questions, conducting observations,

experiments, and other scientific activities with a comprehensive view, and at the same time analyzing and interpreting the results, and expressing them.

(3) Develop attitudes toward conducting scientific inquiry through actively experiencing objects and phenomena related to matter and energy, and at the same time develop holistic views on nature.

2. Contents

(1) Familiar physical phenomena

Through observations, experiments, and other scientific activities regarding familiar physical phenomena, provide instruction to help students acquire the following items.

(a) While making connections between familiar physical phenomena and daily life or society, understand the followings and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Light and sound

i. reflection and refraction of light

Through conducting experiments on reflection and refraction of light, discover and understand regularities when light is reflected and refracted by an interface of materials such as water and glass.

ii. Function of convex lenses

Through conducting experiments on function of convex lenses, discover and understand the relationship between the position of the object and its image.

iii. Properties of sound

Through conducting experiments regarding sound, discover and understand that sound is produced by vibrating objects and travels through space, and that the pitch and volume of sound are related to how the object vibrates.

b. Function of force

i. Function of force

Through conducting experiments that exert force on objects, discover and understand how the object deforms, or begins to move, or changes its motion, when force is exerted, and at the same time learn that force is expressed by the magnitude and direction. In addition, through conducting experiments that exert two forces on an object, discover and understand the conditions when the forces are balanced.

(b) Regarding familiar physical phenomena, discover and express the regularities and relationships of light reflection and refraction, the function of convex lenses, the properties of sound, and the function of force, through generating questions, and conducting observations, experiments, and other scientific activities with a comprehensive view.

(2) Familiar substance

Through observations, experiments, and other scientific activities regarding familiar substances, provide instruction to help students acquire the following items.

(a) While paying attention to the properties and changes of familiar substances, understand the followings and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Characteristics of Substances

i. Familiar substances and their properties

Through conducting experiments using various methods to examine the properties of familiar substances, discover and understand the unique and common properties of substances such as density and changes when heated, and acquire skills to maneuver experimental apparatus and to record experimental processes and results.

ii. Generation of gases and their properties

Through conducting experiments on the generation of gases and examining their properties, understand the characteristics of various types of gases, and acquire skills to generate and collect them.

b. Aqueous solutions

i. Aqueous solutions

Through conducting experiments to extract solutes from aqueous solutions, understand the results in relation to the concept of solubility.

c. Changes of state

i. Changes of state and heat

Through conducting observations and experiments regarding changes in states of matter, discover and understand that changes of state cause volume of a substance change but not its mass.

ii. Melting and boiling points of substances

Understand that the state of matter changes when it reaches its melting point or boiling point, and through conducting experiments on heating them, discover and understand that mixtures can be separated based on the difference of their boiling points by conducting experiments on heating them.

(b) Regarding familiar substances, discover and express the regularities in the properties of matter and changes in state, through generating questions, and conducting observations, experiments, and other scientific activities with a comprehensive view.

(3) Electric currents and their uses

Through observations, experiments, and other scientific activities regarding electric currents and their uses, provide instruction to help students acquire the following items.

(a) While making connection between daily life or society and objects and phenomena concerning electric currents and magnetic fields, understand the followings and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Electric currents

i. Circuits and electric currents and voltage

Through conducting experiments on circuits and measuring their electric currents and voltage, discover and understand regularities in the electric current flowing through each point of the circuit and the voltage taken at each segment of the circuit.

ii. Electric current and voltage and resistance

Through conducting experiments to measure voltage and electric currents on metal wires, discover and understand the relationship between voltage and electric currents, and understand that metal wires have a resistance to electricity.

iii. Electricity and its energy

Through conducting experiments that generate heat and light by the use of electric currents, discover and understand that heat and light can be produced from electric currents, and that there are differences in the amount of generated heat and light based on the differences in electrical power.

iv. Static electricity and electric currents

Discover and understand that static electricity is generated by rubbing different substances together, and that there is a force working in the space between charged objects, and that there is a relationship between static electricity and relates to electric currents.

b. Electric currents and magnetic fields

i. Magnetic fields which generated by electric currents

Through conducting observations on magnetic fields by the use of magnets and electric currents, understand that magnetic fields are represented by lines of magnetic force, and learn that a magnetic field can be generated around a coil.

ii. Force produced by electric currents in a magnetic field

Through conducting experiments using magnets and a coil, discover and understand that a force is produced when an electric current flows through a coil in a magnetic field.

iii. Electromagnetic induction and power generation

Through conducting experiments using magnets and a coil, discover and understand that an electric current can be generated by moving the coil or magnets, and understand the differences between DC and AC.

(b) Regarding phenomena related to electric currents and magnetic fields, discover and express the regularities and relationships of electric currents and voltage, the functions of electric currents, static electricity, and electric currents and magnetic fields, through designing a method for solving a problem and conducting observations, experiments, and other scientific activities with a comprehensive view, and then analyzing and interpreting the results.

(4) Chemical changes, atoms and molecules

Through observations, experiments, and other scientific activities regarding chemical changes, provide instruction to help students acquire the following items.

(a) While relating chemical changes to atomic and molecular models, understand the followings and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Composition of substances

i. Decomposition of substances

Through conducting experiments which break down a substance, discover and understand that the resulting substances that are separated are different from the original substance.

ii. Atoms and molecules

Understand that substances are made of atoms and molecules, and learn that the varieties of atoms that compose substances are represented by symbols.

b. Chemical changes

i. Chemical changes

Through conducting an experiment that causes a reaction between two substances, discover and understand that different substances are generated by the reaction afterwards, and understand that chemical changes can be explained using atomic and molecular models, that the composition of the chemical compound is expressed through a chemical formula, and that chemical changes are expressed through chemical reaction formulas.

ii. Oxidation and reduction in chemical changes

Through conducting experiments on oxidation and reduction, discover and understand that oxidation and reduction are reactions that are related to oxygen.

iii. Chemical changes and heat

Through conducting experiments which extract heat in the process of chemical changes, discover and understand that chemical changes are accompanied by the release and absorption of heat.

c. Chemical changes and the mass of substances

i. Chemical changes and the conservation of mass

Through conducting experiments which measure the mass of substances before and after chemical changes, discover and understand that the sum total of the mass of the reactant is equal to the sum total of the mass of the product material.

ii. Regularities of mass changes

Through conducting an experiment which measures the mass of substances concerned with the chemical change, discover and understand that there is a specific relationship between the mass of the chemicals that undergo the reaction.

(b) Regarding chemical changes, discover and express the changes and quantitative relationships in the properties of substances that undergo chemical changes, through designing a method for solving a problem, conducting observations, experiments

and other scientific activities with a comprehensive view, and then analyzing and interpreting the results in relation to the idea of atoms and molecules.

(5) Motion and energy

Through observations, experiments, and other scientific activities regarding motion of objects and energy, provide instruction to help students acquire the following items.

(a) While making connections between motion of objects and energy and daily life or society, understand the followings and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Equilibrium of force and its composition and decomposition

i. Force exerted on a body submerged in water

Through conducting experiments regarding water pressure, understand the results relating pressure to the weight of the water. In addition, learn that a buoyant force is exerted on the object submerged in water.

ii. Composition and decomposition of forces

Through conducting experiments regarding the composition and decomposition of forces, understand the regularities in the resultant forces and component forces.

b. Regularities of motion

i. Speed and direction of motion

Through conducting observations and experiments on motion of objects, learn that the motion is expressed by its speed and direction.

ii. Force and motion

Through conducting observations and experiments on motion of an object when a force is exerted on the object and also when a force is not exerted on the object, discover and understand that when a force is exerted on the object, the speed of the object changes according to the direction of motion and the time elapsed, and also for motion when force is not exerted on the object, it moves in a straight line at a uniform speed.

c. Mechanical energy

i. Work and energy

Through conducting experiments related to work, understand the concepts of work and power. In addition, through conducting experiments on collisions,

understand that the amount of mechanical energy of an object can be measured by the work performed by the object to another object.

ii. Conservation of mechanical energy

Through conducting experiments related to mechanical energy, discover and understand that kinetic energy and potential energy transform into one another, and understand that the net amount of mechanical energy is conserved.

(b) Regarding motion and energy, discover and express the regularities and relationships of equilibrium of forces, composition and decomposition of forces, motion of objects, and mechanical energy, through conducting observations, experiments, and other scientific activities with a comprehensive view. In addition, reflect on the processes of inquiry.

(6) Chemical changes and ions

Through observation, experiments, and other scientific activities regarding chemical changes, provide instruction to help students acquire the following items.

(a) While making connections between chemical changes and ion models, understand the following and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Aqueous solutions and ions

i. The composition of atoms and ions

Through conducting experiments on aqueous solutions by applying electric voltage to see if electric currents flow through the substance, discover and understand that there are solutions through which electric currents flow and solutions through which electric currents do not flow. In addition, through conducting experiments on electrolyte aqueous solutions by applying electric voltage and letting electric currents flow through the solution, learn about the existence of ions from the fact that a substance is produced at each of the electrodes and also learn that the production of ions is related to the composition of atoms.

ii. Acids and alkalis

Through conducting experiments to investigate the properties of acids and alkalis, learn that the characteristic of acids and alkalis depend on hydrogen ions and hydroxide ions.

iii. Neutralization and salt

Through conducting experiments on neutralization reactions, understand that water and salts are produced by mixing acids and alkalis together.

b. Chemical changes and batteries

i. Metal ions

Through conducting experiments on electrolyte aqueous solutions by inserting metals in them, discover and understand that the tendency of becoming ions depends on metals.

ii. Chemical changes and batteries

Through conducting experiments on electrolytic aqueous solutions and two types of metals, understand the basic mechanism of batteries and learn that chemical energy is converted into electrical energy.

(b) Regarding chemical changes, discover and express the regularities and relationships of chemical changes, through conducting observations, experiments, and other scientific activities with a comprehensive view, analyzing and interpreting the results in relation to ions. In addition, reflect on the processes of inquiry.

(7) Science & Technology and humans

Through observations, experiments, and other scientific activities regarding the relationship among Science & Technology and humans, provide instruction to help students acquire the following items.

(a) While making connection with daily life or society, understand the following and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Energy and substances

i. Energy and energy resources

Through conducting observations and experiments related to various forms of energy and their conversion, discover and understand that the conversion of various forms of energy is used in daily life or society. In addition, learn that humans obtain energy from hydraulic power, thermal power, atomic energy, sunlight and others, and recognize that the efficient use of energy resources is important.

ii. Various substances and their uses

Through observations, and experiments and other scientific activities regarding substances, understand that various substances have diverse uses in daily life or society, and recognize that the efficient use of substances is important.

iii. Development of Science & Technology

Learn the process of development of Science & Technology, and recognize that Science & Technology enriches and enhances the human life.

b. Conservation of the natural environment and the use of Science & Technology

i. Conservation of the natural environment and the use of Science & Technology

Through scientific considerations on how conservation of the natural environment and the use of Science & Technology should be, recognize that building a sustainable society is important.

(b) Regarding energy and substances used in daily life or society, analyze and interpret the results, through conducting observations, experiments, and other scientific activities with a comprehensive view; based on scientific considerations, make a decision on how conservation of the natural environment and the use of Science & Technology should be.

3. Additional comments on handling the contents

(1) For Content-(1) through (7), while mutually connecting the knowledge and skills shown in (a) and the abilities to think, to make judgments, and to express oneself shown in (b), aim to develop competencies necessary to conduct scientific inquiry throughout three years of the curriculum.

(2) For Content-(1) through (7), Content-(1) and (2) are to be addressed in Grade 1, Content-(3) and (4) are to be addressed in Grade 2, and Content-(5) through (7) are to be addressed in Grade 3.

(3) With regard to Content-(1), the following items should be addressed:

(a) With regard to (a)-a.-i., total reflection should be included, and the qualitative relationships between the angle of incidence and angle of refraction in the case of refraction of light should also be mentioned. Furthermore, the fact that white light is dispersed into light of various colors by prisms should be mentioned.

(b) With regard to (a)-a.-ii., the qualitative relationships between position of the object and position and size of the image should be investigated. In the process of investigation, the idea of real images and virtual images should be addressed.

(c) With regard to (a)-a.-iii., the approximate speed at which sound travels through

the air should be mentioned.

(d) With regard to (a)-b.-i., the relationship between the magnitude of the force applied to a spring and its extension should be addressed. In addition, the difference between weight and mass should be mentioned. The newton should be used as the unit for force.

(4) With regard to Content-(2), the following items should be addressed:

(a) With regard to (a)-a.-i., the differences between organic matter and inorganic matter, and the differences between metals and nonmetals should be addressed.

(b) With regard to (2)-(a)-a.-ii., the fact that the same gas can be produced by using different methods should be mentioned.

(c) With regard to (a)-b.-i., the content should be addressed in connection with the particle model, and the mass percent concentration should also be mentioned. In addition, the solubility curve should be mentioned.

(d) With regard to (a)-c.-i., the content should be addressed in connection with the particle model. In the process, the motion of particles should also be mentioned.

(5) With regard to Content-(3), the following items should be addressed:

(a) With regard to “circuits” in (a)-a.-i., series and parallel circuits should be addressed, and two resistors should primarily be used for each kind of circuits.

(b) With regard to “electrical resistance” in (a)-a.-ii., the fact that the value of resistance differs depending on the type of matter should be addressed. The total resistance of two resistors when they are connected in a circuit should also be mentioned.

(c) With regard to (a)-a.-iii., the amount of electrical energy should be addressed, and the amount of heat energy should also be mentioned.

(d) With regard to (a)-a.-iv., the fact that electric current is related to a flow of electrons should be addressed. In addition, the properties and uses of radiation should be mentioned in connection with electric discharges in a vacuum.

(e) With regard to (a)-b.-ii., the fact that the direction of the force changes, when the direction of the electric current changes, or the direction of the magnetic field changes, should be addressed.

(f) With regard to (a)-b.-iii., the fact that the direction of the electric current changes, when the direction in which the coil or the magnet is moving changes, should be addressed.

(6) With regard to Content-(4), the following items should be addressed:

(a) With regard to (a)-a.-ii., mention the fact that “kinds of atoms that compose matter” are called atomic elements. In addition, regarding “symbols” of atomic elements, the fact that they can be represented using symbols should be mentioned, and some basic examples should be provided. The fact that many kinds of atoms exist should be mentioned by using the periodic table.

(b) With regard to “chemical formulas” and “chemical reaction formulas” in (a)-b.-i., some simple examples should be provided.

(7) With regard to “oxidation and reduction” in (a)-b.-ii., some simple examples should be provided.(7) With regard to Content-(5), the following items should be addressed:

(a) With regard to (a)-a.-i., mention the fact that pressure is exerted from all directions on an object submerged in water. Also mention the qualitative relationship between the water pressure and buoyant force on the object.

(b) With regard to (a)-b.-i., the fact that when a force is exerted on an object, the object also exerts a force in the opposite direction should be mentioned.

(c) With regard to “motion of an object when force is exerted” in (a)-b.-ii., motion of an object on a slope should primarily be addressed as the motion of a falling object. In the process, the fact that an object undergoes a free fall when the angle of the slope is 90° should be mentioned. Regarding the “change in speed of a falling object,” qualitative discussion should be addressed.

(d) With regard to (a)-c.-i., the work-energy principle should also be mentioned.

(e) With regard to (a)-c.-ii., friction should also be mentioned.

(8) With regard to Content-(6), the following items should be addressed:

(a) With regard to the “composition of atoms” in (a)-a.-i., the fact that an atoms is made of electrons and a nucleus should be addressed. In the process, the fact that the nucleus is made of protons and neutrons, and that for the same element, the atoms can have different numbers of neutrons should also be mentioned. In addition, with regard to “ions,” the fact that they are represented by chemical formulas should be mentioned.

(b) With regard to (a)-a.-ii., pH should be mentioned.

(c) With regard to (a)-a.-iii., the fact that there are salts which dissolve in water and salts which do not dissolve in water should be mentioned.

(d) With regard to “metal ions” in (a)-b.-i., basic examples should be provided.

(e) With regard to “batteries” in (a)-b.-ii., the reaction that occurs at each of the electrodes should be discussed in connection with the ion model. In the process,

the Daniell cell should be used in the discussion of the “basic structure of batteries”. In addition, typical batteries which are used in daily life and real world should also be mentioned.

(9) With regard to Content-(7), the following items should be addressed:

(a) With regard to (a)-a.-i., the ways in which heat is transmitted and radiation should also be mentioned. In addition, with regard to the “transformation of energy,” the fact that the net amount of energy is conserved should be addressed, along with efficiency when using energy.

(b) With regard to “various substances” in (a)-a.-ii., typical examples from natural substances and artificial substances should be addressed. The properties of plastic should also be mentioned.

(c) With regard to (a)-b.-i., knowledge and understanding gained in the study of Field One and Field Two should be applied, and the content should be addressed by connecting and integrating with the materials provided in (a)-b.-i. and (b) in Field Two.

[Field Two (Life and Earth Sciences)]

1. Objectives

Aim to develop students’ competencies necessary to conduct scientific inquiry into natural objects and phenomena related to life and the earth in the following ways.

(1) Through conducting observations, experiments, and other scientific activities regarding objects and phenomena related to life and the earth, understand “Structures and functions of the bodies of living organisms”, “Continuity of life”, “Composition and changes of the earth”, “Weather and its changes”, and “The Earth and space”. In addition, acquire fundamental skills for observations, experiments, and other scientific activities necessary to conduct scientific inquiry into the topics mentioned above.

(2) Through experiencing objects and phenomena related to life and the earth, develop abilities to recognize diversity, to discover regularities and to solve problems by conducting scientific inquiry activities that include generating questions, conducting observations, experiments, and other scientific activities with a comprehensive view, and at the same time analyzing and interpreting the results, and expressing them.

(3) Develop attitudes toward conducting scientific inquiry actively into objects and phenomena related to life and the earth, as well as attitudes toward respecting life

and contributing to the conservation of the natural environment, also develop holistic views on nature.

2. Contents

(1) Various living organisms and their similarities

Through observations, experiments, and other scientific activities regarding familiar living organisms, provide instruction to help students acquire the following items.

(a) While paying attention to similarities and differences between various living organisms, understand the following and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Methods for observing and classifying living organisms

i. Observation of living organisms

Through conducting observations of living organisms in the schoolyard and the surrounding area of the school, discover and understand that different living organisms live in a variety of locations, and acquire skills such as how to operate observational equipment and how to record the results of observations.

ii. Characteristics and classification methods for living organisms

Through comparing various living organisms, understand the fact that we can classify them based on found similarities and differences, and acquire the basic skills of classification methods.

b. Similarities and differences of the structures of living organisms

i. Similarities and differences of the structures of plants

Through conducting observation on the external forms of familiar plants, discover similarities and differences among them based on the observation records, and understand the fundamental structure of plants. In addition, discover and understand the fact that we can classify plants based on the similarities and differences.

ii. Similarities and differences of animal body structures

Through conducting observation on the external forms of familiar animals, discover similarities and differences among them based on the observation records, and understand the fundamental structure of animal bodies. In addition, discover and understand the fact that we can classify animals based on the similarities and differences.

(b) Regarding familiar living organisms, discover and express similarities and differences among various living organisms, as well as viewpoints and criteria for classifying them, through conducting observations, experiments, and other scientific activities.

(2) Composition and changes of the earth

Through observations, experiments, and other scientific activities regarding composition and changes of the earth, provide instruction to help students acquire the following items.

(a) While relating composition and changes of the earth to various natural objects and phenomena seen on the surface of the earth, understand the following and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Observations of familiar terrain, strata, and rocks

i. Observations of familiar terrain, strata, and rocks

Through observations of familiar terrain, strata, and rocks, understand the formation and expansion of land and its components, and acquire skills such as how to operate observational equipment and how to record results.

b. Strata and aspects from the past

i. Strata and aspects from the past

Through considering the way strata form with observation of strata appearances and their components, discover and understand regularities in how strata are formed in layers and expand, and understand the fact that we can figure out past environments and estimate geologic age by using strata and the fossils contained within them as clues.

c. Volcanos and earthquakes

i. Volcanic activity and volcanic rocks

Through investigating the shapes of volcanoes, aspects of their activities, and their volcanic products, understand them in relation to the properties of underground magma. Also, through conducting observations on volcanic rocks and plutonic rocks, understand the differences in their components in relation to the ways the rocks were formed.

ii. Propagation of earthquake waves and the movements of the Earth’s interior

Based on personal experiences and records of earthquakes, recognize the regularities in the magnitudes of tremors and how they propagate. In addition, understand the cause of earthquakes in relation to the structure of the Earth’s interior, and understand the aspects of the resulting changes on the land.

d. Prosperity brought by nature and disasters caused by volcanoes and earthquakes

i. Prosperity brought by nature and disasters caused by volcanoes and earthquakes

Trough investigating investigate how nature brings prosperity as well as volcano and earthquake bring disasters, understand them in relation to the structure of volcanic activities and the occurrence of earthquakes.

(b) Regarding composition and changes of the earth, discover and express the regularities in overlapping and expansion of strata, as well as the relationship between the properties of underground magma and forms of volcanoes, through generating questions and conducting observations, experiments, and other scientific activities with a comprehensive view.

(3) Structures and functions of the bodies of living organisms

Through observations, experiments, and other scientific activities regarding structures and functions of the bodies of living organisms, provide instruction to help students acquire the following items.

(a) While paying attention to the relationship between structures and functions of the bodies of living organisms, understand the following and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Living organisms and cells

i. Living organisms and cells

Through conducting observations of the tissues of living organisms, discover and understand that the bodies of living organisms are made of cells, and what are the characteristics of the structure of plant cells and animal cells. In addition, acquire skills such as how to operate observational equipment and how to record results.

b. Structure and functions of plants

i. Structure and functions of leaves, stems, and roots

Through conducting observations on the structure of leaves, stems, and roots of plants, understand their structures in relation to the results of experiments

concerning the mechanisms of photosynthesis, respiration, and transpiration.

c. Body structure and functions of animals

i. Functions that support life

Through conducting observations and experiments on digestion and respiration, understand the mechanisms of animal bodies for taking in and transporting necessary substances, in relation to the results of the observations and experiments. In addition, understand that their bodies have mechanisms for excreting substances which they no longer need.

ii. Stimuli and responses

Through conducting observations on aspects of the appropriate responses to external stimuli by animals, understand these mechanisms in relation to the structures of the sensory organs, nervous system, and motile organs.

(b) Regarding structures and functions of the bodies of familiar plants and animals, discover and express the regularities and relationships of structures and functions of living organisms, through designing methods for solving a problem, conducting observations, experiments, and other scientific activities with a comprehensive view, then analyzing and interpreting the results.

(4) Weather and its changes

Through observations, experiments, and other scientific activities regarding nearby weather, provide instruction to help students acquire the following items.

(a) While paying attention to the relationships between weather components and changes in weather, understand the following and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Weather observations

i. Components of weather

Understand that air temperature, humidity level, atmospheric pressure, and wind direction are components of weather. Particularly with regard to atmospheric pressure, through conducting experiments on pressure, discover and understand that pressure is related to the magnitude of a force and the area on which the force is exerted. In addition, through conducting experiments on atmospheric pressure, understand the results in relation to the weight of the air.

ii. Weather observation

Through conducting continuous weather observations in the schoolyard and other locations, discover and understand the relationship between the weather and changes in atmospheric pressure, humidity level, atmospheric pressure, and wind direction based on the observation records, and acquire skills for observation methods and recording methods.

b. Weather changes

i. Formation of fog and clouds

Through conducting observations and experiments regarding the formation of fog and clouds, understand the relationship between the formation and changes in atmospheric pressure, air temperature, and humidity level.

ii. Passing of weather fronts and weather changes

Based on the results of observed weather changes which follow the passing of weather fronts, understand changes in weather in relation to warm air and cold air.

c. Climate of Japan

i. Characteristics of weather in Japan

Through the use of weather maps and weather satellite images, understand the characteristics of weather in Japan in relation to air masses.

ii. Movement of air masses and the effects of oceans

Through investigating weather satellite images and survey records, understand climate of Japan in relation to the movement of air masses surrounding Japan and effects from oceans.

d. Prosperity brought by nature and disasters caused by weather

i. Prosperity brought by nature and disasters caused by weather

Through investigating prosperity and disasters brought by weather, understand that prosperity and disasters in relation to weather changes and climate of Japan.

(b) Regarding weather and its changes, discover and express the regularities and relationships of weather changes and Japanese climate, though designing methods for solving problems, conducting observations, experiments, and other scientific activities with a comprehensive view, then analyzing and interpreting the results.

(5) Continuity of life

Through observations, experiments, and other scientific activities regarding

continuity of life, provide instruction to help students acquire the following items.

(a) While paying attention to the characteristics of the objects and phenomena related to continuity of life, understand the following and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Growth of living organisms and how they reproduce

i. Cell division and the growth of living organisms

Through conducting observations of cell division, discover and understand the order in its process, and also understand cell division and the growth of living organisms by relating to one another.

ii. How living organisms reproduce

Through conducting observations on the way how living organisms reproduce, discover and understand characteristics of sexual and asexual reproduction, and also discover and understand the fact that traits of parents are passed on to their offspring as living organisms reproduce.

b. Genetic regularity and genes

i. Genetic regularity and genes

Based on the results from crossbreeding experiments, discover and understand regularities when traits of parents are passed on to their offspring.

c. Diversity and evolution of living organisms

i. Diversity and evolution of living organisms

Through comparing existing living organisms and fossils, in relation to the structure of their bodies, understand that diversity of existing living organisms arose as the results of the evolution of living organisms over a long period of time from the past.

(b) Regarding continuity of life, discover and express the characteristics and regularities in the growth of living organisms and the way they reproduce, hereditary phenomena, and the diversity and evolution of living organisms, through conducting observations, experiments, and other scientific activities, analyzing and interpreting the results and resources. In addition, reflect on the processes of inquiry.

(6) The Earth and space

Through observations, experiments, and other scientific activities regarding familiar celestial objects, provide instruction to help students acquire the following items.

(a) While paying attention to the characteristics concerning familiar celestial objects and their movements, understand the following and acquire skills for observations, experiments, and other scientific activities regarding those concepts.

a. Movements of celestial objects, and the rotation and revolution of the Earth

i. Diurnal motion and rotation of the Earth

Through conducting observations on the diurnal motion of celestial objects, understand the observation records in relation to the rotation of the Earth.

ii. Annual motion and revolution of the Earth

Through conducting observations on the annual motion of the constellations and the changes in the height of the Sun at the upper culmination, understand the observation records in relation to the Earth's revolution and the tilting of its axis.

b. The solar system and stars

i. Aspects of the Sun

Through conducting observations of the Sun, discover and understand the characteristics of the Sun based on the observation records and resources.

ii. Planets and stars

Based on observation data, discover and understand the characteristics of the planets and stars, and understand the structure of the solar system.

iii. Motion of the Moon and Venus and their appearances

Through conducting observations of the Moon, understand the revolution of the Moon and her appearance by relating to one another, based on observation records and resources. In addition, understand the revolution of Venus and her appearance by relating to one another, based on observation data on Venus.

(b) Regarding the Earth and space, discover and express the characteristics and regularities in the motion and appearance of celestial bodies, through conducting observations, experiments, and other scientific activities on celestial objects, analyzing and interpreting the results and resources. In addition, reflect on the processes of inquiry.

(7) Nature and humans

Through observations, experiments, and other scientific activities regarding the natural environment, provide instruction to help students acquire the following items.

(a) While making connections with daily life or society, understand the following and acquire skills for observations, experiments, and other scientific activities regarding the investigation of the natural environment.

a. Living organisms and the environment

i. Balance in the natural world

Through investigating the roles of microorganisms, understand plants, animals, and microorganisms by relating to one another in a trophic aspect, and discover and understand that living organisms continue to live by maintaining a balance within the natural world.

ii. Investigations of the natural environment, and environmental conservation

Through investigating the nearby natural environment, understand that various factors have effects on the balance of the natural world, and recognize the importance of conserving the natural environment.

iii. Natural disasters in the local area

Through investigating natural disasters in the local area in integrated ways, recognize the ways that nature and humans are connected.

b. Conservation of the natural environment and the uses of Science & Technology

i. Conservation of the natural environment and the uses of Science & Technology

Through scientific considerations on how conservation of the natural environment and the uses of Science & Technology should be, recognize that building a sustainable society is important.

(b) Through conducting observations, experiments, and other scientific activities to investigate the nearby natural environment and disasters in the local area, make a decision based on scientific considerations on how conservation of the natural environment and the use of Science & Technology should be.

3. Additional comments on handling the contents

(1) For Content-(1) through (7), while mutually connecting the knowledge and skills shown in (a) and the abilities to think, to make judgments, and to express oneself shown in (b), aim to develop competencies necessary to conduct scientific inquiry throughout three years of the curriculum.

(2) For Content-(1) through (7), Content-(1) and (2) are to be addressed in Grade 1, Content-(3) and (4) are to be addressed in Grade 2, and Content-(5) through (7) are to

be addressed in Grade 3.

(3) With regard to Content-(1), the following items should be addressed:

(a) With regard to (a)-a.-i., conduct observations of familiar living organisms. Through the use of magnifying glasses or stereo microscopes, body structures that can be seen should be primarily addressed.

(b) With regard to (a)-b.-i., through the focus on the structure of flowers, address the fact that spermatophytes can be classified into angiosperms and gymnosperms. In the process, mention that ovules become seeds. In addition, focus on the structure of leaves when addressing the fact that angiosperms can be classified into monocotyledons and dicotyledons. Also, the fact that plants that do not produce seeds produce spores should be mentioned.

(c) With regard to (a)-b.-ii., the differences between vertebrates and invertebrates should be primarily addressed. In regard to vertebrates, address the existence of backbones as the common feature of their body structure using humans and fish as examples. In addition, address the fact that classification is possible based on their characteristics such as the way of the outer layer covering the body and the breathing method. In regard to invertebrates, conduct observations of arthropods and mollusks, compare those animals with the characteristics of body structure of vertebrates, and address their similarities and differences.

(4) With regard to Content-(2), the following items should be addressed:

(a) With regard to “observations of familiar terrain, strata, and rocks” in (a)-a.-i., conduct activities for observations of terrain, strata, and rocks in and outside the school.

(b) With regard to (a)-b.-i., typical sedimentary rocks that form strata should be addressed. In addition, mention dislocation and geologic folds in regard to “strata.” Address facies fossils and index fossils in regard to “fossils.” For demarcating geologic age, mention the Paleozoic Era, the Mesozoic Era, and the Cenozoic Era.

(c) With regard to “volcanos” in (a)-c.-i., provide examples of volcanos in connection with viscosity of the lava. Address viscosity in regard to the “properties of magma.” Provide examples of rocks in regard to “volcanic rock” and “plutonic rock.” In addition, provide examples of rock-forming minerals.

(d) With regard to “earthquakes” in (a)-c.-ii., primarily address the phenomenological aspects of earthquakes, and mention the qualitative relationship between the duration of preliminary tremors and the distance to the epicenter from the

observation point. In addition, in regard to “structure of the Earth’s interior,” primarily address the movement of the plates near Japan, and mention the movements of the plates on a global scale. Also mention the mechanism how tsunami occurs.

(e) With regard to “disasters caused by volcanoes and earthquakes” in (a)-d.-i., investigate them using records and resources.

(5) With regard to Content-(3), the following items should be addressed:

(a) With regard to (a)-a.-i., mention similarities and differences between the cellular structures of plants and animals. Also mention cellular respiration and the existence of single-celled organisms.

(b) With regard to (a)-b.-i., mention the functions of chloroplasts for photosynthesis. In addition, address the mutual relationship of the functions of leaves, stems, and roots.

(c) With regard to (a)-c.-i., the functions of each organ should primarily be addressed. Address the functions of typical digestive enzymes in regard to “digestion.” In addition, mention the fact that consumed food turns into substances which are absorbed from the wall of the small intestine through the process of digestion. In relation to blood circulation, the functions of the components of blood and those of the kidneys and liver should also be mentioned.

(d) With regard to (a)-c.-ii., the functions of each organ should primarily be addressed.

(6) With regard to Content-(4), the following items should be addressed:

(a) With regard to “atmospheric pressure” in (a)-a.-i., mention the fact that pressure is exerted from all directions on objects in the atmosphere.

(b) With regard to (a)-b.-i., the fact that changes in the volume of saturated water vapor caused by the change in air temperature are related to the changes in humidity and condensation of water vapor should be addressed. The hydrologic water cycle should also be mentioned.

(c) With regard to (a)-b.-ii., the ways how wind blows should also be mentioned.

(d) With regard to (a)-c.-ii., the movements of the atmosphere surrounding the Earth as well as the size of the Earth and the thickness of the atmosphere should also be mentioned.

(e) With regard to “disasters caused by weather” in (a)-d.-i., investigate them using records and resources.

(7) With regard to Content-(5), the following items should be addressed:

(a) With regard to (a)-a.-i., the fact that chromosomes are replicated should be mentioned.

(b) With regard to (a)-a.-ii., mechanisms for sexual reproduction should be addressed in relation to meiosis. For “asexual reproduction,” cell division of single-celled organisms and vegetative reproduction should also be mentioned.

(c) With regard to (a)-b.-i., the law of segregation should be addressed. In addition, the fact that the actual substance of genes is DNA should be mentioned.

(d) With regard to (a)-c.-i., phenomena that serve as evidence of evolution and concrete examples of evolution should be provided. In the process, it should be mentioned that beneficial traits can be seen in living organisms that suit their life in the environment they inhabit. In addition, the fact that changes in genes can alter traits should be mentioned.

(8) With regard to Content-(6), the following items should be addressed:

(a) With regard to the “changes in the height of the Sun at the upper culmination” in (a)-a.-ii, the seasonal changes in the length of day and night as well as changes in the air temperature should also be mentioned.

(b) With regard to the “characteristics of the Sun” in (a)-b.-i., its shape, size and the appearance of its surface should be addressed. In the process, the effects of the large amount of light and energy emitted from the Sun on the surface of the Earth, should also be mentioned.

(c) With regard to the “planets” in (a)-b.-ii., their size, atmospheric composition, surface temperature and the presence of satellites should be addressed. In the process, the fact that the Earth is furnished with the conditions to support life should also be mentioned. For the “stars,” the fact that they emit their own light, and that the Sun is one of such stars should be addressed. In the process, the existence of the galactic system as a collection of stars should also be mentioned. With regard to the “structure of the solar system,” the fact that celestial objects other than planets exist should also be mentioned.

(d) With regard to the “motion of the Moon and her appearance” in (a)-b.-iii., the motion and phases of the Moon should be addressed. In the process, solar and lunar eclipses should also be mentioned. In addition, in regard to the “revolution of Venus and her appearance,” Venus’ motion, phases, and apparent size of Venus should be addressed.

(9) With regard to Content-(7), the following items should be addressed:

(a) With regard to (a)-a.-i., the relationship between producers and consumers in ecosystems should be addressed. The function of decomposers should also be addressed. In the process, soil animals should also be mentioned.

(b) With regard to (a)-a.-ii., activities should be conducted to investigate living organisms and natural environments such as atmosphere and water through actual observations, as well as through the use of records and resources. Climate change and nonnative living organisms should also be mentioned.

(c) With regard to (a)-a.-iii., activities should be conducted to investigate regional natural disasters, as well as activities to investigate records and resources.

(d) With regard to (a)-b.-i., knowledge and understanding gained in the study of Field One and Field Two should be applied, and the content should be addressed by connecting and integrating with the materials provided in (a)-b.-i. and (b) in Field One.

III. SYLLABUS DESIGN AND ADDITIONAL COMMENTS ON HANDLING THE CONTENTS

1. In designing the syllabus, the following should be considered:

(1) By overseeing the whole picture of contents and times in the units, provide instructions for realization of proactive, interactive, and authentic learning of the pupils in order to develop competencies that are focused on those units. When doing this, based on the characteristics of learning process in school science, enhance learning activities to conduct scientific inquiry such as observations and experiments with a comprehensive vision, using discipline-based epistemological approaches of science.

(2) In each grade, roughly the same amount of school hours should be allocated to each field throughout the year. In the process, due consideration should be given to the connections between each field and between each item, so that the discipline-based epistemological approach that is characteristic to each field can be comprehensively utilized, and competencies necessary to conduct scientific inquiry into natural objects and phenomena can be developed.

(3) Depending on the situations of the schools and students, sufficient time for observations, experiments, and other scientific activities as well as sufficient time for conducting inquiry to solve problems should be provided. In the process, there should be enriched learning activities for students to generate questions, to plan observations

and experiments, to analyze data and interpret the results from observations and experiments, and to think and explain the results through the use of scientific concepts.

(4) Make connections with daily life and other subjects.

(5) For students with disabilities or special needs, devise instructional contents and methods in a planned and organized manner which are tailed to difficulties that can occur while doing learning activities.

(6) Based on the objectives of moral education listed in Subsection I. 2 (2) of Chapter 1 “General Provisions”, treat appropriately the content listed in Subsection II. of Chapter 3 “Special Subject Morality” in accordance with the characteristics of school science, considering the relationship to the subject of Morality.

2. In handling the content from Field 2, the following should be considered:

(1) Emphasis should be placed on observations, experiments, and field observations, and the circumstances of the regional environment and school setting should be utilized in order to help students develop fundamental concepts regarding natural objects and phenomena, and abilities and positive attitudes to conduct scientific inquiry, through step-by-step manners without forcing them.

(2) Develop attitudes toward respecting life and contributing to the conservation of the natural environment.

(3) Through learning activities outlined in 1-(3), language activities should be emphasized.

(4) In the process of providing instruction in each field, there should be active and appropriate use of tools like computers and information and communication networks in areas such as searching for information in the course of observations and experiments, conducting experiments, data processing and experimental measurements.

(5) Instructional guidance should be provided systematically to students in order to help them plan their learning activities and reflect on their learning.

(6) Hands-on activities of making things in order to deepen understanding of principles and laws of science should be incorporated appropriately according to the characteristics of the contents.

(7) Continuous observations and fixed-point observations of the changing of the seasons should be incorporated appropriately according to the characteristics of the contents.

(8) There should be considerations for enhancing experience-based learning activities such as observations, experiments, and field observations. There should also be sufficient considerations of improving the learning environment.

(9) Active coordination and cooperation should be undertaken with museums, science learning centers, and other such organizations.

(10) It should be mentioned that Science & Technology enriches our daily lives or society, and serve to improve safety. In addition, it should be mentioned that knowledge and understanding gained in science lessons is related to various different occupations.

3. For the instruction on observations, experiments, and field observations, sufficient care should be given to accident prevention measures. In particular; considerations should be given to ensuring that appropriate measures are taken with regard to the management and disposal of the chemicals that are used.